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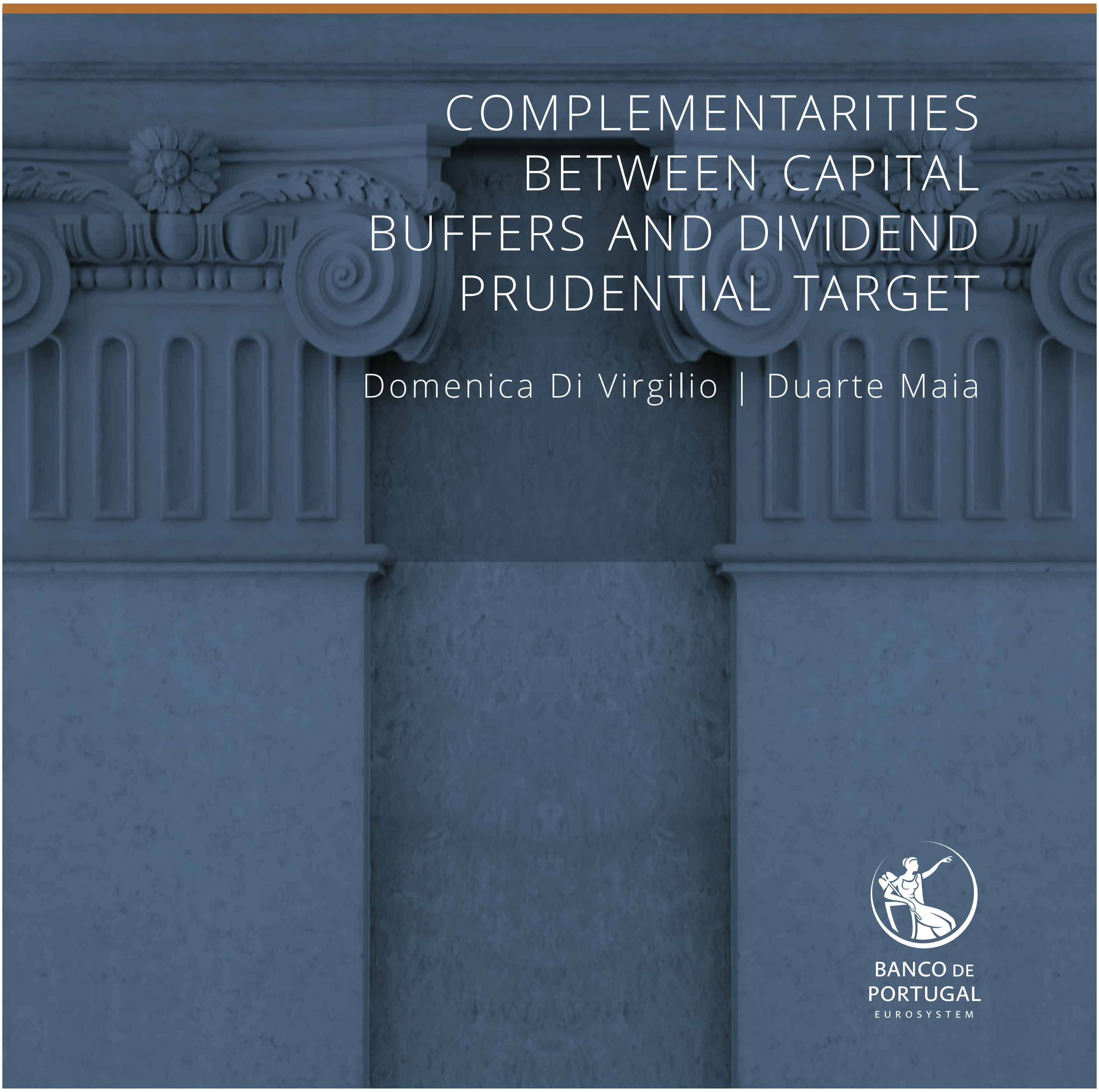

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Complementarities between capital buffers and dividend prudential target

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Abstract
In this paper, the authors introduce a dividend prudential target rule (DPT) à la Muñoz (2021) in a DSGE model, by Clerc *et al.* (2015), where banks can default, and extend the model by introducing bankers' preference for dividend smoothing. Both versions of the model - the original by Clerc *et al.* (2015) and the extension to banker dividend smoothing – shed light on the same transmission channels of the DPT. However, the results are quantitatively more pronounced in the extended version. The results show the beneficial impact of the DPT on bank resilience and in mitigating the credit downturn and supporting the economic recovery in response to shocks, originating either from the financial system or from the real economy. Moreover, the paper shows the existence of complementarities between the DPT and the countercyclical capital buffer (CCyB) in smoothing the credit cycle and in improving the social welfare. Compared to the original version of the model, in presence of the more realistic assumption of bankers' preference for dividend smoothing the benefits of the synergy between the CCyB and the DPT rule appear to be bigger.

JEL: C53, G21, G28

Keywords: Macroprudential policy, general equilibrium, DSGE modelling, Portugal, Slovenia.

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Disclaimer: the views expressed in this paper are those of the authors and should not be taken as the views of the Banco de Portugal, the Banka Slovenije and the Eurosystem.

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1. Introduction

Examining the historical perspective of banks' dividend behavior provides critical insights into the evolution of dividend policies and their implications within the banking sector. Banks' dividend practices have been shaped by a confluence of economic conditions, regulatory changes, market expectations, and the intrinsic nature of the banking business. Understanding this historical context sheds light on the factors influencing dividend decisions and their impact on banks and the broader financial landscape.

Throughout history, banks have demonstrated a tendency to maintain stable dividend payouts consistent with shareholders' expectations, a phenomenon commonly known as "dividend smoothing". The concept of dividend smoothing, a practice of maintaining stable dividend payments over time, has been studied extensively in financial literature. It involves the tendency of banks to moderate changes in dividends, ensuring a relatively constant or gradually changing level of dividend payouts, even in the face of fluctuations in earnings or economic conditions and profitability prospect.

The phenomenon of dividend smoothing in banking is driven by several factors. Firstly, it serves as a signal of financial stability, helping banks maintain a stable and reliable image for both depositors and investors. Secondly, market expectations often favor predictability in dividends, and banks may align with these expectations to bolster market confidence. Thirdly, dividend smoothing can align the interests of stakeholders, reducing conflicts among management, shareholders, and debt holders by providing a stable income stream to shareholders and demonstrating prudent financial management to debt holders. Lastly, it helps mitigate information asymmetry, as maintaining a stable dividend policy can reduce uncertainty about the company's financial condition, potentially lowering the cost of capital.

Considering the significant disruptions and uncertainties brought about by the COVID-19 pandemic, the European Central Bank – Banking Supervion (ECB-SSM), as the supervisory authority overseeing the eurozone's banking sector, took a proactive stance to safeguard financial stability. This included, first, a temporary relaxation of the requirements regarding the Pillar 2 Guidance (P2G) and the Combined Buffer Requirement (CBR) and issuing, later, a recommendation concerning banks' dividend distribution policies –not to pay dividends and refrain from buying back shares–, marking a crucial intervention to maintain the sector's resilience in the face of economic turbulence.

Macroprudential restrictions on bank dividends limit banks' autonomy and can lead to unintended consequences. Literature demonstrates that the ECB's recent recommendation for banks to refrain from paying dividends or buying back shares has a causal negative impact on share prices, which affects banks' market values and delays investor cash flows by increasing uncertainty over future distributions (Andreeva *et al.* 2023). Restricting dividend payouts also raises funding costs, as mutual funds tend to reduce their ownership in banks, reflecting a positive relationship between fund ownership and banks' dividend yields, underscoring the importance of dividends for European bank investors (Mücke 2023; Cáceres and Lamas 2023). However, clear communication about the rationale and duration of these restrictions may alleviate this effect, resulting in a negative but moderate and temporary impact on bank stock prices, as observed during the ECB's system-wide dividend recommendation (Ampudia *et al.* 2023). Despite unintended effects on bank value and funding costs, the restriction on dividends has had a positive effect on credit supply (Sanders *et al.* 2024). In addition, suspending dividends early is justified to maintain financial system stability by preventing negative spillovers from weakened banks to the broader system. While it limits shareholder autonomy, banking has long accepted reduced autonomy when externalities affect systemic stability (Acharya *et al.* 2011).

The ECB's stance on dividend distribution represents a crucial facet of its broader efforts to ensure the stability and health of the banking industry. The guidance issued by the ECB sought to address the immediate challenges faced by banks during an unprecedented crisis, balancing the imperative of preserving capital buffers to withstand economic shocks while ensuring the continued flow of credit to support businesses and households.

The specifics of the recommendation included temporary constraints on dividend payouts and share buybacks, urging banks to withhold dividend payments and exercise prudence regarding variable remuneration. This approach aimed to reinforce the resilience of banks by bolstering their capital positions and preserving resources to support lending activities, thus contributing to the broader efforts of economic recovery and financial stability.

The relationship between dividend restrictions and the usability of buffers during the COVID-19 pandemic period highlights the dynamic nature of banking regulations. The restrictions on dividends acted as a short-term measure to ensure capital conservation, while the availability of capital buffers offered a mechanism for banks to navigate the crisis and continue their critical role in providing credit to support economic activities.

This interplay underscores the importance of a balanced regulatory approach. While limiting dividends preserved capital, the usability of buffers provided a means for banks to maintain their lending capacities, supporting the broader economic recovery efforts during a time of immense stress and uncertainty. The strategic use of these regulatory tools showcased the adaptability and effectiveness of the regulatory framework in responding to and mitigating the impact of a global crisis on the banking sector.

In this context, Muñoz (2021) put forward an original macroprudential rule for bank dividend payouts. The dividend prudential target (DPT), as defined by Muñoz, reacts to deviations of a macroeconomic indicator of the choice of the regulator from its steady-state. Deviations from the DPT are penalized by a sanction regime. While banks are allowed to deviate from the DPT conditional on the payment of a sanction, the penalty gives incentives for bankers to tolerate a higher degree of dividend volatility in order to sustain retained earnings and loan supply in economic downturns. The study by Ampudia *et al.* (2023) builds on Muñoz (2021) to model, in a similar environment, the system-wide dividend restrictions as a rule according to which the authority activates these restrictions if and only if the cyclical position of the economy falls below a given threshold.

However, the general equilibrium model used in these studies do not account for borrower or bank default. The absence of default in the model has two consequences. First, their analysis does not capture the transmission channel which relates to the positive effect of the dividend restrictions on bank resilience. Second, the effect of the dividend restrictions on credit might be overestimated, as the model does not capture the fact that banks might still be reluctant to lend, because of the credit risk.

The aim of the present paper is to assess the transmission of the DPT measure in the short and long term within a general equilibrium model that allows for borrower default and bank default. Specifically, we use the dynamic stochastic general equilibrium (DSGE) model by Clerc *et al.* (2015), that we extend by introducing bankers' preference for dividend smoothing. We perform a welfare analysis and impulse response function analysis in the model calibrated for Portugal and Slovenia. The model captures sufficiently well many relevant features of the country-specific macroeconomic and financial system. Portugal and Slovenia differ in key features of their banking systems that are critical for the transmission of the DPT measure. Although having such a rich model featuring several frictions makes it difficult to disentangle the different channels of the passthrough of shocks and policies, it allows to investigate more thoroughly the impact of the policies on the financial system resilience and the interaction with borrowers leverage and associated credit risk.

The main contribution of this paper is the consideration of mechanisms and relevant aspects of the transmission of the DPT and its interaction with the CCyB which are not visible in prior studies, such as Muñoz (2021) and Ampudia *et al.* (2023). This is achieved thanks to the presence of credit risk and bank default risk and by calibrating the model to two distinct economies with different values of certain key structural parameters. By accounting for default among banks, impatient households and entrepreneurs we can evaluate how the considered macroprudential measures affect the banking system resilience. Moreover, we offer a more detailed study of the effects and transmission of different degrees of enforcement of the DPT rule than the one presented in Ampudia *et al.* (2023).

Three main transmission channels of the DPT measure are discussed. The first channel is strengthening of bank resilience through increased retained earnings, an effect not observed in previous studies due to the absence of default risk. As expected, this effect appears to be more pronounced in banking systems with lower capitalization.

The second channel relates to the possibility that the higher retained earnings are used to smooth the credit downturn. Smoothing the credit downturn has two opposite effects. On the one hand, it helps the economic recovery. On the other hand, banks remain exposed to the risk embedded in the loans that they roll over. Therefore, we expect that the DPT measure is more effective at smoothing the credit downturn in banking systems with lower exposure to credit risk. This aspect, which was not evident in prior studies, emerges from the comparison of two economies.

The third transmission channel consists in a redistributive effect from patient households, who are the beneficiaries of bank dividends, to impatient households and companies, which benefit from the rollover of the loans. The redistributive effect of the DPT is not captured in models with a single household type, as seen in previous literature.

Results mostly show that the higher the responsiveness of the CCyB to the credit cycle and the stronger the bankers' preference for dividend smoothing, the bigger the welfare gain associated with a higher responsiveness to the credit cycle and higher degrees of enforcement of the DPT rule. The reason is connected to the positive effect of the DPT in preserving bank capital, thus enhancing bank resilience and helping smooth the credit cycle. However, certain aspects of the transmission mechanisms might affect in opposite way the behavior of banks and the welfare, as shown by an analysis of different combinations of key parameters and by the impulse response function analysis.

In particular, we document a positive effect of a CCyB release in smoothing the downturn in mortgage and corporate loans, in response to both a temporary productivity shock and a financial shock that increases the riskiness of bank assets. However, the induced higher leverage in the economy implies an increase in bank default and in the deposit risk premium. Therefore, if the capital release persists for too long, the higher cost of external funding for banks leads to a tightening of credit conditions, resulting in a contraction in loans, consumption, investment and GDP.

The DPT measure helps offsetting the aforementioned backfiring effects of the CCyB release. In fact, the retained earnings can be used partially to support the flow of credit and partially to boost the bank capital, thus enhancing the bank resilience. Our simulations for two economies, which differ in key structural parameters, shed light on crucial aspects of the transmission mechanisms of the DPT. First, the positive effect of the DPT on bank resilience is bigger in the case of a lower level of bank capitalization. Second, the impact of the DPT on smoothing the credit cycle is smaller for a banking system with higher exposure to credit risk.

The rest of the paper is organized as follows. Section 2 connects the paper with the related literature. Section 3 describes the main features of the reference model by Clerc *et al.* (2015), shows how we introduce the bankers' preference for dividend smoothing and the DPT and it presents an assessment of bankers potential response to the DPT rule. Section 4 presents the calibration of the model to Portugal and Slovenia, highlighting the key differences for which it is worth to replicate the analysis for the two selected calibrations. In Section 5, we describe the conducted welfare analysis, which addresses the effects of the DPT and its interplay with the CCyB in the long run (in steady-state). In Section 6, we discuss more in detail the transmission of the CCyB release and the DPT and their interaction, by means of the impulse response function analysis. Section 7 offers concluding remarks.

2. Related literature

This paper relates to the studies that attempts to justify the policy proposals for regulating earnings distributions under certain conditions. Based on U.S. banking data for the period 2007-09, Acharya *et al.* (2011) suggest the imposition of regulatory restrictions on dividend payments that erode common equity. Admati *et al.* (2013) propose dividend restrictions in crisis periods and in transition to higher capital requirements. Goodhart *et al.* (2010) and Acharya *et al.* (2017) provide theoretical rationales for the use of dividend restrictions for banks under various circumstances.

Several studies have been conducted to assess the implications of the prudential measures taken to contain the impact of the COVID-19 pandemic on the economy, in particular capital flexibility measures and dividend payment restrictions for banks. The adopted capital flexibility measures include capital buffer releases and capital buffer use, while the restrictions on dividends resemble the dividend prudential target rule proposed by Muñoz (2021) and the system-wide dividend restrictions examined in Ampudia *et al.* (2023).

Empirical analyses conducted at the ECB[1] 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. Martínez-Miera and Vegas (2021) assessed the impact of the dividend distribution restriction on the flow of credit to non-financial corporations (NFC) in Spain. According to the results therein, the dividend restrictions appear to have had significantly positive and economically relevant effects on lending.[2].

The present paper differs from the aforementioned studies, as it relies on a structural model, namely a DSGE model, while the latter are based on an empirical approach (panel regression). The former allows 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 study relates more closely to Muñoz (2021), who incorporates in a DSGE model, with a banking sector, a prudential rule on bank dividend payouts, and to Ampudia *et al.* (2023), who extend the analysis to regime-dependent dividend restrictions, in a similar environment. It also connects to De Lorenzo Buratta *et al.* (2023) and Di Virgilio (2023), who introduce the dividend restriction measure in the model by Clerc *et al.* (2015), as an unexpected policy shock that

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[1]See Dautović *et al.* (2021).

[2]Similar findings are documented in the empirical analysis in Ampudia *et al.* (2023)

temporarily reduces the bank dividend-to-wealth ratio to zero on impact, followed by a recovery.[3] While this approach makes it possible to perform impulse response function analysis, it does not allow to make an assessment of the long run impact of the dividend restriction measure in steady-state.

By incorporating dividend restrictions as a policy rule, following Muñoz (2021), and extending the model of Clerc *et al.* (2015) to include bankers' preference for dividend smoothing, this paper provides a more comprehensive evaluation of the dividend measure. Compared to De Lorenzo Buratta *et al.* (2023) and Di Virgilio (2023), it assesses both impulse response functions and long-run steady-state effects. The absence of dividend smoothing in the models used in these studies may lead to differences in the estimated impact of dividend restrictions.

Furthermore, the aforementioned model by Muñoz does not contemplate 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, this paper, along with previous studies, examines the transmission of countercyclical capital buffer release and/or capital buffer use and their interaction with dividend measures across different shocks. The findings confirm the effectiveness of these macroprudential tools in smoothing the credit cycle and supporting economic recovery. Additionally, the results highlight the complementarity between capital buffer release/use and dividend restrictions, particularly in response to financial shocks.

3. The model

3.1. The reference model by Clerc et al. *(2015)*

Our analysis is carried out within the model presented by Clerc *et al.* (2015) – henceforth the 3D model. The model incorporates financial intermediaries and three layers of default –which captures the dynamics of financial distress and default risk in a multi-layered financial system– into a standard DSGE framework, but devoid of nominal and real rigidities. It also introduces risk of default for banks, non-financial corporations and households. The model incorporates two distinct types of distortions that provide a rationale for capital regulation: limited liability of banks and bank funding cost externalities, which can incentivize excessive risk-taking by banks.

[3] A summary of the analysis in Di Virgilio (2023) appeared in the Financial Stability Review of Banka Slovenije, April 2021. A similar analysis of the dividend restriction measure in Portugal, based on the same approach, appeared in the Financial Stability Report of Banco de Portugal, June 2021.

Figure 1 provides a concise overview of the primary connections among economic actors within the 3D model. The model comprises six types of representative agents: patient households, impatient households, entrepreneurs of non-financial corporations, banks, bankers and the macroprudential authority. Banks play a pivotal role in the model as intermediaries, financing their loans through equity (provided by bankers) and deposits (supplied by patient households). It is assumed the existence of two classes of banks, denoted as H and F, each specialized in providing mortgage loans to impatient households and offering corporate loans to entrepreneurs, respectively. Deposits are insured by a deposit insurance agency that is funded by lump-sum taxes paid by both patient and impatient households. However, in the event of a bank default, depositors incur certain verification costs. This feature establishes a connection between bank risk and banks' funding costs.

