Capital Requirements in Light of Monetary Tightening*

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In 2021, euro-area inflation surged, prompting the European Central Bank to reverse its monetary stance. This paper argues that this shift did not generate significant financial stress, partly because of the bank capital requirements introduced in the 2010s. We develop a framework to assess their effects over the business cycle. Although capital requirements remained broadly stable, they shaped the transmission of the structural shocks underlying this episode. We find that while these requirements modestly constrained post-COVID growth, they successfully prevented the materialization of risks. Overall, capital requirements strengthened the economy's resilience to adverse shocks at a relatively low macroeconomic cost.

JEL Codes: E44, E52, E58, G28.

1. Introduction

Starting in 2021, euro-area inflation surged, prompting the European Central Bank (ECB) to sharply tighten its monetary stance. The rapid increase in interest rates could have generated financial stress, for instance if lenders had imperfectly hedged fixed-income positions or if borrowers had been unable to absorb the rise in financing

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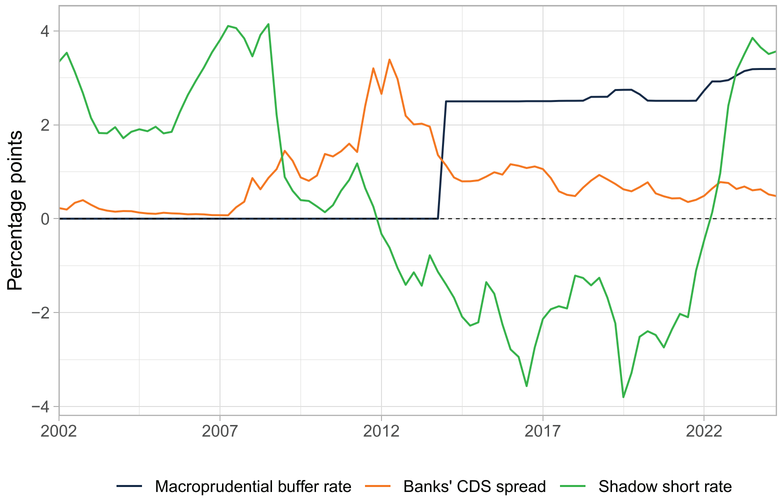
Figure 1. Monetary Policy, Macroprudential Buffer, and Financial Risks



Source: ESRB, Bloomberg, Krippner (2013).
Note: The macroprudential buffer rate is the simple average of the capital conservation buffer (CCoB), systemic risk buffer (SyRB), and countercyclical capital buffer (CCyB) rates, measured at their announcement rather than implementation date. Banks' CDS spread corresponds to the average spread of a sample of euro-area banks, weighted by their market capitalization. The shadow short rate is an estimate of the implicit short-term interest rate derived from the yield curve, accounting for the unconventional monetary policies implemented over the period.

costs. Such risks were particularly salient given prevailing financial and macroeconomic conditions. First, Figure 1 shows a U-shaped ECB's stance over the past 15 years, a pattern historically associated with financial crises (Jiménez et al. 2022). Second, part of the surge in inflation stemmed from supply-side forces, another well-documented predictor of financial stress (Boissay et al. 2025). Yet, despite these regularities, the euro area did not experience a major financial disruption, as evidenced by the only modest increase in banks' credit default swap (CDS) spreads after 2022 (see Figure 1). This paper argues that a key reason lies in the bank capital requirements introduced during the 2010s.

Indeed, the prudential environment faced by banks today differs substantially from that prevailing during past monetary tightening episodes. Following the 2008 Global Financial Crisis (GFC) and the 2010 euro-area sovereign debt crisis, European authorities introduced a range of prudential instruments that raised banks' capital requirements from 8 percent to at least 10.5 percent of risk-weighted assets (see Figure 1).[1] Although these tools were initially conceived as countercyclical instruments, consistent with early academic contributions on the topic (Mendoza 2010; Bianchi 2011), authorities have since reassessed this view. During the monetary tightening of 2021–23, despite a marked slowdown in credit growth, these capital buffers were not released. In some jurisdictions, they were even tightened. Overall, capital requirements have been used primarily to bolster banks' resilience rather than to smooth the financial cycle (Hempell, Scalone, and Silva 2024; ECB-ESRB 2025).

In this paper, we assess the implications of this new prudential paradigm in a context of monetary tightening. Although capital requirements have remained relatively stable over time, they can nonetheless shape the transmission of the structural shocks underlying macroeconomic fluctuations. We develop a framework to quantify the costs and benefits of time-invariant capital requirements over the business cycle. Our analysis focuses on the post-COVID period and the subsequent monetary tightening episode, which represents the most volatile macroeconomic environment in the euro area since the post-GFC regulatory reforms. We find that while capital requirements modestly constrained post-COVID growth, they also prevented the materialization of financial risks as the ECB raised policy rates. Put differently, capital requirements acted as automatic stabilizers, complementing monetary policy. Overall, they have contributed to safeguarding macrofinancial resilience at a relatively low macroeconomic cost.

[1] The first measure strengthened time-invariant requirements through the capital conservation buffer (CCoB). The second introduced potentially time-varying and sector-specific buffers, namely the systemic risk buffer (SyRB) and the countercyclical capital buffer (CCyB). A third measure established additional requirements for systemically important institutions. This last dimension lies beyond the scope of the present paper, as it would require explicitly modeling heterogeneous banks. While this framework is defined at the European level, its specific design and activation are determined nationally. See the European Systemic Risk Board (ESRB) website for details.

To evaluate the contribution of capital requirements to business cycle dynamics, we employ a medium-scale New Keynesian dynamic stochastic general equilibrium (DSGE) model with financial frictions, building on Clerc et al. (2015) and Mendicino et al. (2018). The model features two dynasties of households: patient households, who own banks and nonfinancial corporations, and impatient households, who borrow from banks. Both impatient households and nonfinancial corporations can default on their loans, which entails costly bankruptcies. Banks, in turn, borrow from patient households, who are assumed to be myopic with respect to banks' risk profile. A prudential authority therefore imposes a limit on banks' leverage through capital requirements. We estimate the model using euro-area data from 2002:Q1 to 2024:Q2 and recover the structural shocks over this period. Given that the model includes a broad set of standard structural disturbances, we can jointly fit a large number of macro-financial series and identify the main drivers of the business cycle, particularly during the post-COVID monetary tightening. We then construct counterfactual scenarios altering the level and design of capital requirements to assess the effects of the current prudential