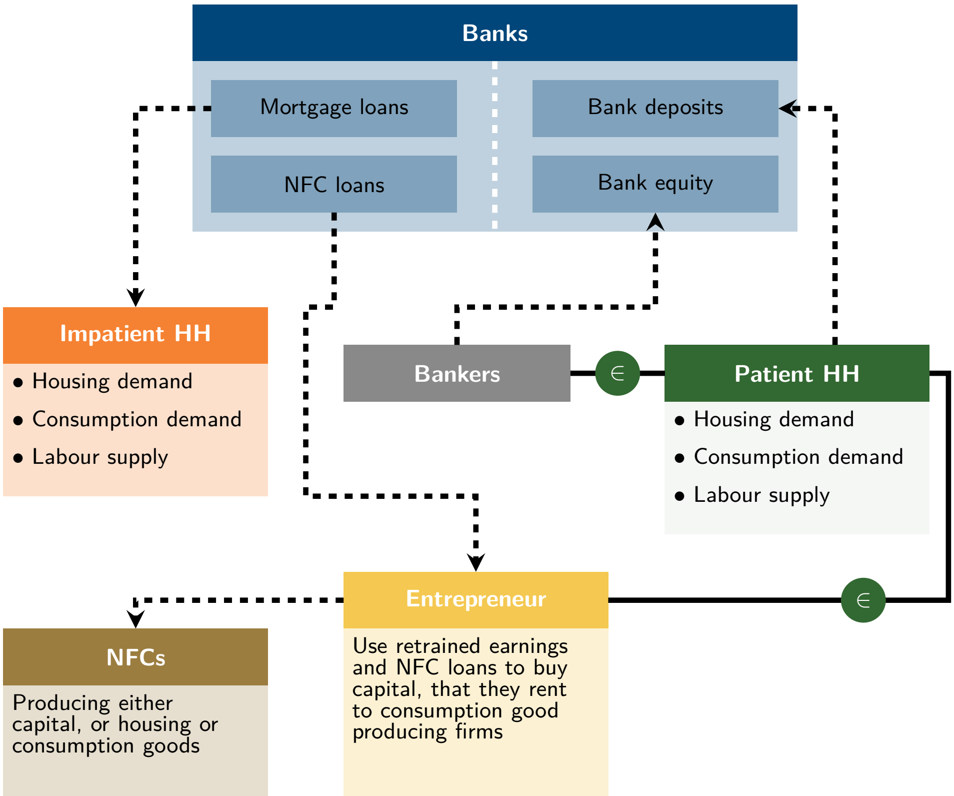


Figure 1: Schematic view of the 3D model by Clerc *et al.* (2015).

Moreover, the model posits that depositors lack the ability to discern individual bank-specific risk exposures; instead, they can only gauge the overall risk level of the banking system as a whole. Consequently, the deposit risk premium is based on the system-wide probability of default, thus creating an environment where banks are incentivized to engage in overly risky behavior. Higher capital ratios, however, act as a constraint on credit supply by reducing the inducements for banks to leverage themselves excessively. Simultaneously, higher capital ratios curtail the expenses tied to transaction costs in the event of a bank failure, despite the presence of deposit insurance, thereby reducing the cost of credit. The net effect hinges on which of the two channels dominates.

Furthermore, a trade-off arises between the welfare of patient and impatient households. In the long-run, patient households reap the advantages of stricter capital regulation, as it diminishes the likelihood of bank failures, thereby ensuring the safety of bank deposits. Conversely, capital ratios exceeding a specific threshold impose a burden on impatient households, by constraining the credit supply. The existence of this trade-off makes an optimal level of capital ratio emerge.

In essence, the model features allow for the study of macroeconomic implications of the interactions between the different layers of default, and the influence of financial distress on the broader economy. Default events, where an economic agent is unable to meet its financial obligations, can occur endogenously within the model, and those events can trigger contagion effects, affecting other agents and propagating throughout the financial system. Capital regulation serves as a pivotal policy instrument within the model, playing a central role in upholding financial stability. As a result, Clerc *et al.* (2015) model stands as a valuable instrument for comprehending the interplay between capital regulation, banking behavior, systemic risk, and the dynamics of the macroeconomy in a multi layered financial system.[4]

3.2. Expanding the 3D model to incorporate bankers' preference for dividend smoothing

The 3D model presented in Clerc *et al.* (2015) operates under the assumption that a constant portion of bankers' net worth is distributed as dividends. Consequently, fluctuations in dividends mirror changes in bankers' net worth.

Within this model, bankers decide how to allocate the realized profit between retained earnings (n^b_{t+1}) and dividend (c^b_{t+1}). The optimization problem that the bankers encounter can be summarized as follows:

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

$$\text{subject to}$$

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

where W^b_{t+1} is the net worth of bankers at *t+1*, and $\chi^b \in (0,1)$ sets a bankers (invariant) preference between retaining earnings and distribute dividends to patient households.

[4] For a detailed description of the model see the original Clerc *et al.* (2015) paper.

Empirical evidence from the literature indicates that corporations often increase the proportion of profits distributed as dividends to shareholders during stress events to maintain a smoother dividends distribution (see, e.g., Lintner 1956; Allen and Michaely 2003; DeAngelo *et al.* 2009; Shin 2016). This pattern is also observed in banks (see, e.g., Floyd *et al.* 2015; Acharya *et al.* 2017; Koussis and Makrominas 2019).

Operating under the assumption that bankers prioritize the smoothing of dividends distribution over time, we incorporate a cost that they bear when they deviate from the objective of maintaining dividends distribution at the steady-state level. Following Jerman and Quadrini (2012) and Begenau (2020), we assume quadratic dividend adjustment costs, which impact bankers' net worth and are structured as follows:[5]

$$T_B(c^b_{t+1}) = \frac{\kappa^B}{2}\left(c^b_{t+1} - \bar{c}^b\right)^2, \tag{2}$$

where κ^B quantifies the extent to which bankers prioritize dividend smoothing, while $\bar{c}^b$ represents the level of dividends distribution in the steady-state equilibrium. Based on this assumption, the constraint (1b) becomes:

$$c^b_{t+1} + n^b_{t+1} \leq \widehat{W}^b_{t+1} \equiv W^b_{t+1} - T_B\left(c^b_{t+1}\right), \tag{3}$$

Therefore, the problem solved by bankers to decide the amount of dividend payment and of retained earning is represented by equations (1a), (2)-(3). The above described extension of the 3D model to include the bankers' preference for dividend smoothing represents the baseline scenario against which we will assess the impact of the DPT rule. In section 3.3 we explain how we introduce the DPT rule in this extended version of the 3D model.

3.3. Introducing the Dividend Prudential Target

The extension of the 3D model in Clerc *et al.* (2015) to the case of bankers' preference for dividend smoothing, introduced in section 3.2, establishes a robust framework to explore the effects of dividend restrictions on both financial stability and economic growth.

Upon the introduction of a Dividend Prudential Target inspired by Muñoz (2021), the constraint of the aforementioned problem undergoes a transformation. The change is driven by the penalty that the macroprudential authority imposes

[5]In accordance with the literature, the expenses linked to the strategy of maintaining stable dividends can be diverse and encompass (but are not restricted to): (i) opportunity cost, where banks might pass up opportunities to invest in potentially more lucrative ventures. Funds earmarked for dividend payments could otherwise be directed toward growth, acquisitions, or other strategic initiatives; (ii) diminished adaptability when it comes to reacting to shifts in economic conditions; and (iii) in the long run, abstaining from potential investments in favor of dividend smoothing can impede a bank's prospects for sustained growth and profitability.

on the bankers if the distributed dividend deviates from the level stipulated by the macroprudential authority. As a result, the constraint outlined in (3) becomes:

$$c_{t+1}^{b} + n_{t+1}^{b} \leq \widehat{\widehat{W}}_{t+1}^{b} \equiv W_{t+1}^{b} - T_B\left(c_{t+1}^{b}\right) - T_P(c_{t+1}^{b}, c_{t+1}^{b,*}), \tag{4}$$

$$T_P(c_{t+1}^{b}, c_{t+1}^{b,*}) = \frac{\kappa^P}{2}\left(c_{t+1}^{b} - c_{t+1}^{b,*}\right)^2, \tag{5}$$

where $c_{t+1}^{b,*}$ denotes the permissible dividend distribution level in accordance with the Dividend Prudential Target, and $T_P(c_{t+1}^{b})$ stands for the sanction imposed for straying from the dividend prudential target.

The Dividend Prudential Target (DPT) rule is specified as follows:

$$\chi_t^{b,*} = \rho_c + \rho_x\left(\frac{x_t}{x_{ss}} - 1\right) \tag{6}$$

$$c_{t+1}^{b,*} = \chi_t^{b,*} W_{t+1}^{b} \tag{7}$$

According to the dividend prudential rule, bank dividends are expected to vary in response to the fluctuations of a macroprudential indicator, denoted as x_t, chosen by the regulator from its stable equilibrium level, represented as x_{ss}. The choice of x_t relates to indicators who may signal potential weakening of the financial system resilience, or building up of financial vulnerabilities, and to avoid transfers from depositors to equity holders. Variables, such as the credit-to-GDP ratio or total credit, might be employed if the policymakers are apprehensive about banks' deleveraging during stress events. Considering the DPT rule's role as a macroprudential tool, the objective of smoothing the credit cycle, and the aim of evaluating its connection and interaction with a countercyclical capital buffer, we adopt total credit as our macroprudential indicator.

Moreover, ρ_c represents the level of the bank dividend-to-wealth ratio in equilibrium. Given that ρ_c is precisely the steady-state value of the bank dividend-to-wealth ratio, we set this parameter equal to the dividend payout parameter χ^b, established for bankers in the 3D model as presented by Clerc *et al.* (2015). The parameter ρ_x determines how the Dividend Prudential Target reacts to changes in the chosen macroeconomic indicator. Its setting may be guided by optimization criteria, including the minimization of volatility in a specific variable of interest or maximization of certain measures of social welfare.

Solving bankers' problem

Within the 3D model, bankers engage in a two-step decision-making process. In the first stage, they determine the allocation of capital between the two types of banks (bank activity), involved in either mortgage loans or corporate loans. This allocation is made under the assumption that the expected profits from both types of bank activity are equal; otherwise, only one type of bank activity would exist.

In an effort to control the disbursal of dividends during tumultuous periods affecting the banking sector, while acknowledging the pivotal role of the banking industry in supplying credit to the economy, we introduce two countervailing influences. These influences come into play in the second stage as bankers make decisions on the most advantageous allocation of net worth between distributing dividends and retaining earnings. The regulatory decision, which curtails dividend disbursements in times of stress, is designed to bolster the banks' capitalization by accumulating retained earnings, which can be used for lending or cushioning against losses. As a result, this policy prompts bankers to deviate further from the equilibrium level of dividend distribution. This gives rise to a new maximization problem for bankers, which reads as follows:

$$\underset{c^b_{t+1}, n^b_{t+1}}{\text{maximize}} \quad \left(c^b_{t+1}\right)^{\chi^b} \left(n^b_{t+1}\right)^{1-\chi^b} \tag{8a}$$

subject to

$$c^b_{t+1} + n^b_{t+1} \leq W^b_{t+1} - T_B\left(c^b_{t+1}\right) - T_P\left(c^b_{t+1}, c^{b,*}_{t+1}\right), \tag{8b}$$

$$T_B(c^b_{t+1}) = \frac{\kappa^B}{2}\left(c^b_{t+1} - \bar{c}^b\right)^2, \tag{8c}$$

$$T_P(c^b_{t+1}, c^{b,*}_{t+1}) = \frac{\kappa^P}{2}\left(c^b_{t+1} - c^{b,*}_{t+1}\right)^2 \tag{8d}$$

It is important to note, by contrasting equation (8c) with (8d), that the DPT rule calls for more volatile bank dividends and a relatively more stable dividend payout ratio over the cycle than in the baseline scenario, characterized by bankers' preference for dividend smoothing and absence of the DPT rule. By solving the bankers' optimization problem described in equations (8a)-(8d), we derive the following optimal conditions for the "earnings retention" rule:

$$n^b_{t+1} = \frac{\left(1-\chi^b\right)\left(1+\Sigma^T_{t+1}\right)}{\chi^b + \left(1-\chi^b\right)\left(1+\Sigma^T_{t+1}\right)} \widehat{\widehat{W}}^b_{t+1} \tag{9}$$

and the "dividend distribution" rule:

$$c^b_{t+1} = \frac{\chi^b}{\chi^b + \left(1-\chi^b\right)\left(1+\Sigma^T_{t+1}\right)} \widehat{\widehat{W}}^b_{t+1}. \tag{10}$$

where $\Sigma^T_{t+1} = \kappa^P\left(c^b_{t+1} - c^{b,*}_{t+1}\right) + \kappa^B\left(c^b_{t+1} - \bar{c}^b\right)$ is the cumulative marginal costs incurred by bankers due to deviations from both the equilibrium level of dividend distribution and the target set by the DPT rule. χ^b represents the dividend-to-wealth ratio in the 3D model. Notice that the earnings retention rule and the dividend distribution rule in equations (9) and (10), respectively, are optimal from the bankers' perspective in presence of the DPT rule specified in equations (6)-(7). In other words, bankers might find optimal to deviate from the DPT rule and face the related penalty. However, only if there is no penalty (i.e. if the parameter κ^P is equal to 0) bankers distribute the same amount of dividends as in absence of the DPT rule.

We can identify three transmission channels of the DPT rule. The first channel relates to the positive effect of dividend restrictions on bank resilience, in periods of increasing risk of bank losses. Through the limits imposed on the distribution of dividends, the DPT rule prevents a dilution of bank equity. This effect is more important when the estimated probability of bank default is higher [6], that is when it is more important to build-up bank resilience. The positive effect on resilience is also more important in presence of a capital buffer release, as there is the risk that the freed-up capital is used to pay a bigger amount of dividends, leading to a reduction in bank equity.

The second transmission channel of the DPT rule relates to the possibility that the retained earnings are used to smooth the downturn in the credit cycle. This channel has two effects. On one hand, smoothing the credit downturn helps the economic recovery, for instance by preventing the detrimental effects for the real economy and the financial system that might emerge if banks stop the rollover of commercial loans that companies use to finance their running costs. On the other hand, the rollover of risky loans increases the vulnerabilities in the financial system. Because of these opposite effects, we expect that the impact of the DPT on smoothing the credit downturn would be smaller in the case of a banking system characterized by higher exposure to credit risk. Indeed, section 5.2 shows that the positive effect of the DPT on corporate loans is bigger in Portugal than in Slovenia, with the former country characterized by a portfolio of corporate loans with lower exposure to credit risk[7]. Finally, the DPT measure has a redistributive effect, as it causes a temporary transfer of resources from the patient households, who (being the bankers) would be the beneficiaries of bank dividends, to the impatient households and companies, which would benefit from the rollover of loans.

3.4. The Dividends Prudential Target rule in action

The implementation of the DPT rule alters bankers' behavior by introducing a non-linear dynamic into the optimal allocation between dividend distribution and earnings retention. As depicted in equation (11), the penalty imposed on bankers for deviating from the DPT target, combined with their preference for smoothing dividend distribution, creates a wedge in the initial relationship between dividend distribution and retained earnings. This wedge, given by $1 + \kappa^P(c^b_{t+1} - c^{b,*}_{t+1}) + \kappa^B(c^b_{t+1} - \bar{c}^b)$, compels a shift in earnings retention, n^b_{t+1}, whenever the dividends distribution, c^b_{t+1}, strays from the target specified by the DPT rule.

[6]Comparing two banking systems or the same banking system in two different periods, the probability of bank default can be higher either because of a lower level of bank capitalization, or because of a higher level of riskiness in bank assets, or both.

[7]We use the write-off rate as a measure of credit risk. The calibrated write-off rate for corporate loans is one-third higher for Slovenia (2.41) than Portugal (1.62).

Furthermore, the extent of bankers' preference for smoothing dividends diminishes the effectiveness of the DPT rule in achieving its objective.

$$\frac{n^b_{t+1}}{c^b_{t+1}} = \frac{1-\chi^b}{\chi^b}\left(1+\kappa^P\left(c^b_{t+1}-c^{b,*}_{t+1}\right)+\kappa^B\left(c^b_{t+1}-\bar{c}^b\right)\right) \tag{11}$$

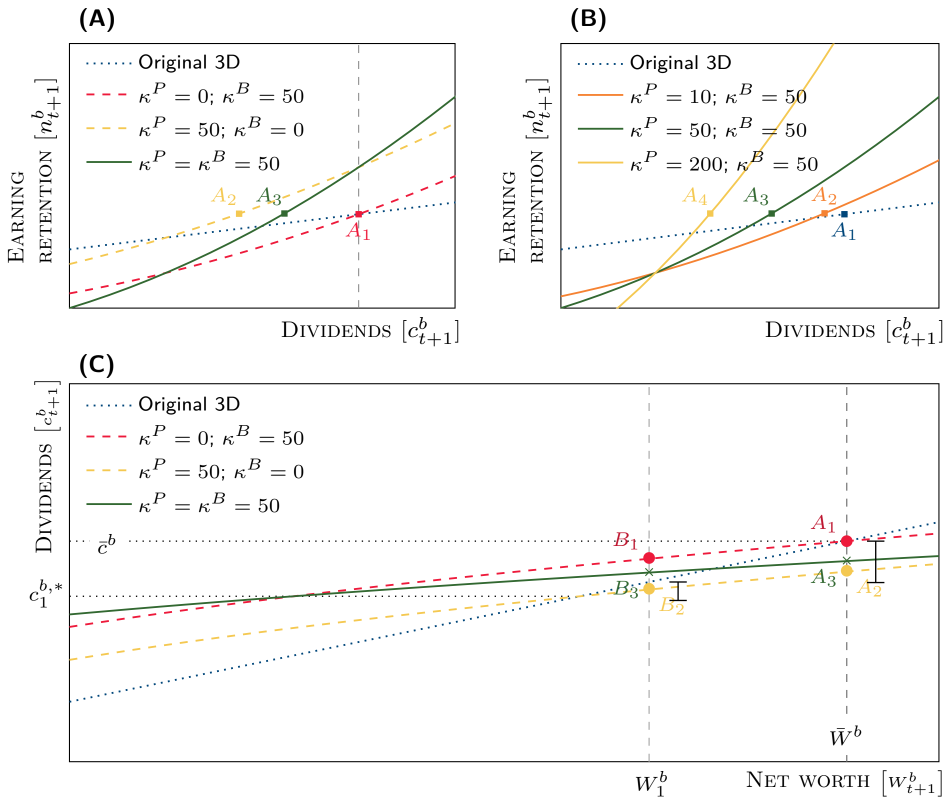
The effectiveness of the DPT is contingent on three factors: (i) the extent, ρ_x, to which the dividend rule responds to the chosen financial indicator (e.g., for the credit cycle) determining its fluctuation, (ii) the severity of the penalties imposed on bankers for diverging from the aforementioned target, denoted by κ^P, and (iii) the bankers willingness to smooth the dividends distribution, indicated by κ^B. The last two factors are illustrated in panels (A) and (B) of Figure 2. The greater the disparity between intended dividends distribution and the DPT, the more pressure is exerted on bankers to adjust their net worth allocation toward retained earnings by curbing dividends distribution.

The squares (A_1, A_2, and A_3) in panel (A) illustrate the optimal allocation under different scenarios, considering the presence or absence of two forces: the DPT rule (captured by the enforcement parameter κ^P) and bankers' preference for smoothing dividends (captured by κ^B).[8] These scenarios start from the steady-state allocation A_1 before any shock disrupts the economy's equilibrium. The DPT rule's influence on shifting the dividend distribution is evident (see the shift from A_1 to A_2), along with a reduction in its effectiveness due to the bankers' tendency to smooth dividends (see the shift from A_2 to A_3).

In Panel (A), we can compare the set of optimal allocations in the case (a) corresponding to the original 3D model (blue dotted line) with the case (b) characterized by bankers' preference for dividend smoothing (red dashed line). In the case (b) compared with the case (a), bankers retain a relatively smaller share of profits (i.e. they pay as dividends a relatively larger share of profits) when bankers' wealth is smaller than in the intersection point A1 (i.e. to the left of A_1). The opposite is true when bankers' wealth is greater than in point A_1 (i.e. to the right of A_1). Conversely, there is a higher level of earnings retention and a reduced dividend in the case (c) in which bankers' preferences are as in the original 3D model and the DPT rule is introduced (yellow dashed line), than in the case (b).

Finally, let's compare the case (d) when both factors are at play ($\kappa^P = \kappa^B = 50$– green line), with case (c). In the case (d) compared with the case (c), bankers tend to distribute as dividends a larger share of earnings as their net worth decreases, i.e. to the left of the intersection point between green and yellow dashed line, in panel (A). The opposite is true when bankers' net worth is greater, i.e. to the right of the aforementioned intersection point. In other words, in the case (d) compared with the case (c), the impact of the DPT rule is lessened by the bankers' preference for dividend smoothing.

[8] Optimal allocation refers to the combination of dividend distribution and retained earnings resulting from the bankers' optimization problem, based on their net worth.



Notes: The colored squares in panels (A) and (B) represent the allocations of bankers' net worth between earning retention and dividends distribution among all possible combinations under the same initial net worth level. The colored circles and crosses in panel (C) indicate the distributed dividends in various scenarios, which differ in banker net worth, banker preference for dividend smoothing and presence/absence of DPT rule.

Figure 2: Illustration of the Dividend Prudential Target rule effect on the bankers' decision.

The squares in panel (B) show the optimal allocation, between earning retention and dividends distribution, of bankers' net worth without policy (blue) and with different degrees of commitment (or enforcement) of the DPT rule, measured by the parameter κ^P, which determines the penalty for deviations from the rule. Examining panel (B) we observe that the level of enforcement plays a key role on the effectiveness of the DPT rule. In fact, higher values for κ^P cause a shift toward the earning retention (shift from A_2 to A_3 and, then, to A_4). In other words, the higher the cost incurred by bankers for deviating from the DPT, the more pronounced the distortion created in the allocation of bankers' net worth. In particular, for the assumed initial level of bankers' wealth, as the cost of deviating from the DPT increases, bankers are persuaded to reduce the dividends distribution.

Panel (C) illustrates a scenario of bankers' net worth depletion. In this situation, we examine the interaction between the two forces captured by κ^B and κ^P influencing the optimal allocation between dividend distribution and earnings retention. To prevent net worth depletion, the early activation of the DPT, before the materialization of bank losses, seeks to bolster banks' resilience by increasing their capitalization through greater earnings retention.[9] In absence of bankers' preference for dividend smoothing ($\kappa^P = 50$; $\kappa^B = 0$), we observe a significant reduction in dividends compared to a scenario without any prudential measure targeting bank dividends (from point A1 to A2, before the materialization of shocks).[10] In presence of bankers preference for dividend smoothing, the effect of the DPT before the materialization of bank losses is however smaller (from A_1 to the allocation with abscissa $\bar{W}^b$ indicated by a cross on the green line).

When risks materialize and bankers incur losses that reduce their net worth from the steady-state level $\bar{W}^b$ to W_1^b , dividends are further adjusted downwards. In particular, the optimal allocation changes as follows: a) from point A_2 to B_2, when $\kappa^B = 0$; and b) from the allocation on the green line with abscissa $\bar{W}^b$ to B_3, when $\kappa^B = 50$. Conversely, in the absence of the DPT rule, with the materialization of bank losses the optimal allocation undergoes a smaller adjustment than in presence of the DPT. In particular, the optimal allocation changes as follows: it moves along the blue dotted line from A1 to the point with abscissa W_1^b when $\kappa^B = 0$; and b) from A_1 to B_1 when $\kappa^B = 50$.

We can use the difference in distributed dividends in absence and in presence of the DPT as a measure of the DPT rule effectiveness. Therefore, in absence of bankers' preference for dividend smoothing the effect of the DPT (in terms of reduction in dividends) would be the small vertical difference between the point on the blue dotted line with abscissa W_1^b and the point B_2 on the yellow dashed line. In contrast, by acknowledging bankers' preference for dividend smoothing, we obtain a bigger effect of the DPT measured by the difference in ordinate between point B_1 (on the red dashed line) and B_3 (on the green line). In other words, if we believe that bankers' have a tendency toward dividend smoothing, not allowing for such a feature in the model leads to underestimate the effectiveness of macroprudential dividend restrictions.

[9]Remember that as long as there is a fluctuation in the reference indicator for the DPT, in our case in credit, the DPT rule implies a change in the allocation of profits between retained earning and dividends.

[10]Notice that the allocation A_1 belongs to the blue dotted line and to the red dashed line. This means that A_1 is the initial (i.e. before credit fluctuations and materialization of losses) optimal allocation in two cases. First, when $\kappa^P = 0$ and $\kappa^B = 0$ (i.e. in the original 3D model) – blue dotted line. Second, when $\kappa^P = 0$ and $\kappa^B = 50$ (i.e. in absence of the DPT rule and in presence of bankers preference for dividend smoothing) – red dashed line.

4. Calibration

This section presents the outcome of the 3D model's calibration. The model undergoes two separate calibration processes: one is conducted using data from Portugal, while the other is carried out with data from Slovenia. The calibration, for both countries, encompasses quarterly data spanning from 2001Q1 to 2020Q1.[11]

Table 1 details the calibration targets, specified in terms of means and standard deviations, alongside the corresponding values derived from the model. Overall, the model exhibits a good fit with the data, as the theoretical first (mean) and second (volatility) moments computed from the model are either equal or very close to the targeted empirical moments.

Table 2 provides the parameter values obtained through the calibration process. Panel (A) highlights the parameters that were pre-established, while panel (B) showcases the parameters that were calibrated based on the data targets from Table 1.

The definitions of the capital ratios for mortgage and corporate loans, denoted as ϕ^H and ϕ^F, exhibit variations between the two calibrations. In the case of Portugal, the capital ratios for banks are defined in terms of Common Equity Tier 1 (CET1). In the Slovenian calibration, these ratios are defined in Total Capital, encompassing CET1, Additional Tier 1 (AT1), and Tier 2. Despite this distinction, which is evident in the target levels (9.61% for Portugal against 13% for Slovenia), it does not qualitatively affect the analysis conducted. These targets are linked to risk weights of 100% for corporate loans and of 50% for mortgages (loans to households), following Clerc *et al.* (2015).[12]

While the calibration of the two economies shares similarities, there are certain specific characteristics that make them interesting for a comparative analysis. To begin, the elevated write-off rate for corporate loans in Slovenia, in contrast to the Portuguese average, is evident in the higher standard deviation of NFC risk shocks, which is more pronounced in the former. Conversely, a contrasting pattern emerges concerning the relationship between the target for the mortgage loan write-off rate and the standard deviation of risk shocks for impatient households, albeit to a lesser degree. Given that the Dividend Prudential Target (DPT) rule has implications for bank capitalization, this provides an opportunity to explore the interplay between bankers' resilience (capitalization) and fluctuations in borrowers' ability to meet their obligations. The DPT could complement other macroprudential

[11]In both cases, the calibration procedure, as outlined in Lima *et al.* (2023), initiates with a first set of parameters predetermined based on established literature and conventions. Subsequently, after locking in these initial parameters, the calibration of the remaining parameters considers the first and second moments of various macro-financial variables, which serve as targets that the model strives to replicate.

[12]While not directly reflecting the precise average risk weights for the two credit segments, it mirrors the less stringent risk weights stipulated in regulation for the latter type of loans.

Description	Portugal Data	Portugal Model	Portugal Diff.	Slovenia Data	Slovenia Model	Slovenia Diff.
(A) Means						
Fraction of impatient households (%)	45.93	45.93	-	44.48	44.48	-
Return on average bank equity (%, ann)	6.44	6.44	-	6.03	6.03	-
Regulatory capital ratio (%)	8.00	8.00	-	8.00	8.00	-
CET1 capital ratio (%)	9.61	9.61	-	–	–	–
Total capital ratio (%)	–	–	–	13.00	13.00	-
Write-off rate for mortgage loans (%, ann)	0.32	0.40	0.08	0.26	0.47	0.21
Write-off rate for corporate loans (%, ann)	1.34	1.62	0.29	2.64	2.41	0.23
Mortgage loans to GDP (ratio)	2.88	2.95	0.07	0.83	0.83	-
Corporate loans to GDP (ratio)	2.17	2.17	-	1.87	1.86	0.01
Housing investment to GDP (ratio)	0.04	0.04	-	0.03	0.03	-
Impatient HH housing wealth share	0.55	0.53	0.02	0.51	0.51	-
Spread mortgage loans (pp., ann)	0.84	0.61	0.23	1.40	0.70	0.70
Spread corporate loans (pp., ann)	2.60	2.06	0.54	2.53	2.94	0.41
Average bank default (%)	1.69	1.69	-	2.93	2.93	-
(B) Standard deviations [$\sigma(\cdot)$]						
STD(House prices)/STD(GDP)	3.03	2.99	0.04	2.48	2.50	0.02
STD(Mortgage loans)/STD(GDP)	4.34	4.43	0.09	2.99	2.76	0.23
STD(Corporate loans)/STD(GDP)	5.42	4.58	0.16	4.98	3.66	0.32
STD(Mortgage spreads)/STD(GDP)	0.07	0.06	0.01	0.03	0.03	-
STD(Corporate spreads)/STD(GDP)	0.08	0.08	-	0.03	0.04	0.01
STD(GDP)	3.18	3.19	0.01	5.79	6.29	0.50
STD(Average bank default)	2.73	2.72	0.01	4.83	4.45	0.43

Notes: The variable Return on Average Bank Equity (ROAE) is based on positive values of the return on equity (ROE) and results from taking the time series average of the cross-sectional median ROE. Aggregate values for the banking sector are obtained considering a weighted average across banks, with weights given by the share of each individual bank's assets in total assets. HH stands for households, GDP for Gross Domestic Product, CET1 for Common Equity Tier 1, STD for standard deviation and ann is short for annualized. The differences between the data and the model (*Diff.* column) are in absolute terms.

Table 1. Calibration targets

policies aimed at countering the economic cycle, in particular the credit cycle, such as the Countercyclical Capital Buffer (CCyB), for example.

Moreover, the volatility of the business cycle and bank defaults varies between the two economies, as illustrated by the targets for the standard deviations of GDP and average bank defaults. Consequently, the calibrated standard deviations for productivity shocks, as well as risk shocks for banks of both types, are distinctive. A higher standard deviation for these shocks corresponds to greater macroeconomic volatility and increased uncertainty regarding the economy's performance. Like before, these distinctions prompt an exploration of the potential role of the DPT rule in reducing the fluctuations in the business cycle and credit cycle, by enhancing banks' capacity to absorb losses in adverse scenarios. This analysis also highlights the complementary role of other countercyclical macroprudential policies, such as the CCyB. In addition to the variances, we also note a greater proportion

Description (Par.)	PT	SI	Description (Par.)	PT	SI
(A) Preset parameters					
Housing weight in s utility (υ^s)	0.1	0.1	HH bankruptcy cost (μ^m)	0.3	0.3
Disutility of labor ($\varphi^{\varkappa}$, $\varkappa \in \{s, m\}$)	1	1	Entrep. bankruptcy cost (μ^e)	0.3	0.3
Frisch elasticity of labor (η)	1	1	Bank M bankruptcy cost (μ^H)	0.3	0.3
Physical Cap. share in prod. (α)	0.3	0.3	Bank F bankruptcy cost (μ^F)	0.3	0.3
Physical Cap. depreciation (Σ^K)	0.03	0.03	Shock persistence (ρ^A)	0.9	0.9
Patient HH discount factor (β^s)	0.995	0.995	Cap. ratios for mort. loans (ϕ^H)	4.81%	6.50%
Banks' capital persistence (ρ^ϕ)	0.9	0.9	Cap. ratios for corp. loans (ϕ^F)	9.61%	13.00%
(B) Calibrated parameters					
Share of impatient HH (n^m)	0.8496	0.8012	HH transaction cost (γ)	0.0003	0.0003
Impatient HH discount factor (β^m)	0.9842	0.9811	Entrepreneurs' endowment (χ^e)	0.0446	0.0343
Housing weight in m utility (υ^m)	0.3016	0.2404	Bankers' endowment (χ^b)	0.0158	0.0149
Housing adjustment cost (ξ^H)	7.4925	3.0374	Physical Cap. adjust. cost (ξ^K)	7.4935	9.7400
Housing depreciation (Σ^H)	0.0034	0.01	STD productivity shock (σ^z)	0.0504	0.1292
STD risk for NFC (σ^{ω^e})	0.2404	0.4309	STD risk for imp. HH (σ^{ω^m})	0.2674	0.2427
STD risk for HH banks (σ^{ω^H})	0.0187	0.0273	STD risk for NFC banks (σ^{ω^F})	0.0382	0.0566

Notes: The disutility of labor is the same for patient and impatient households. HH stand for households, STD stands for standard deviation. s and m stand for the households' type, patient and impatient, respectively.

Table 2. Parameters

of mortgage loans to GDP in the Portuguese economy. However, disentangling the connection between the DPT rule and household indebtedness in the model is not straightforward, as the substantial difference in mortgage loans does not result in a significant rise in the write-off rate for mortgage loans, with a similar default rate observed for impatient households in both calibrations. Nevertheless, the elevated level of mortgage loans could carry implications for social welfare when implementing a DPT rule, especially when it operates to facilitate credit smoothing.

5. Beyond the Horizon: Long-Term Welfare Effects

In this section we take a normative approach and address the question of what is the optimal combination of capital requirements and dividend prudential target that maximize some measure of social welfare. We specify the social welfare as a weighted average of expected lifetime utility of saving and borrowing households, and we find the value of the policy parameters that maximize the social welfare. Formally,

$$\arg\max_{\Theta} V_0 = \zeta_s V_0^s + \zeta_m V_0^m \tag{12}$$

where V_0^l is the expected utility function of household type $l = s, m$, ζ_l indicates the utility weight for the respective agent class and Θ denotes the set of policy parameters over which the objective function is maximized – specifically, the responsiveness of the DPT rule, ρ_x, to the reference indicator for a given enforcement level, κ^P.[13] In particular, following the approach of Mendicino and Punzi (2014), we establish ζ_l as $(1 - \beta^l)$ to prevent an excessive emphasis on the utility of patient households in the calculation of social welfare. It's important to recognize that the DPT rule triggers a shift in bankers' behavior. On the one hand, this shift benefits the impatient households by easing the pressure of fluctuations in capital ratios (both build up/replenishment and releases of CCyB), thus improving credit conditions. On the other hand, it reduces income for patient households through cuts in bankers' dividends distribution. These opposing effects of the DPT rule can ultimately influence the expected lifetime utility of both patient and impatient households.

The bank capital requirements incorporate a cyclical buffer that responds to deviations in total credit from its steady-state level, represented as:

$$\phi_t^j = \rho^\phi \phi_{t-1}^j + \left(1 - \rho^\phi\right) \bar{\phi}^j + \underbrace{\rho_{CCyB} \left[\log(b_t) - \log(\bar{b})\right]}_{\text{Countercyclical capital buffer}}, \tag{13}$$

Here, ϕ_t^j denotes the capital requirements for banks of type j, ρ^ϕ is the persistence of changes in banks' capital requirement, $\bar{\phi}^j$ represents the steady-state capital requirements, ρ_{CCyB} determines the degree of response of the cyclical buffer to deviation of total credit, b_t, from the respective steady-state level, $\bar{b}$. The persistence of changes in banks' capital requirements is set at 0.9, reflecting the assumption that the replenishment of capital buffers is not immediately required and allows for some persistence in fluctuations in capital requirements.

Section 5.1 and 5.2 highlight the existence of welfare tradeoffs induced by the DPT rule. In order to better identify these tradeoffs, in Section 5.1 we abstract

[13] The model is solved using second-order perturbation techniques in Dynare (Adjemian *et al.* 2022). Unconditional lifetime utility is calculated as the theoretical mean based on the first-order terms of the second-order approximation to the nonlinear model, providing a second-order accurate welfare measure (see, e.g., Kim *et al.* 2008).

from the role of different degrees of bankers' preference for dividend smoothing. In section 5.2 we show how these welfare tradeoffs caused by the DPT are affected by the strength of bankers' preference for dividend smoothing.

5.1. Examining Dividend Prudential Target Rules: Disregarding Bankers' Dividend Smoothing Bias

Figure 3 shows how the social welfare changes with the responsiveness, ρ_x, of the DPT rule to the reference indicator of financial vulnerabilities or risk materialization (specifically total credit, as indicator of the credit cycle). It also considers the indirect enforceability of the DPT rule, represented by the penalization parameter κ^P for deviations from the DPT rule, for given values of the CCyB rate, ρ_{CCyB}[14].

Increasing the responsiveness of the DPT, ρ_x, to the reference indicator is welfare-improving for certain combination of values for the CCyB rate and the DPT enforceability, κ^P. In other words, Figure 3 shows the existence of an optimal (i.e. welfare-maximizing) value of the DPT countercyclical component, ρ_x, for each combination of CCyB rate, degree of enforceability κ^P and country-specific characteristics. The optimized DPT rules trade off the welfare gains and costs that the DPT generates for different agents. In fact, a more responsive countercyclical component of the DPT rule fosters credit smoothing, which is beneficial for borrowers. Moreover, it helps preserving bank resilience, which is a relevant transmission channel in presence of bank default. This effect turns out to be positive for bank owners, as they need to pay a smaller contribution to the deposit insurance. On the other hand, however, they receive less dividends during a downturn than they would receive in absence of the DPT measure.

The second important insight from Figure 3 relates to the complementarity between CCyB and DPT rule. In fact, the higher the CCyB rate, the bigger the range of welfare-improving values for the countercyclical component ρ_x of the DPT, except for very small values of the CCyB rate and relatively high values of the total capital requirement as captured by the Slovenian case (comparing the two upper left panels in Figure 3). As discussed in Muñoz (2021), DPT rules complement the CCyB through various channels: (i) they reinforce the effectiveness of the CCyB in mitigating financial and economic fluctuations regardless of the nature of the shock; and (ii) they allow to strike a balance between borrowers' preference for a countercyclical DPT rule (as the DPT is more effective than the CCyB in smoothing

[14]In the subsequent discussion, the term "CCyB rate" is used to denote the parameter ρ_{CCyB}, which captures the countercyclical capital buffer. However, it is crucial to clarify that a value of $\rho_{CCyB} = 0.1$ implies that the countercyclical capital buffer is set at 10% of the observed percentage deviation of total credit from the steady-state level. To illustrate, a 5% decrease in total credit prompts the release of 0.5% of the CCyB. Similarly, a credit growth (deviation from the steady-state level) of 10% triggers a 1 percentage point increase in the CCyB.

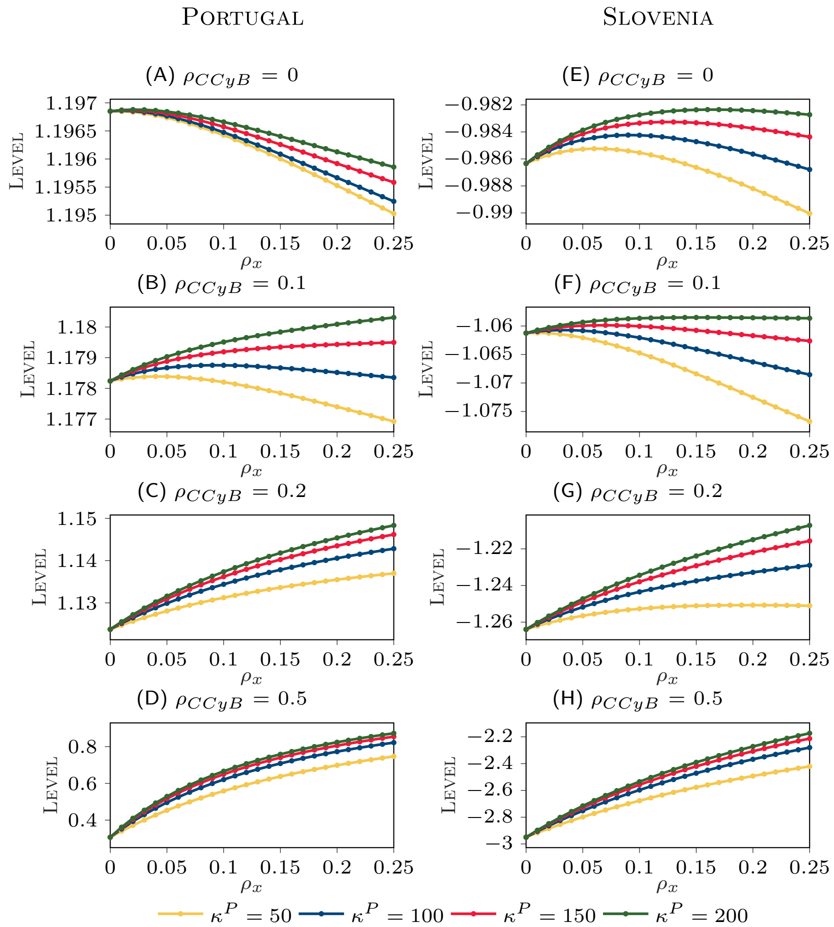


Figure 3: Social welfare for different combinations of CCyB and DPT rule.

the loan supply) and bankers' preference for the CCyB (as the CCyB favors credit smoothing without demanding higher bank dividend volatility). Moreover, while the CCyB helps smooth the credit cycle, and its release in the downturn can lead to a reduction in banks' capital ratios, the DPT helps counterbalance this effect, contributing to preserving bank resilience.

The complementarity between DPT and CCyB does not emerge for very small values of the CCyB rate when the total capital requirement is relatively high (for instance, by comparing $\rho_{CCyB} = 0$ with $\rho_{CCyB} = 0.1$ for the case of Slovenia) for the following reasons. First, the higher the capital requirements, the stronger the bank resilience and, thus, the smaller the welfare gains from the positive effect of the DPT in lowering the bank default probability. By the same token, the lower the CCyB rate, the smaller the allowed CCyB release and, consequently, the smaller the positive effect of the DPT in preserving the bank resilience during a downturn alongside with a CCyB release.

A further key takeaway from Figure 3 is that the more effective the macroprudential authority is at enforcing the DPT rule (i.e. the higher the κ^P), the greater the welfare gains. This reveals that bankers will strike a balance between the DPT and the amount of dividend that they would choose to pay in absence of the DPT rule. However, the bigger the sanction for deviating from the DPT, the smaller the deviation. Therefore, a bigger κ^P is associated with bigger positive effects of the DPT, in terms of credit smoothing and on bank resilience, and likely with a smaller cost of the sanction for bankers, as this cost results from the product of the penalization parameter κ^P and the deviation between the paid dividend and the DPT.

Moreover, the bigger the penalization parameter κ^P, the larger the set of welfare-improving values of the DPT countercyclical component ρ_x. The reason is that, for higher values of κ^P, bankers have weaker incentives to deviate from the DPT. In this case, a DPT rule more responsive to the credit cycle enlarges the positive wedge between the welfare gains, from credit smoothing and from a more resilient banking system, and the welfare cost for bankers, due to the sanction and to more volatile dividends, for given values of relevant parameters.

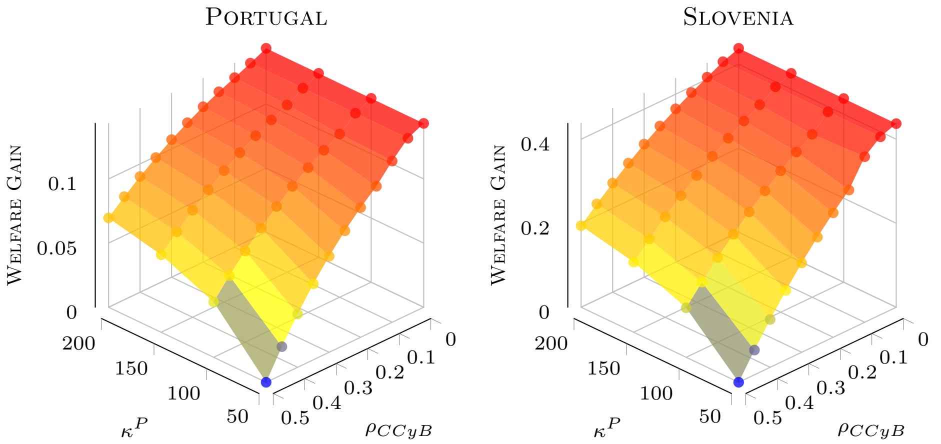
The observations from Figure 3 are further underscored by Figure 4, which illustrates that the welfare improvements from higher degrees of enforceability of the DPT measure become more pronounced with higher releases of the CCyB rate. This is in comparison to the benchmark scenario of $\rho_{CCyB} = 0.5$ and $\kappa^B = 50$, used to standardize results in the two countries.

It can be argued that the dividend restrictions on financial institutions, particularly banks and insurance companies, in the European Union during the COVID-19 pandemic were by and large enforced, as evidenced by compliance with these macroprudential measures, even in countries where they were merely recommendations.[15] Therefore, higher values of the penalization parameter κ^P better represent the experience with dividend restrictions in the European Union during the pandemic.

5.2. Integrating Perspectives: Bankers' Dividend Smoothing and Prudential Targets

Next, our objective is to explore the implications of bankers' preference for smoothing dividends distribution. We approach this by considering social welfare

[15] Dautovi *et al.* (2023) provide an aggregate view of dividend plans and banks' compliance with the ECB recommendation in the euro area. They demonstrate that the planned but undistributed dividends by the 110 significant euro area banks under ECB supervision amount to an additional 47 basis points of risk-weighted common equity, which banks could use. Belloni *et al.* (2022) indicate that without the supervisory sector-wide recommendations to suspend dividend payouts, banks would likely have only slightly reduced their payouts in the first year of the pandemic.



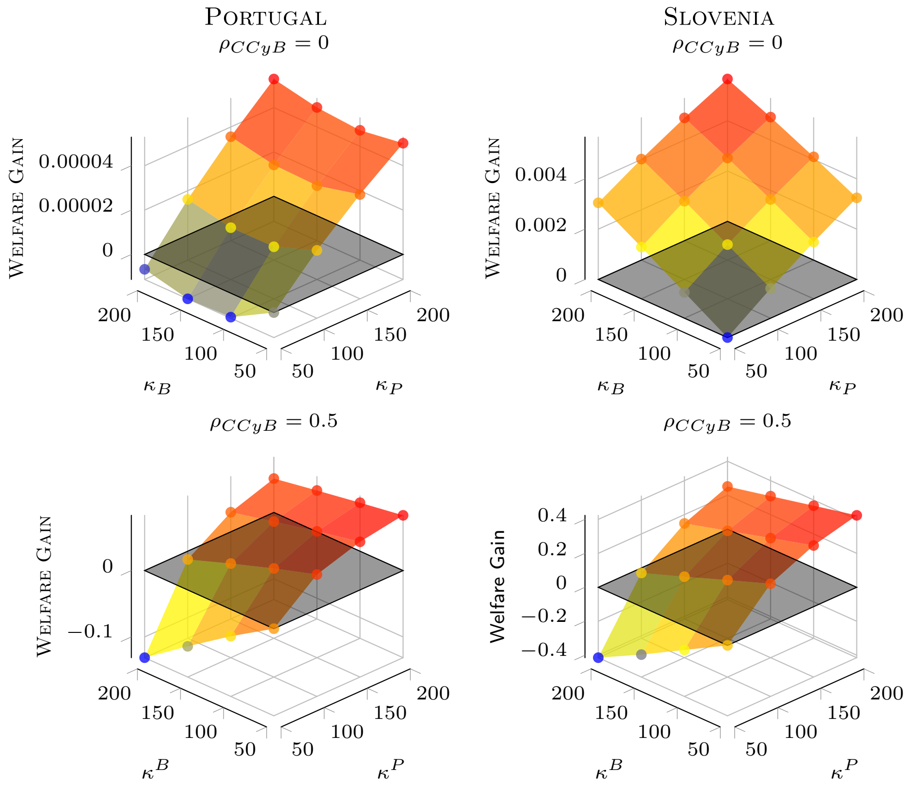
Note: For each combination of DPT rule enforceability, κ^P, and CCyB buffer rate responsiveness, ρ_{CCyB}, the DPT rule's response to total credit fluctuations is optimized for maximum social welfare, with an upper limit of 1.5.

Figure 4: Social welfare for different combinations of CCyB and DPT rules, comparing to the benchmark scenario ($\rho_{CCyB} = 0.5$ and $\kappa^B = 50$), used to standardize results in both countries.

as a weighted average of the expected lifetime utility of saving and borrowing households, which policymakers seek to maximize as articulated in equation (12). Given the uncertainty surrounding the degree to which bankers prioritize dividend distribution smoothing (κ_B), we explore various values for this parameter. We then determine the optimal value for the policy parameter, ρ_x, that maximizes social welfare, restricting the feasible range to values between 0 and 1.5 to prevent negative targets for dividends distribution set by prudential authorities.

Figure 5 illustrates the welfare gain (or loss), using as a benchmark the scenario in which bankers express a lesser inclination for dividend smoothing ($\kappa_B = 50$) and the cost of deviation from the DPT is also lower ($\kappa_P = 50$). In our analysis, we determine the policy parameter, ρ_x, that maximizes social welfare for each combination of the parameters κ_B and κ_P. To explore the implications of the interaction between the DPT and a CCyB, we consider scenarios both with and without a CCyB in place, setting $\rho_{CCyB} = 0$ and $\rho_{CCyB} = 0.5$.

Our findings reveal that a stronger bankers' preference for dividend smoothing (κ_B) may be associated with a reduction in social welfare, especially when the cost for banks deviating from the DPT is low ($\kappa_P = 50$). In fact, smoothing dividends implies higher volatility in bank equity and in credit supply, which in turn penalizes borrowers (that would prefer credit smoothing) and makes banks more exposed to default risk. However, it may happen that a stronger bankers' preference for dividend smoothing is not necessarily associated with a drop in social welfare, as observed in Slovenia in absence of the CCyB (top right panel of Figure 5). A reason could be that the positive effect of dividend smoothing for patient households



Note: The figures show the welfare gain (loss) taking as benchmark $\kappa_B = \kappa_P = 50$. For each combination of DPT rule enforceability, κ^P, degree of bankers' preference for smoothing dividends distribution, κ^B, and CCyB buffer rate responsiveness, ρ_{CCyB}, the DPT rule's response to total credit fluctuations, ρ_x, is optimized for maximum social welfare, with an upper limit of 1.5.

Figure 5: Social welfare in light of bankers' preference for dividend smoothing and the DPT

outweighs the negative effect on impatient households. A further reason could be that the welfare gains for borrowers from a stronger countercyclicality of the optimal DPT in presence of greater preference for dividend smoothing exceed the welfare loss for bankers.

Regarding the level of commitment of the policymaker to the DPT rule, quantified by κ_P, it is noted that, irrespective of the degree of bankers' preference for smoothing dividend distribution, adopting a policy that imposes costs for deviations from the DPT is welfare-enhancing, because it reduces the bankers' incentives to smooth dividends. In other words, the sanction regime weakens the conflict of interests between borrowers and bankers.

Qualitatively, with a CCyB in place, we observe similar outcomes for Portugal and Slovenia. However, quantitatively, the effects of adjusting parameters that govern bankers' preferences for smoothing dividend distribution and their commitment level to the DPT rule, κ_B and κ_P, are more pronounced for Slovenia.

This aligns with the earlier findings in Section 5. This discrepancy can be attributed, among other factors, to the lower ROAE used as a target for calibration in Slovenia, resulting in a lesser reduction in income losses for patient households. In contrast, impatient households benefit from improved credit conditions when the DPT rule is rigorously enforced.

6. Revealing Impact: Impulse Response Insights

6.1. DPT rule during an economic slowdown scenario: impact on GDP, credit and dividends

To gain a deeper understanding of the short-term effects of the DPT rule and its connection with the CCyB, we examine their impact on total credit, as both rules respond to deviations of this variable from its respective steady-state level. To do this, we consider a negative productivity shock of 1%, which causes the economy to deviate from its equilibrium and leads to a contraction in overall lending.

As bankers increasingly prefer to smooth dividend distribution, impatient households experience more pronounced adverse effects from the CCyB release once credit begins to recover. Bankers choose to allocate a greater share of net worth to distributed dividends instead of retaining earnings –panel (C) of Figure 6. This undermines the banks' equity and, consequently, their capital ratios position, leading to a slightly larger contraction in credit –panel (B) of Figure 6– and negatively impacting the expected lifetime utility of impatient households. Conversly, the smoothing of dividend distribution can have a positive effect on patient households, depending on whether the earnings from dividends outweigh the lump-sum taxes paid to finance the deposit insurance agency, which increases as banks become less capitalized. Additionally, without a DPT rule in place, the effect on GDP is negligible –panel (A) of Figure 6–, despite the mild increase in credit contraction due to higher dividend distribution. Overall, without a DPT rule, the negative effect on credit from bankers' preference for smoothing dividends is evident, though its impact on GDP is minimal. This is because patient households benefit from increased disposable income.

In contrast, when we examine the effect of introducing and enforcing the DPT rule in a scenario where bankers strongly prefer smoothing dividend distribution (bottom panels of Figure 6), the impact on GDP is significant. While the immediate aftermath of the shock is not substantially affected, the DPT rule significantly influences mid-to-long-term dynamics, leading to a notably accelerated recovery to the initial GDP level. This is due to its substantial impact on lending and its ability to partially mitigate the credit contraction, thereby contributing to a faster return to steady-state levels. This economic and financial improvement is achieved as the DPT rule fosters banking system resilience by promoting better capitalization through retained earnings, with a substantial reduction in dividend distribution. It's

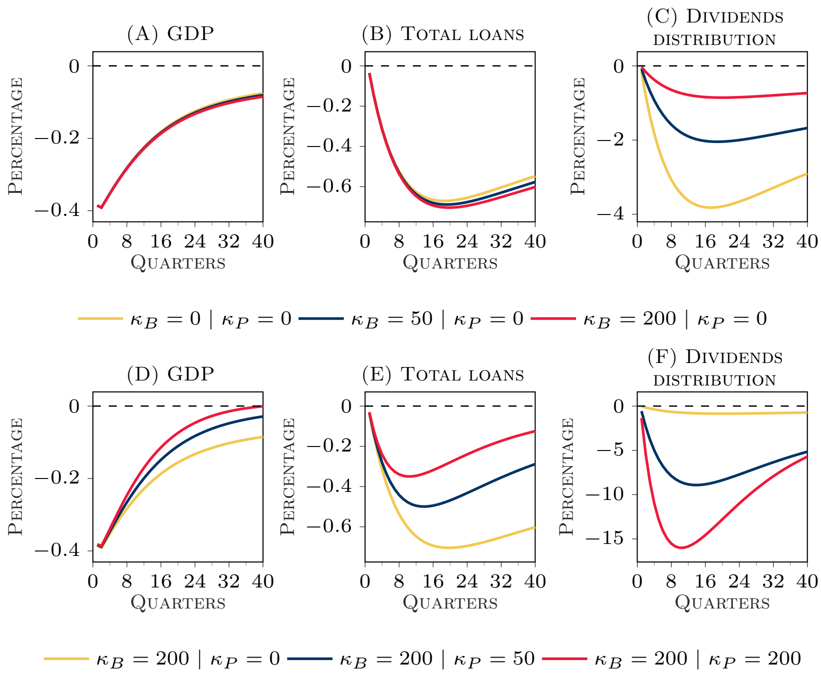


Figure 6: Synergy of bankers' dividend smoothing and the DPT in economic slowdown scenario: Productivity (TFP) shock of 1%.

important to note the link between the restriction on dividend distribution induced by the DPT rule and credit flows. As dividend distribution begins to return to steady-state levels, the pace of recovery slows considerably.

6.2. DPT rule and CCyB interaction: effect on GDP during financial turbulence scenario

In Figure 7, we investigate the dynamics and interconnections between the two rules. This exploration involves a range of values for the CCyB parameter ρ_{CCyB}, spanning from 0 to 0.5, and for the commitment degree to the DPT rule represented by the parameter κ_P, which varies from 0 (no-DPT rule) to 200 (strong commitment). To conduct this assessment, we consider a shock originating within the banking system, involving an increase in bank riskiness that affects their default rate, subsequently leading to a negative impact on bank lending, ultimately leading to a decline in economic activity and GDP.

As depicted in panel (A) of Figure 7, in the absence of the DPT rule, the release of the CCyB introduces a trade-off, characterized by a short-term impact in alleviation of the GDP decline and a medium-to-long-term impact, contributing to a deceleration in the recovery phase of the cycle. This results in a slower convergence

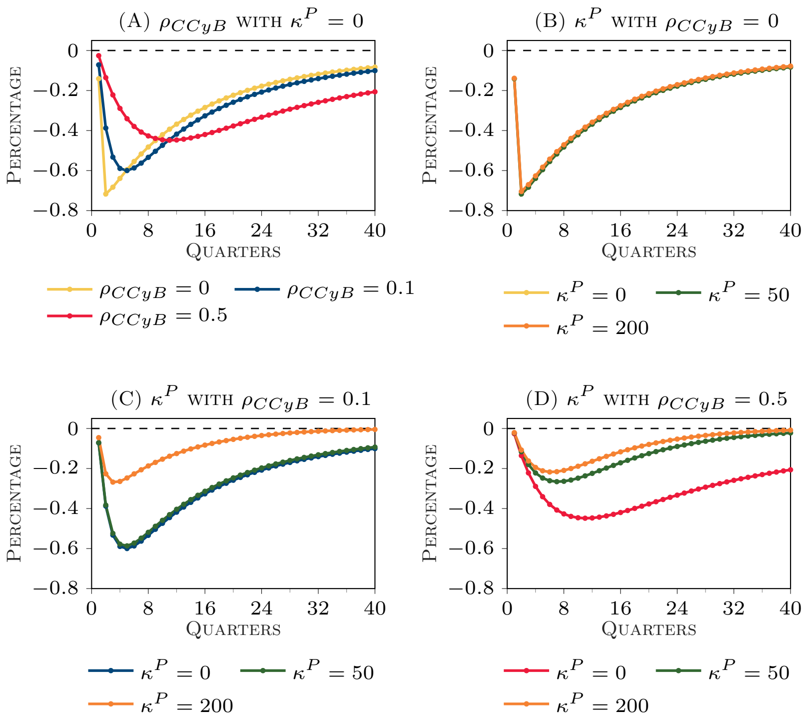


Figure 7: Influence of the CCyB and the DPT on the dynamics of GDP under a financial distress event: increase in bank riskiness.

to its steady-state level due to the negative impact on bank resilience from having lower capital ratios for a longer period. Moreover, this trade-off becomes more pronounced with an increase in the responsiveness of the CCyB rule. Additionally, the implementation of a DPT rule on its own, without considering the activation of the CCyB, has a minimal impact on GDP, which results in being ineffective in containing the GDP contraction, as depicted in panel (B) of Figure 7. The results almost overlap, regardless of the degree of rule enforcement. This outcome stems from the low responsiveness of the rule, indicated by ρ_x, which maximizes social welfare in a scenario where countercyclical capital buffers are not utilized. These insights underscore the critical importance of defining and calibrating instruments appropriately to achieve the desired outcomes. They also emphasize the significance of recognizing the trade-offs and limitations associated with these instruments.

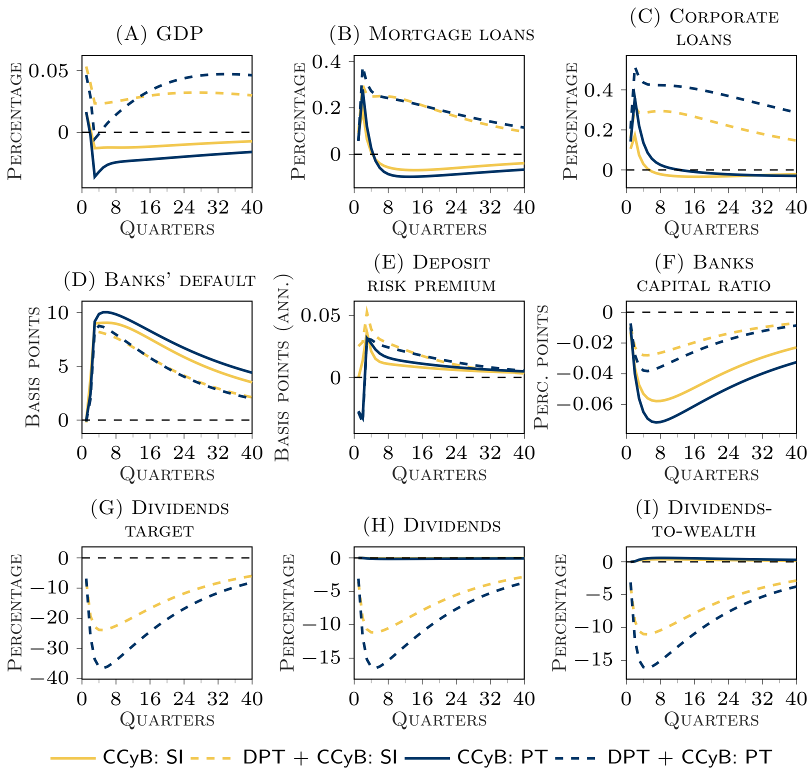
Panels (C) and (D) of Figure 7 depict the interplay between the CCyB and DPT rules, considering various enforcement degrees of the DPT rule for two levels of CCyB rule responsiveness. When the CCyB rule exhibits a mild responsiveness to total credit deviation from its steady-state level ($\rho_{CCyB} = 0.1$), the degree of commitment with the DPT rule, along with its responsiveness plays a crucial role. Stronger commitment (and the associated optimal responsiveness of the DPT rule denoted by ρ_x) significantly reduces the decline in GDP on the impact and improves the recovery phase of the cycle, surpassing the pace observed without any policy intervention ($\rho_{CCyB} = 0$; $\kappa_P = 0$). In a scenario with a stronger responsiveness of the CCyB rule ($\rho_{CCyB} = 0.5$), the results underscore the importance of DPT rule responsiveness in mitigating the trade-off induced by a CCyB release. In such circumstances, increasing the sensitivity of the DPT rule to fluctuations in the variable of interest proves beneficial in alleviating the pressure on replenishing capital ratios during the recovery phase. This underscores the importance of implementing a DPT rule, irrespective of the level of enforcement commitment, although better with stronger commitment, for the considered values of κ_P. Even with modest commitment ($\kappa_P = 50$) the effectiveness in mitigating the GDP contraction becomes apparent.

6.3. CCyB in stress events: enhancing buffer release with the DPT rule

Figures 8-11 illustrate how key macroeconomic and financial variables respond to two distinct shocks: a financial shock characterized by an increase in bank riskiness and a real sector shock arising from a negative change in total factor productivity (TFP). These responses are examined in the context of the release of a CCyB alone or combined with the DPT rule, the latter restricting dividends distribution. They represent the net effect compared to a benchmark scenario of no policies (CCyB or DPT rule) implemented.

It is useful to discuss first the effects of the mere release of the CCyB. In the two scenarios (i.e., productivity shock and financial shock) and in both countries, the release of the CCyB has an initial positive effect on mortgage and corporate loans (over five to six quarters), with bigger volume and lower rates compared to the baseline scenario where neither the CCyB release nor the DPT rule are activated. At the same time, the resulting higher leverage of households and companies is reflected in a small increase in credit risk, as captured by the respective probability of default and by the probability of bank default. Though small, the higher risk of bank default is priced by depositors, who demand a higher deposit risk premium.

A higher deposit risk premium means a higher cost of external funding, which erodes the bank profits and, therefore, the dividends for bankers. Since both depositors and bankers belong to the dynasty of patient households, the final effect on patient households' wealth depends on which of the two channels prevail, i.e., the deposit risk premium versus the dividend channel. It is possible to infer which of these two transmission channels is stronger in our simulations, by looking at the response of real variables, such as housing investment and consumption. We notice that both the patient and the impatient households decrease their consumption. Moreover, the total amount of housing investment (from both types of households) also decreases. However, the initial larger volume of mortgage loans is used by the impatient households to finance their investment in housing (though not shown in the figure). Then, it must be the case that the patient households decrease their investment in housing and their response dominates the response



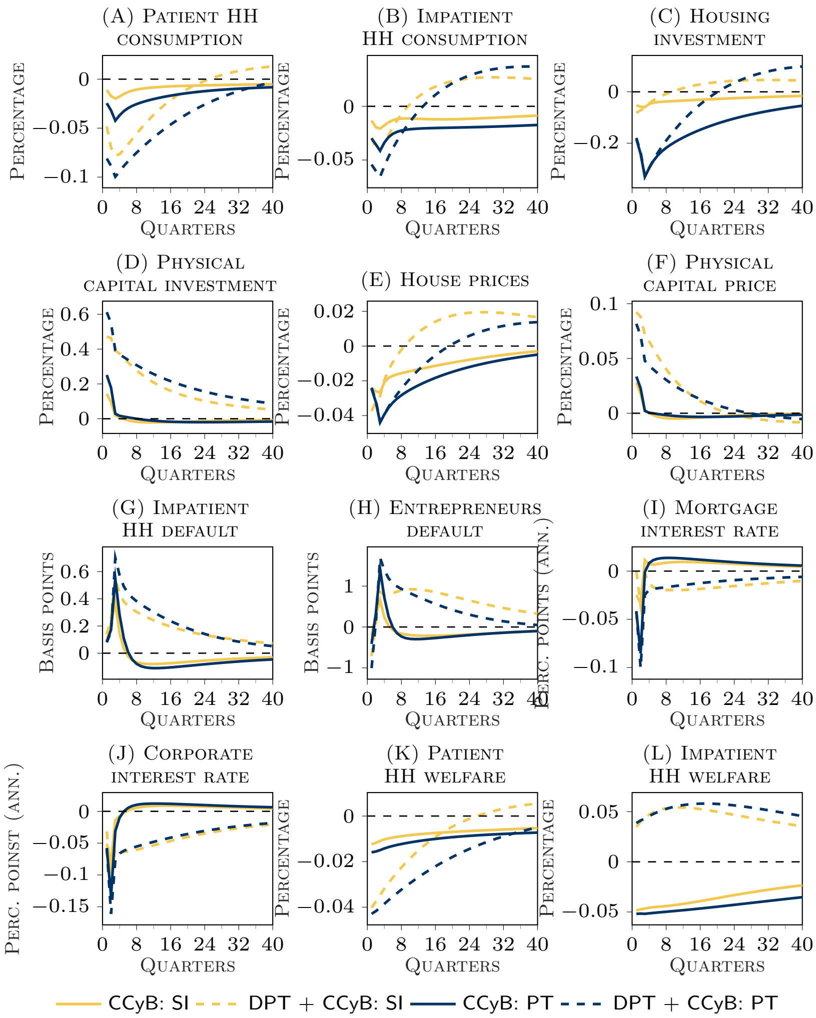
Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure 8: Impulse response functions: net effect on GDP and the main aggregate financial variables to a productivity shock.

from the impatient households. It follows that, in our simulation, the CCyB induce a temporary transfer of wealth from the patient to the impatient households.

Moreover, the initial bigger volume of corporate loans is transmitted to the investment in physical capital. The resulting effect on GDP is positive, though small and limited to the initial two or three quarters, in our simulations. Beyond this short-term horizon, the release of the CCyB backfires, because the higher cost of external funding for banks leads to a tightening of credit conditions (i.e., higher rates on both mortgage and corporate loans) and a reduction in the volume of loans. The resulting effect on consumption, investment and GDP is negative and tends to die out.

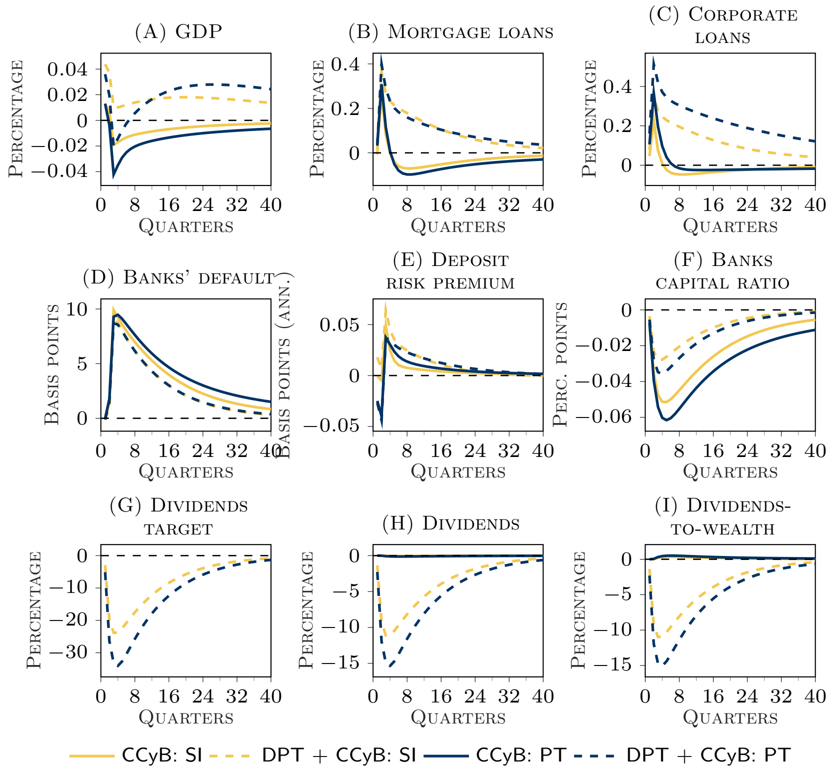
In response to both shocks, combining the dividend restriction measure (DPT) with a release of the CCyB significantly enhances the response of GDP and credit (in both segments of mortgage and corporate loans), in both countries, surpassing



Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure 9: Impulse response functions: net effect on consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a productivity shock.

the impact of a mere CCyB release. There are two reasons why the impact on GDP and credit of the combined use of the two macroprudential measures is better than the impact of a mere CCyB release. First, retained dividends are resources that banks can employ to support of the flow of credit, complementing the purported positive effect on credit of a CCyB release.[16] Second, retained earnings contribute to bank capital, bolstering resilience, counteracting the opposing effect of a CCyB release

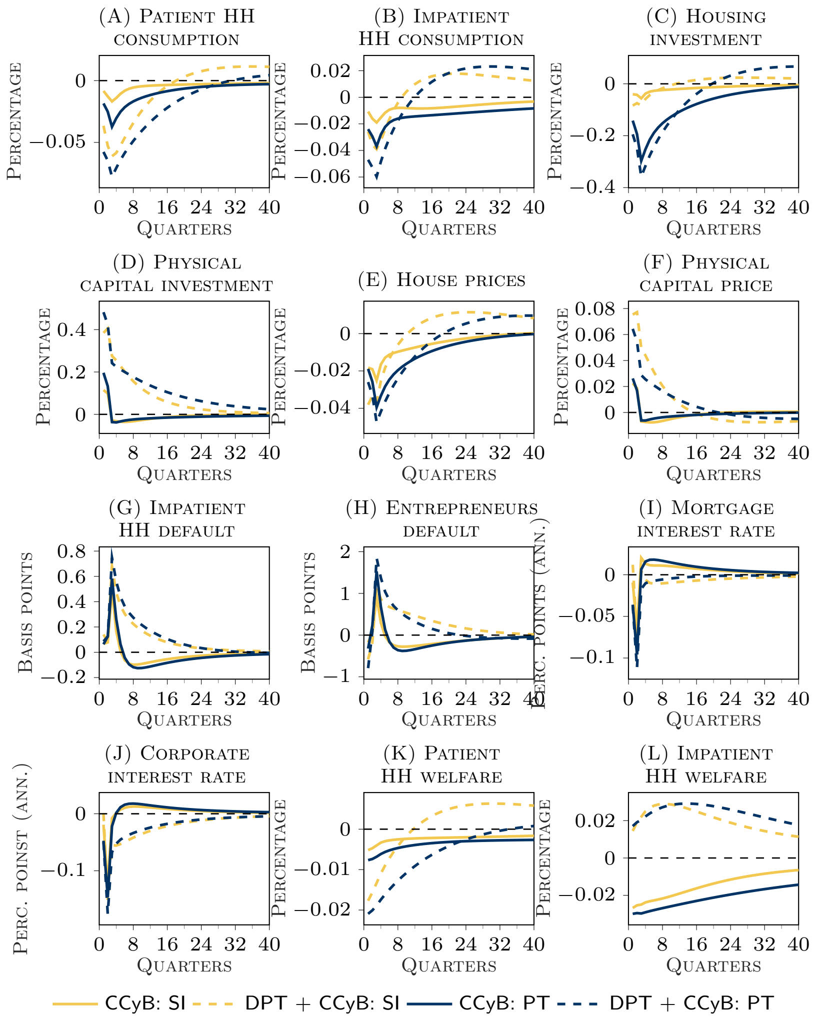


Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure 10: Impulse response functions: net effect on GDP and the main aggregate financial variables to a financial shock consisting in an increase in bank riskiness.

The favourable effect of the dividend restriction measure on bank resilience is captured by the bank capital ratio and the probability of bank default and reflected in the deposit risk premium (Figures 8 and 10). The increased credit flow to households and companies made available by the dividend measure translates into a higher level of leverage in the economy, which implies a temporary small increase

[16] As a matter of fact, the current regulatory framework does not impose restrictions on the use of the capital freed up by a CCyB release. Therefore, in absence of payout restrictions, there are no means to prevent that banks distribute the freed up capital as dividends or other forms of payouts, thus diluting the bank capital.



Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure 11: Impulse response functions: net effect on consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a financial shock consisting in an increase in bank riskiness.

in the probability of default of borrowing households (impatient households) and companies (entrepreneurs), as illustrated in Figures 9 and 11. This small increase in credit risk is priced by depositors, through a higher deposit risk premium, however, it does not manifest in the price of the loans (mortgage and corporate interest rate).

The support of the considered macroprudential measures to the flow of credit has a beneficial effect on capital investment and, after few quarters, on housing investment. The reason why the impact of the DPT rule is not univocal on the housing investment relies on the opposing sign effect of the dividend measures on borrowing (impatient) and saving (patient) households. The former benefits, while the latter faces disadvantages following the shocks that make the dividend restriction binding. On the one hand, the borrowing households experience easier access to credit (or rollover of existing loans). On the other hand, the saving households suffer from a reduction of dividend income, being ultimately the bank owners. For the same reason, the DPT measure has a similar ambiguous effect on consumption, for the initial few quarters after the shocks hit the economy. Finally, the resulting effect on GDP is positive and persistent.

It is worth to make two observations. The first observation relates to the positive effect of the DPT on bank resilience, captured by the difference in the probability of bank default in presence of a mere CCyB release and in presence of the CCyB combined with the DPT. The positive effect on bank resilience is bigger in the case of Portugal, for which a lower level of capital is used in the simulation, compared to Slovenia. The second observation relates to the effect of the DPT on credit. On the one hand, smoothing the credit downturn helps the recovery. On the other hand, the rollover of risky loans increases the vulnerabilities in the banking system, especially if the initial level of credit risk is higher. Because of these opposing effects, the impact of the DPT on smoothing the credit cycle is smaller for a banking system and a portfolio of loans characterized by higher exposure to credit risk. In fact, in our simulations (for the negative productivity shock and for the increase in bank riskiness), the positive effect of the DPT on corporate loans is smaller for Slovenia, where the write-off rate for corporate loans is one-third higher (2.41) than in Portugal.

7. Concluding remarks

The paper shows the interactions of different transmission channels of the dividend prudential target (DPT) rule in a DSGE model where banks can default and bankers have a preference for dividend smoothing. The key takeaway from the analysis presented herein is that the more effective the macroprudential authority is at enforcing the DPT rule, the greater the welfare gain. Moreover, the DPT optimal responsiveness to the reference indicator of financial vulnerabilities depends on the combination of DPT enforcement and CCyB rate. In particular, we show the existence of complementarity between CCyB and DPT rule. While the CCyB helps smooth the credit cycle, and its release in the downturn, combined with ongoing dividend distributions, may weaken bank capital ratios, the DPT helps to counterbalance such an effect, thereby bolstering bank resilience. In fact, for relatively high values of the CCyB rate, associated with stronger release of the CCyB in the credit downturn, it is always optimal is our simulations to increase the responsiveness of the DPT rule to the reference indicator. Moreover, the welfare gains resulting from the DPT rule are more substantial for higher values of the CCyB rate release.

In response to shocks, originating either form the financial system (like an increase in bank riskiness) or from the real sector of the economy (like a decrease in total factor productivity), combining the dividend restriction measure with a release of the CCyB significantly enhances the response of GDP and credit. This favorable impact of combining the two measures overweighs the positive effect of a mere CCyB release. There are two reasons why the combined impact on GDP and credit of the two macroprudential measures is better than the impact of a mere CCyB release. First, retained dividends are resources that banks can employ to support the flow of credit, complementing the purported positive effect on credit of a CCyB release. Second, retained earnings contribute to bank capital, bolstering resilience, counteracting the opposing effect of a CCyB release.

In the context of this model, the favorable effect of the dividend restriction measure on bank resilience is reflected in the deposit risk premium and is transmitted to the borrowers through a reduction of the interest rate on the loans. The positive impact of the considered macroprudential measures on the credit supply has a beneficial effect on capital investment. However, the dividend measure has an ambiguous impact on housing investment and consumption, due to opposing effects for borrowing and saving households. On the one hand, the borrowing households experience easier access to credit (or rollover of existing loans). On the other hand, the saving households suffer from a reduction of dividend income, being ultimately the bank owners. Compared to the original version of the model, in presence of the more realistic assumption of bankers' preference for dividend smoothing the benefits of the synergy between the release of the CCyB and the enforcement of a DPT rule appear to be bigger.

However, it is worth to say that the assumption that banks only invest in loans is a shortcoming of the present paper as well as the model used in Muñoz (2021) and the model used in De Lorenzo Buratta *et al.* (2023) and Di Virgilio (2023) alike. This feature tends to overestimate the effect of dividend restrictions on credit. Another key assumption through which the DPT is more effective in the model than in practice is the fact that bank equity fully accumulates out of retained earnings whereas, in practice, around 50% of bank capital is retained earnings and the other 50% is share capital. Extending the reference model to remove the assumption that banks only invest in loans and allowing for banks to issue equity can be avenues for future research.

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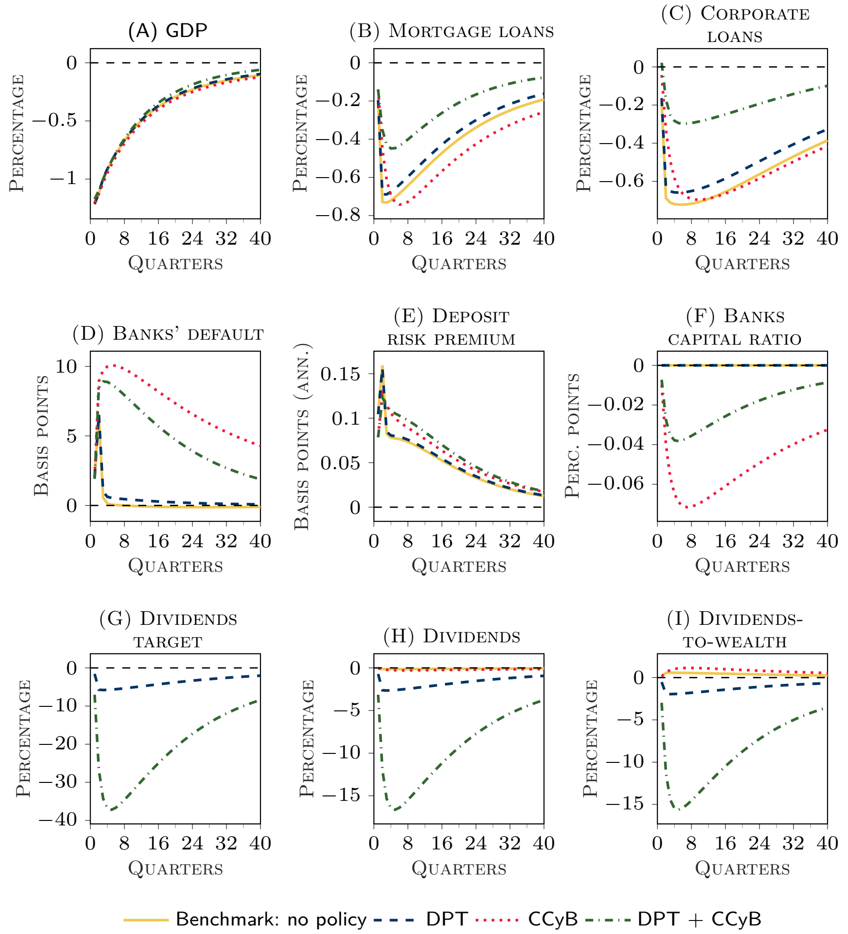
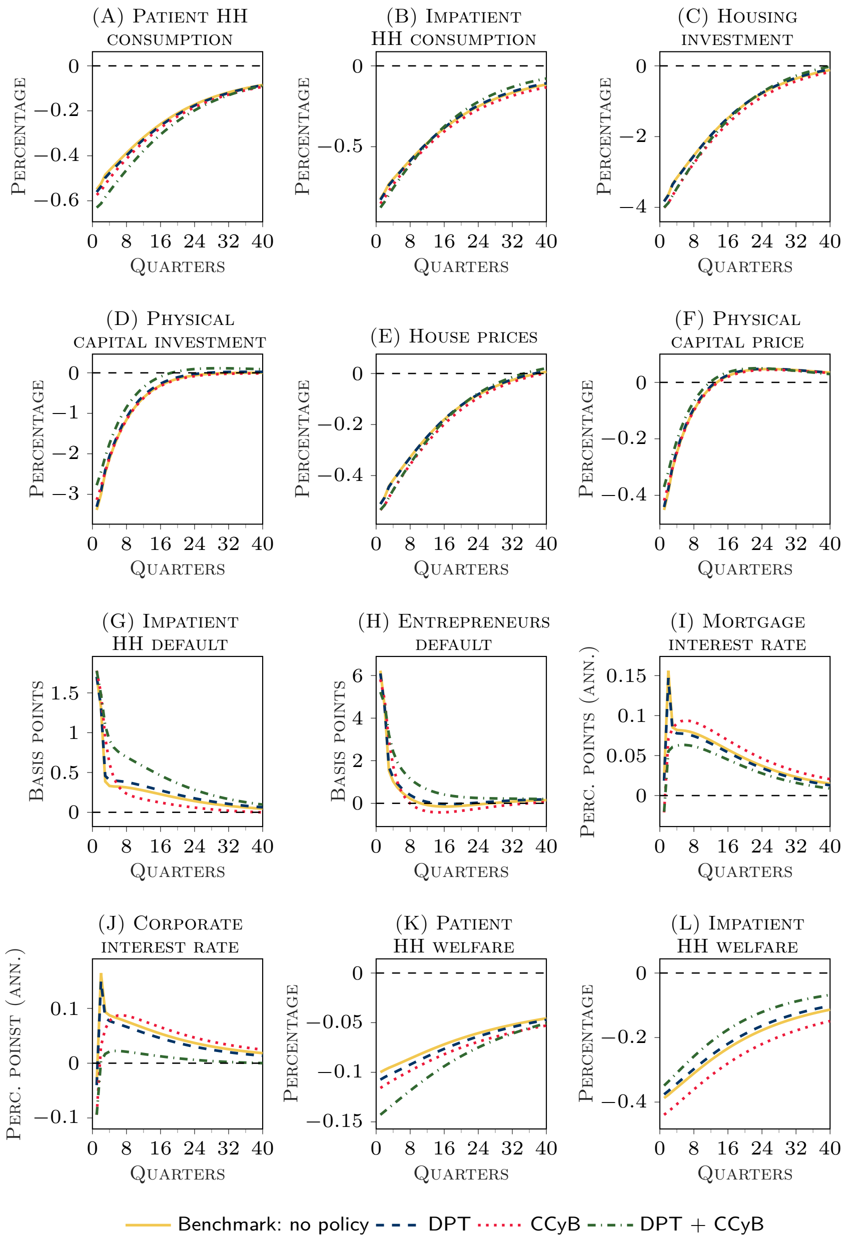
Appendix A: Short run effects (in response to shocks) – DPT rule

A.1. Portugal



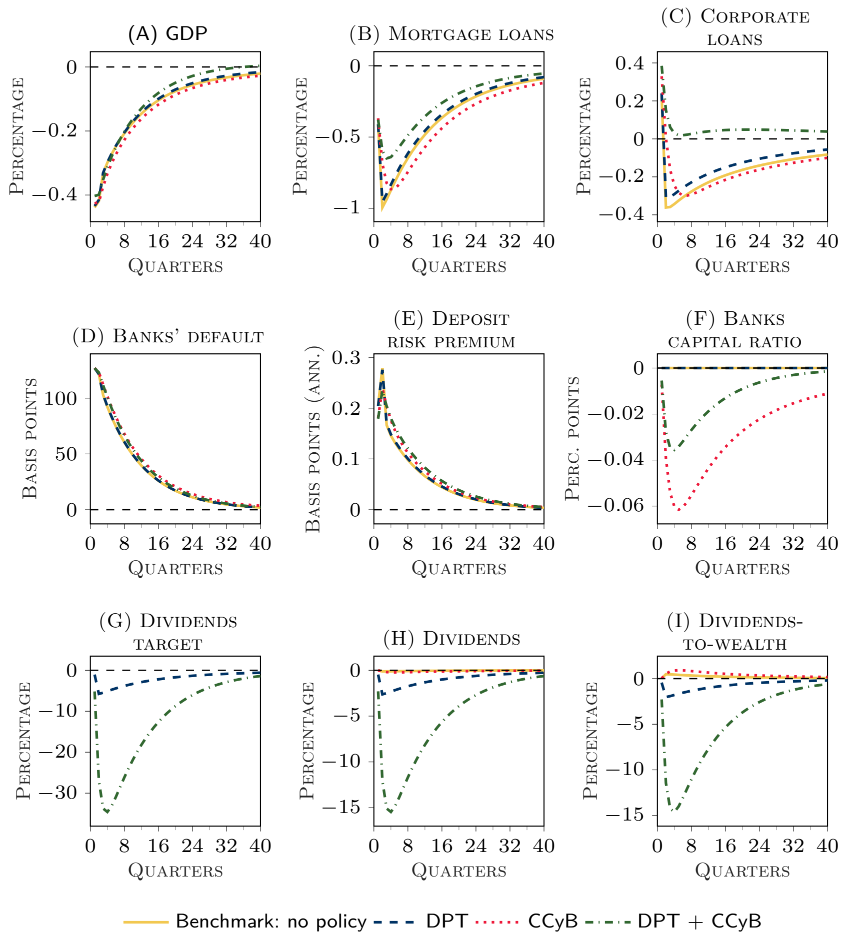
Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.1: Impulse response functions of GDP and the main aggregate financial variables to a productivity shock for Portugal.



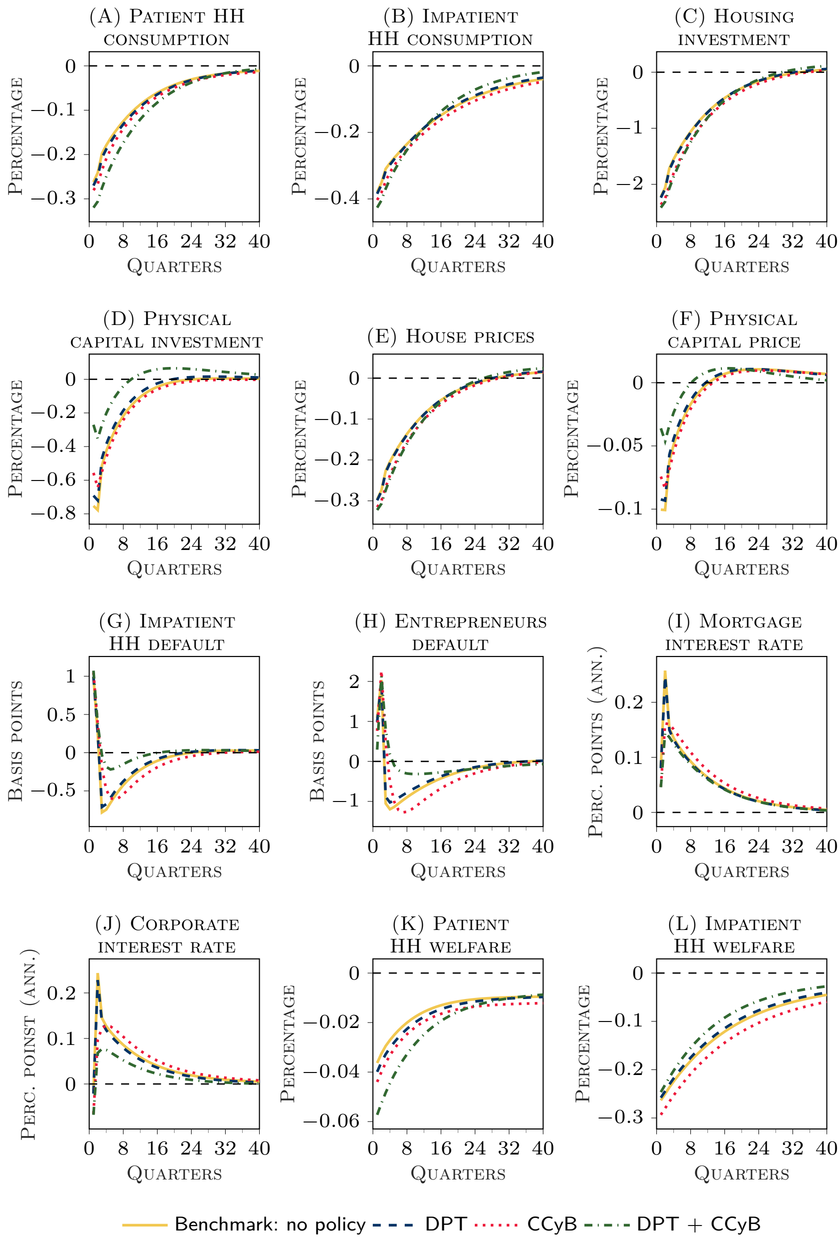
Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.2: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a productivity shock for Portugal.



Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

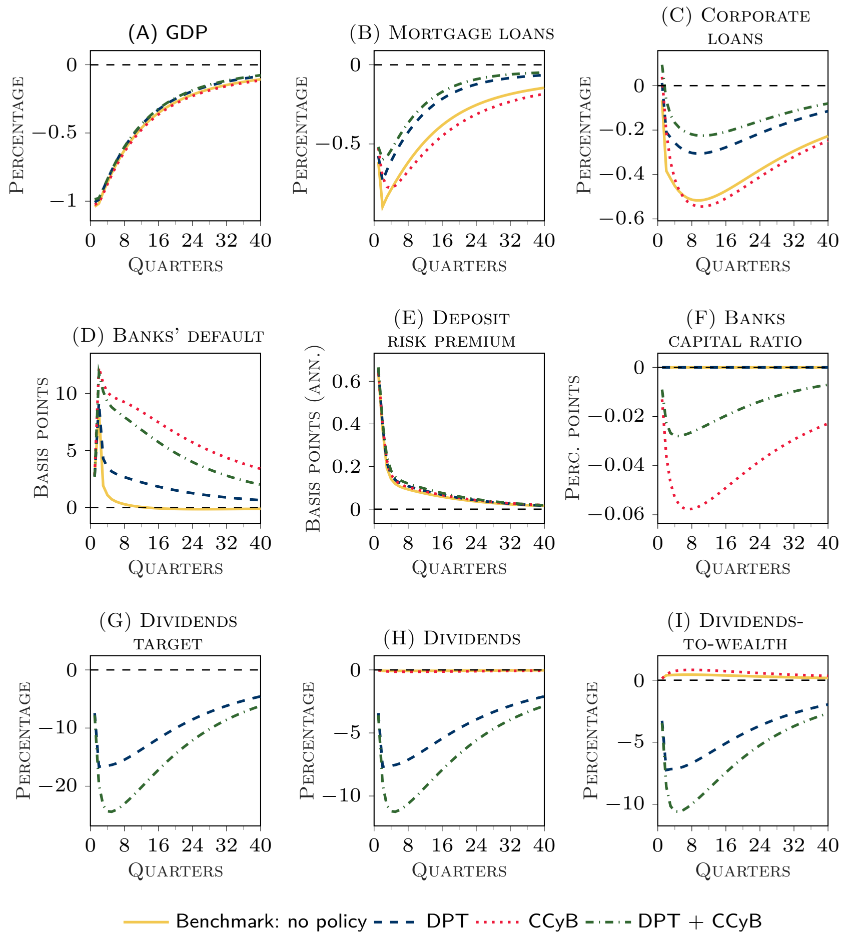
Figure A.3: Impulse response functions of GDP and the main aggregate financial variables to a financial shock consisting in an increase in bank riskiness for Portugal.



Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

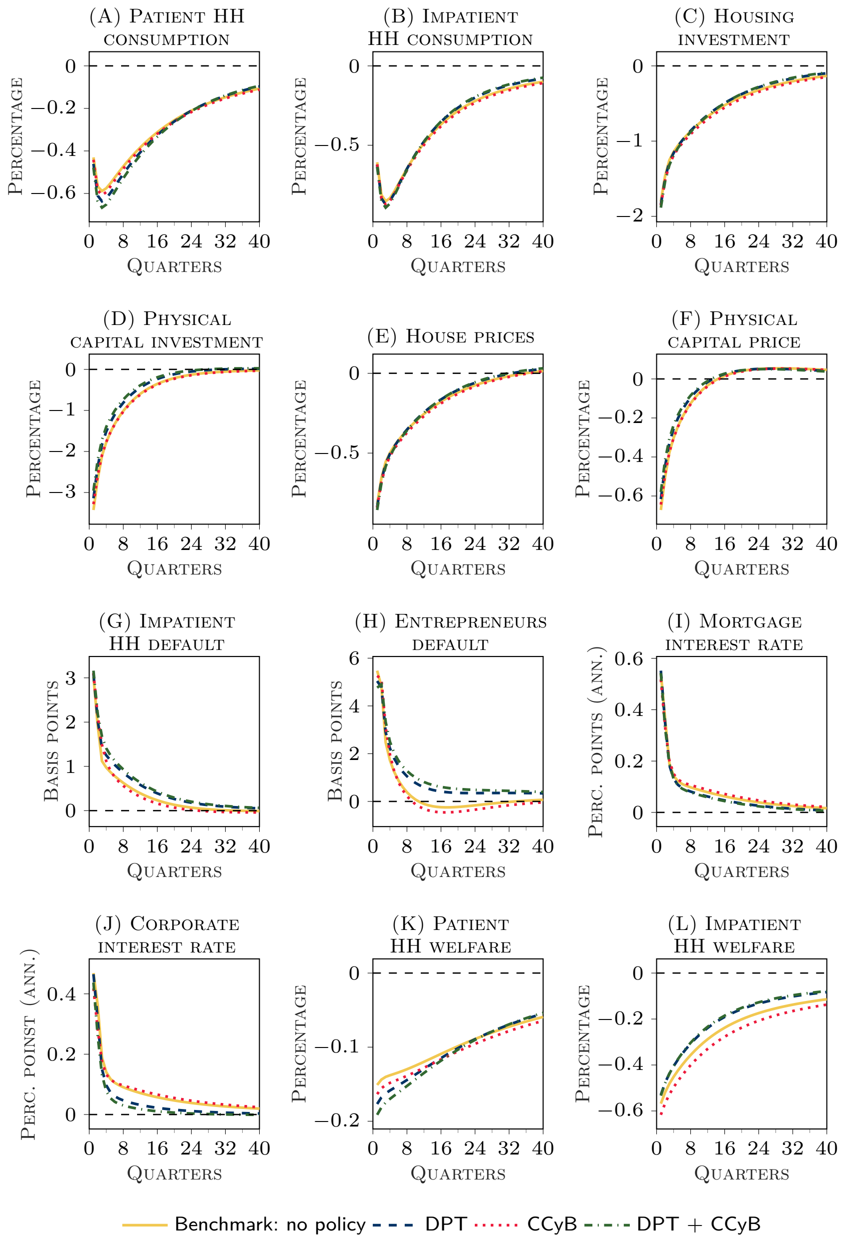
Figure A.4: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a financial shock consisting in an increase in bank riskiness for Portugal.

A.2. Slovenia



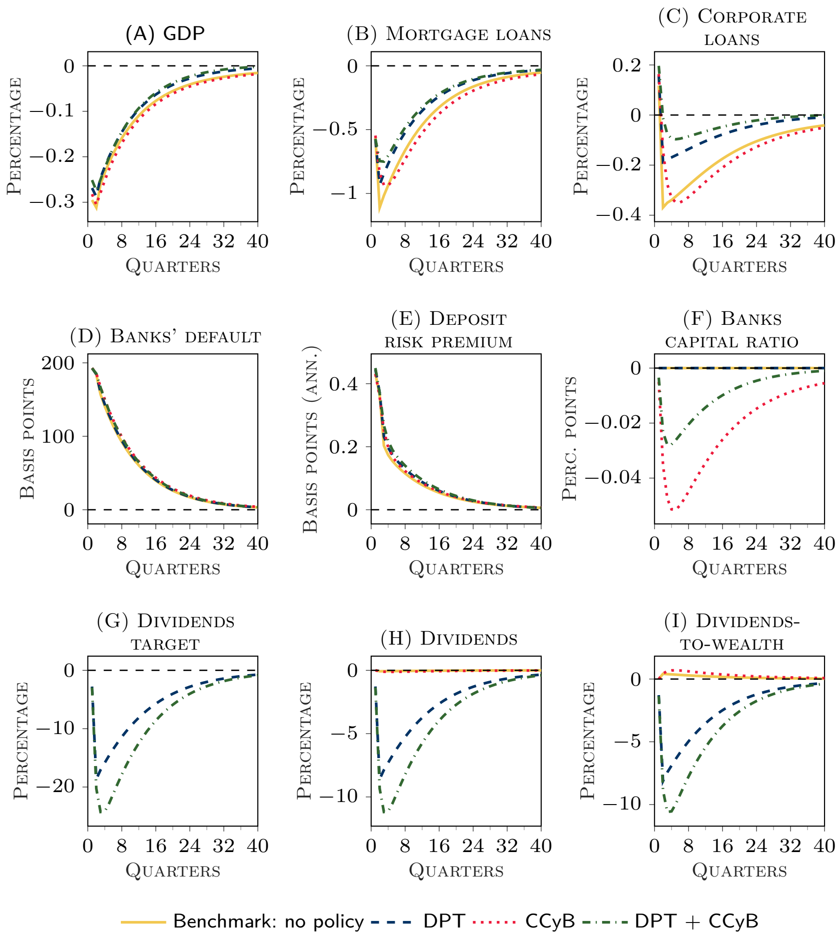
Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.5: Impulse response functions of GDP and the main aggregate financial variables to a productivity shock for Slovenia.



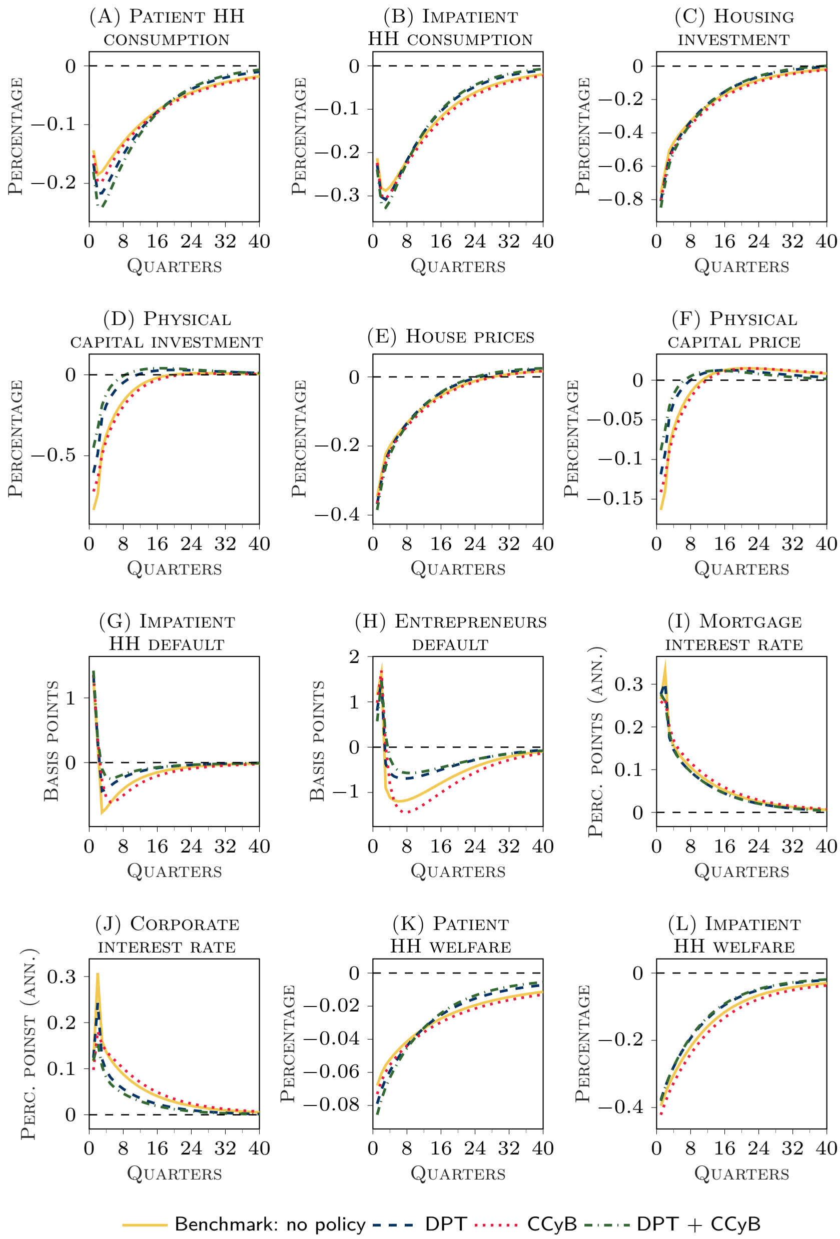
Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.6: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a productivity shock for Slovenia.



Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.7: Impulse response functions of GDP and the main aggregate financial variables to a financial shock consisting in an increase in bank riskiness for Slovenia.

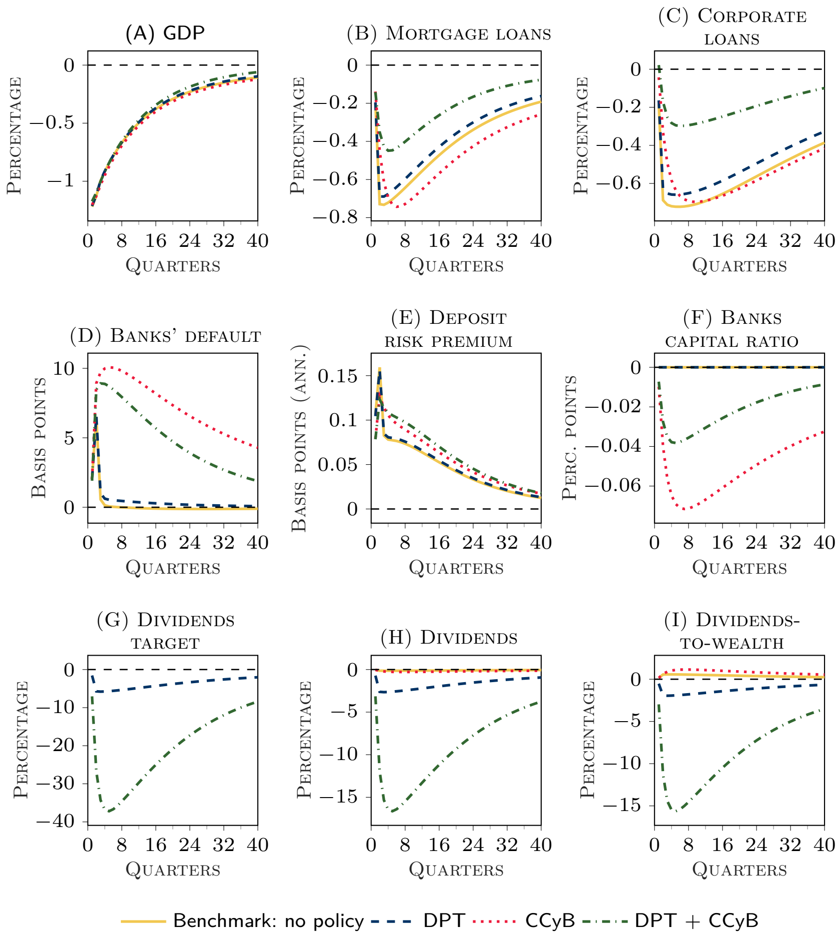


Notes: For this simulation, we set $\rho_{CCyB} = 0.1$, $\rho_x = 1.5$ and $\kappa^P = \kappa^B = 200$, where ρ_{CCyB} and ρ_x denote the responsiveness of CCyB and DPT, respectively, to deviations of total credit from its steady-state level; κ^P captures the degree of commitment to the dividend restriction and κ^B the degree of bankers preference to smooth dividends distribution.

Figure A.8: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a financial shock consisting in an increase in bank riskiness for Slovenia.

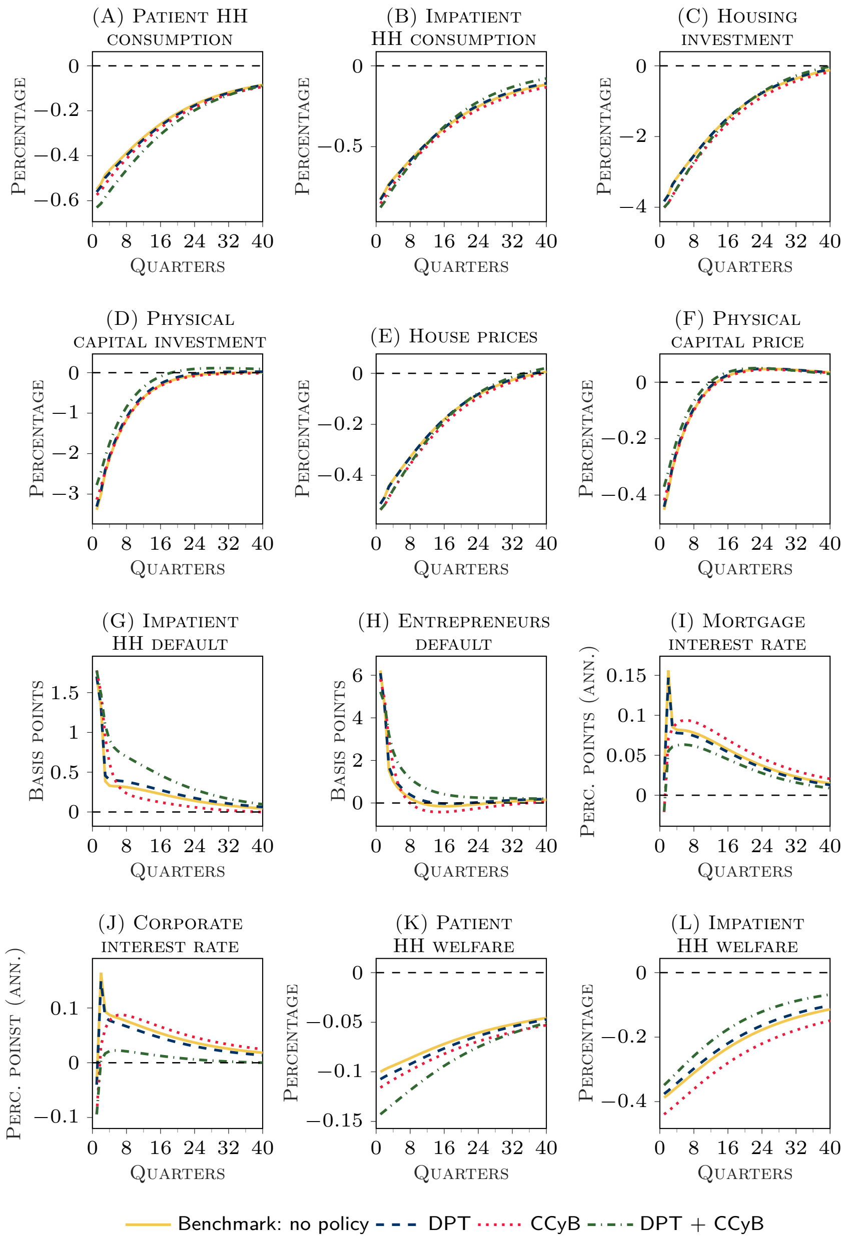
Appendix B: Short run effects (in response to shocks) – DPT rule with bankers perspective

B.1. Portugal



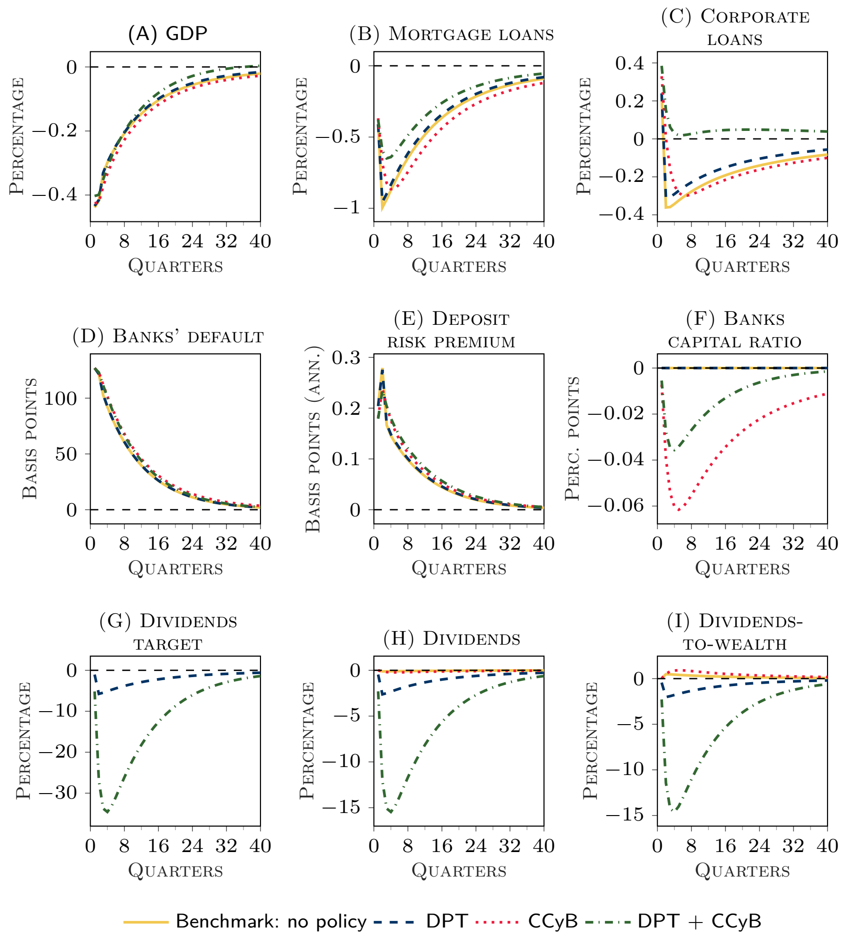
Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.1: Impulse response functions of GDP and the main aggregate financial variables to a productivity shock for Portugal.



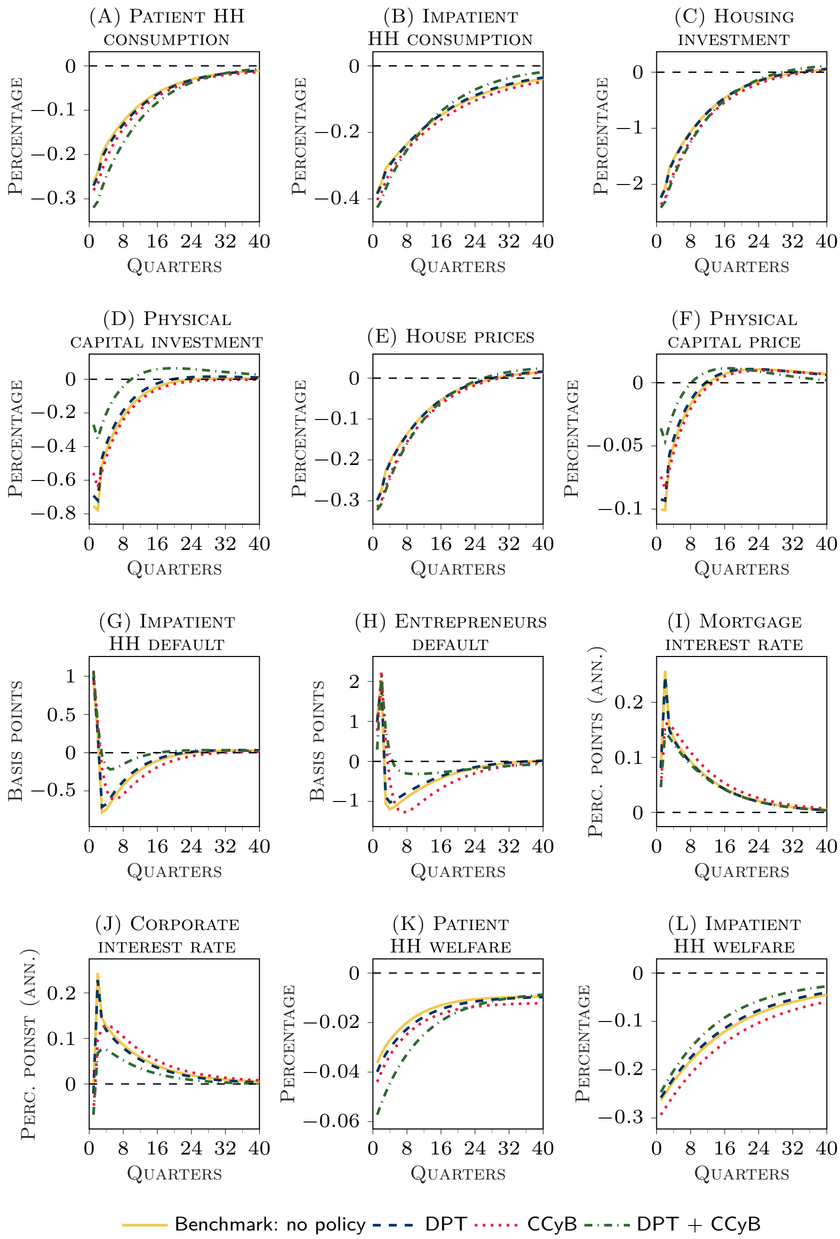
Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.2: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a productivity shock for Portugal.



Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

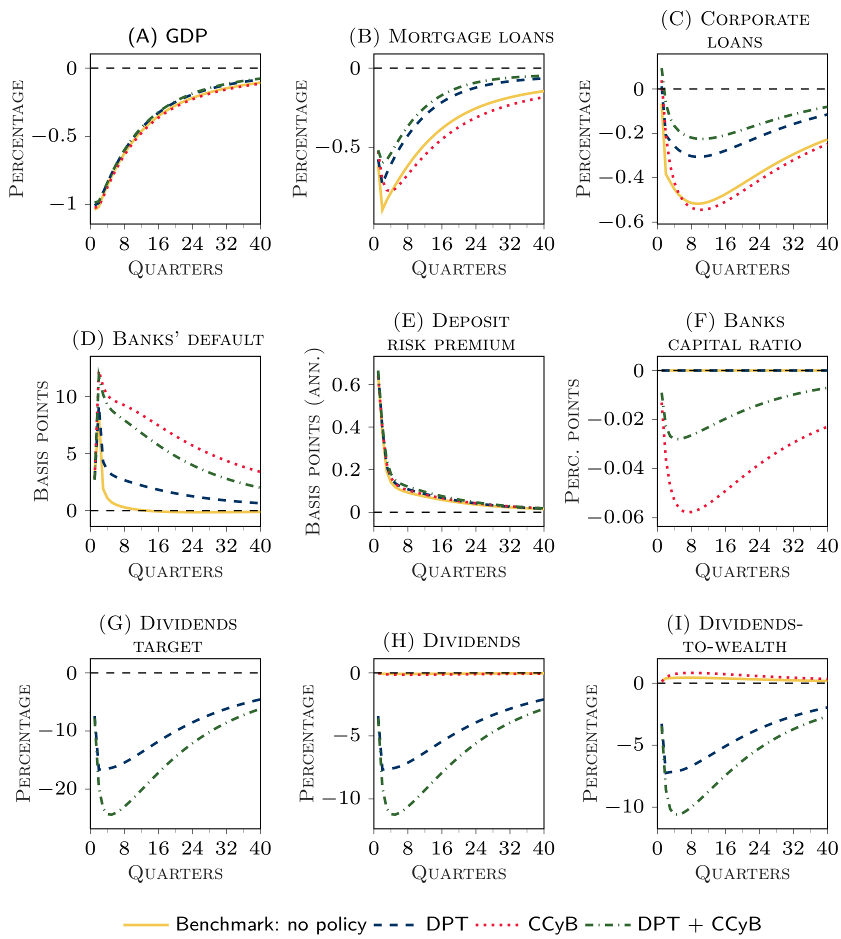
Figure B.3: Impulse response functions of GDP and the main aggregate financial variables to a financial shock consisting in an increase in bank riskiness for Portugal.



Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

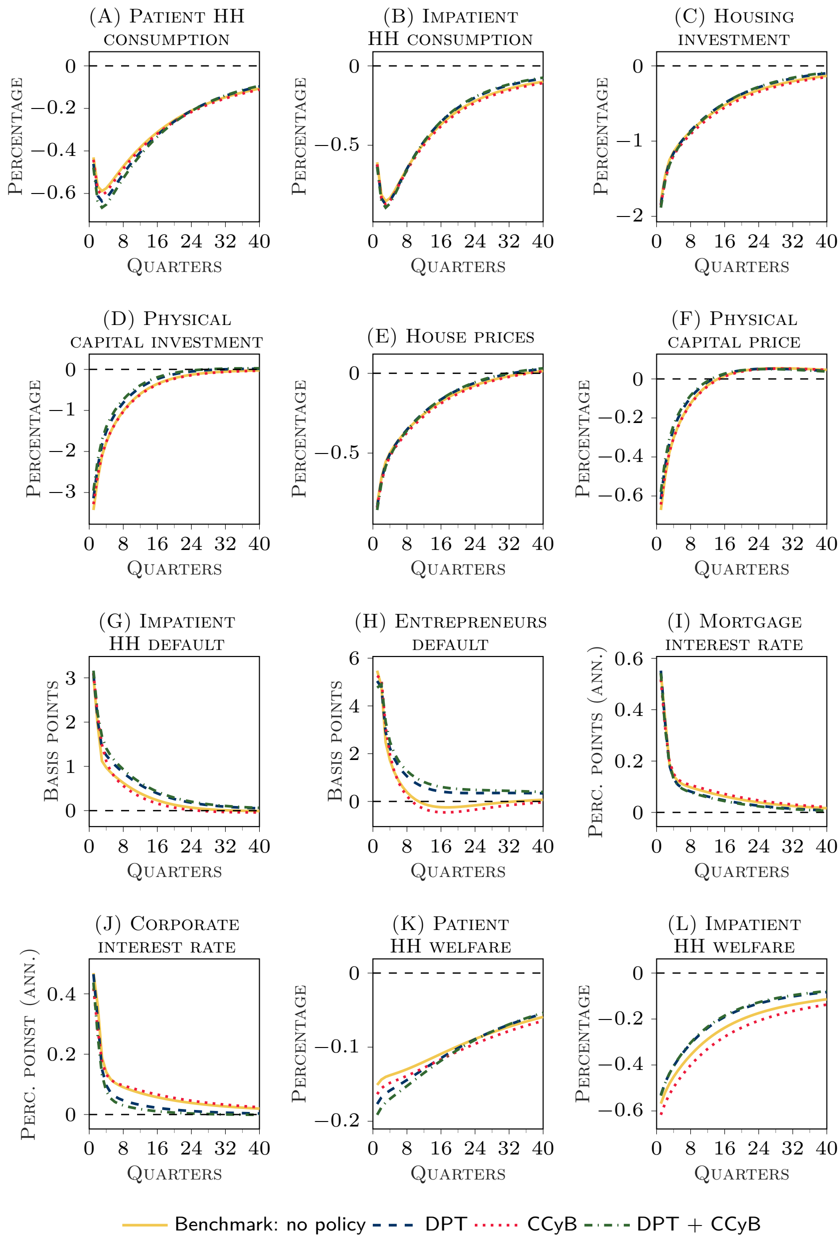
Figure B.4: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a financial shock consisting in an increase in bank riskiness for Portugal, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

B.2. Slovenia



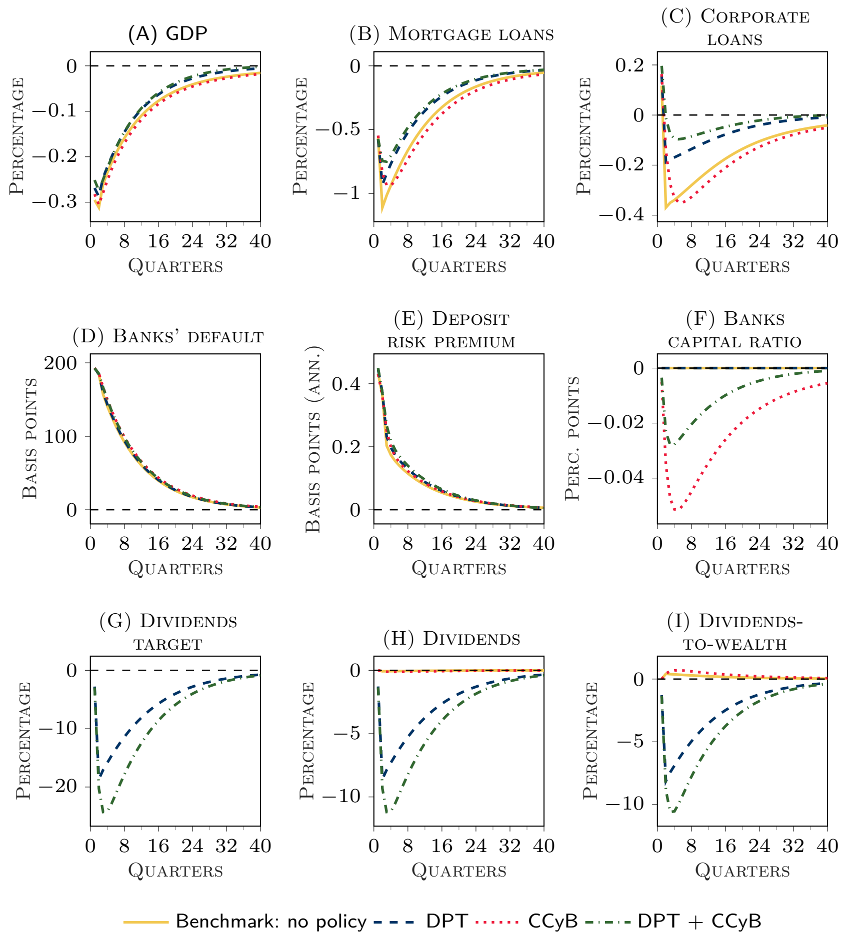
Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.5: Impulse response functions of GDP and the main aggregate financial variables to a productivity shock for Slovenia.



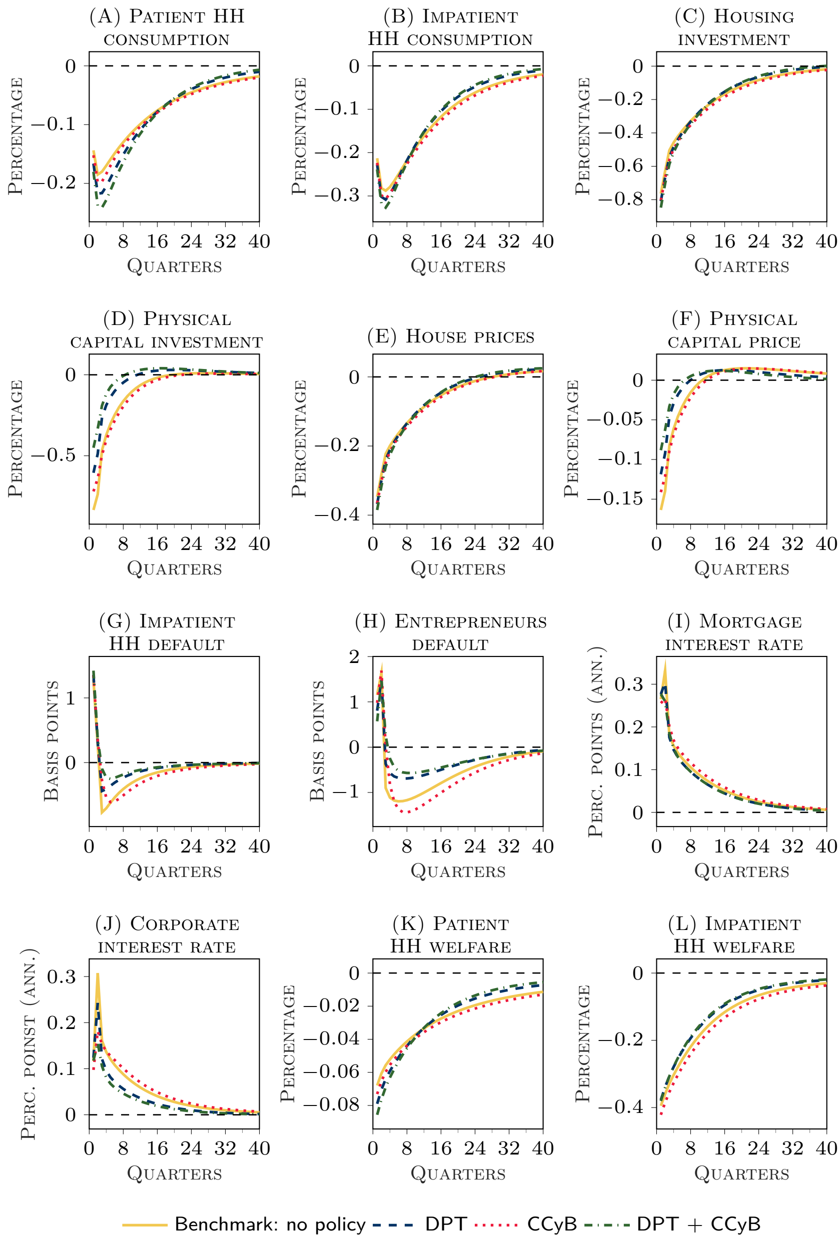
Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.6: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a productivity shock for Slovenia.



Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.7: Impulse response functions of GDP and the main aggregate financial variables to a financial shock consisting in an increase in bank riskiness for Slovenia.



Notes: Simulation with ρ_{CCyB} set at 0.1 to denote the responsiveness of the CCyB to deviations in total credit from its steady-state level, with ρ_x at 1.5 indicating the responsiveness of the DPT rule also to deviations in total credit from its steady-state level, and κ_P adjusted to 200, for a stronger commitment to the dividend restriction, and κ^B set also to 200 (bankers higher preference for dividends smoothing).

Figure B.8: Impulse response functions of consumption, investment, asset prices and other relevant financial variables by sector/groups of agents to a financial shock consisting in an increase in bank riskiness for Slovenia.

Appendix C: Model description

C.1. Households

Patient Households

Patient households maximizes its expected lifetime utility:

$$\mathbb{E}_t \left[\sum_{i=0}^{\infty} (\beta^s)^{t+i} [\log(c^s_{t+i}) + \tau_t \upsilon^s \log(h^s_{t+i-1}) - \frac{\phi^s}{1+\eta} (l^s_{t+i})^{1+\eta}] \right] \tag{C.1}$$

subject to

$$\begin{aligned} c^s_t + q^k_t(K^s_t + s^k_t) + q^H_t h^s_t + d_t \leq w_t l^s_t + q^H_t (1 - \delta^H_t) h^s_{t-1} + \\ + (r^k_t + (1 - \delta^K_t) q^k_t) K^s_{t-1} + \widetilde{R}^D_t d_{t-1} - T^s_t + \Pi^s_t \end{aligned} \tag{C.2}$$

where c^s_t is the consumption of non-durable goods, h^s_t is the total stock of housing, l^s_t is the hours worked, η is the inverse of the Frisch elasticity of labour supply, τ_t is a housing preference shock, υ^s is a housing preference parameter ϕ^s is a labour preference parameter, q^H_t is the price of housing, $\delta^H_t \equiv \delta^H + \iota^H_t$ is the depreciation rate of housing units, subject to the shock ι^H_t, w_t is the real wage rate, q^k_t is the price of physical capital, $\delta^k_t \equiv \delta^K + \iota^K_t$ is the depreciation rate of physical capital units, subject to the shock ι^k_t, K^s_t is the stock of physical capital, and s^k_t is the fee paid to the capital management firms. $\widetilde{R}^D_t$ is defined as $\widetilde{R}^D_t \equiv R^D_{t-1}(1 - \gamma PD^b_t)$, where R^D_t is the gross fixed interest rate received at t on the savings deposited at banks at $t-1$, denoted by d_t, and PD^b_t is the economy-wide probability of bank default in period t. T^s_t is a lump-sum tax to finance the deposit insurance,and Π^s_t stands for the donations ("dividends payments"), made by entrepreneurs and bankers, and for the profits received.

Impatient Households

Impatient households maximize their expected lifetime utility:

$$\mathbb{E}_t \left[\sum_{i=0}^{\infty} (\beta^m)^{t+i} [\log(c^m_{t+i}) + \tau_t \upsilon^m \log(h^m_{t+i-1}) - \frac{\varphi^m}{1+\eta} (l^m_{t+i})^{1+\eta}] \right] \tag{C.3}$$

subject to

$$\begin{aligned} c^m_t + q^H_t h^m_t - b^m_t \leq w_t l^m_t - T^m_t \\ + \int_0^{\infty} \max\{\omega^m_t q^H_t (1 - \delta^H_t) h^m_{t-1} - R^m_{t-1} b^m_{t-1}, 0\} dF^m(\omega^m_t) \end{aligned} \tag{C.4}$$

where T^m_t is to the lump-sum tax imposed to impatient households to cover the losses of the deposit insurance agency, b^m_t is aggregate borrowing from the banks, R_{t-1}^m is the gross interest rate, b_{t-1}^m is the mortgage loan, ω_t^m is an idiosyncratic shock to efficiency units of housing owned. The shock is assumed to be independently and identically distributed across impatient households and to follow a lognormal distribution with density and cumulative distributions functions denoted by $f(\cdot)$ and $F(\cdot)$, respectively. Individual households default in period t whenever the idiosyncratic shock ω_t^m satisfies:

$$\omega_t^m \leq \bar{\omega}_t^m = \frac{x_{t-1}^m}{R_t^H} \tag{C.5}$$

C.2. Entrepreneurs

The problem of the entrepreneurs in period $t+1$ is:

$$\max_{\left\{c_{t+1}^e, n_{t+1}^e\right\}} \quad (c_{t+1}^e)^{\chi^e}(n_{t+1}^e)^{1-\chi^e} \tag{C.6a}$$

$$\text{s.t.}$$

$$c_{t+1}^e + n_{t+1}^e \leq W_{t+1}^e, \tag{C.6b}$$

where W_{t+1}^e is the wealth in $t+1$ resulting from the activity in the previous period, c_{t+1}^e is the transfers made to the patient households, n_{t+1}^e is the entrepreneurs wealth (retained earnings), and $\chi^e \in (0,1)$ reflects the entrepreneurs preferences.

C.3. Banks

Each bank maximizes the expected equity payoff:

$$\pi_{t+1}^j = \max\left\{\omega_{t+1}^j \tilde{R}_{t+1}^j b_t^j - R_t^D d_t^j, 0\right\} \tag{C.7}$$

subject to the bank's capital constraint:

$$e_t^j \geq \phi_t^j b_t^j, \tag{C.8}$$

where ϕ_t^j is the bank's capital ratio, ω_{t+1}^j is an idiosyncratic portfolio return shock, which is i.i.d. across banks and follows a log-normal distribution with mean one and a distribution function $F^j(\omega_{t+1}^j)$, b_t^j and d_t^j are respectively the loans granted and deposits taken by bank at period t, R_t^D is the gross interest rate paid on deposits taken in period t and $\tilde{R}_{t+1}^j$ is the realized return on a well-diversified portfolio of loans of type j.

C.4. Production sector

The production technology is given by a standard Cobb-Douglas function:

$$y_t = A_t k_{t-1}^{\alpha} l_t^{(1-\alpha)} \tag{C.9}$$

where A_t is total factor productivity and α is the output elasticity of capital, k_{t-1} is the physical capital and l_t is the labour supplied by households.

Optimality in the use of the physical capital and labour input requires

$$r_t^K = \alpha \frac{y_t}{k_{t-1}} \tag{C.10}$$

and

$$w_t = (1-\alpha)\frac{y_t}{l_t} \tag{C.11}$$

C.5. Physical capital and housing production

The objective of the representative physical capital producing firms is to maximize expected profits:

$$\mathbb{E}_t \sum_{i=0}^{\infty} (\beta^s)^i \left(\frac{c_t^s}{c_{t+i}^s}\right) \left\{ q_{t+i}^K I_{t+i}^K - \left[1 + g^K \left(\frac{I_{t+i}^K}{I_{t+i-1}^K}\right)\right] I_{t+i}^K \right\} \tag{C.12}$$

where I_t^K is the investment from physical capital producers and q_t^K is the price of physical capital.

The maximization problem of the representative housing producing firm is:

$$\mathbb{E}_t \sum_{i=0}^{\infty} (\beta^s)^i \left(\frac{c_t^s}{c_{t+i}^s}\right) \left\{ q_{t+i}^H I_{t+i}^H - \left[1 + g^H \left(\frac{I_{t+i}^H}{I_{t+i-1}^H}\right)\right] I_{t+i}^H \right\} \tag{C.13}$$

where I_t^H the investment to produce new units of housing and q_t^H is the housing price.

C.6. Capital management firms

The profits of physical capital management firms are given by:

$$PI_t^k = s_t^k K_t^s - z_t^k \tag{C.14}$$

The revenues (per unit of capital) of capital management firms are:

$$s_t^k = \xi^K {K_t^s}^{\phi^K - 1} \tag{C.15}$$

And the costs of capital management firms are given by:

$$z_t^k = \frac{\xi^K k_t^s}{\phi^K {K_t^s}^{\phi^K}} \tag{C.16}$$

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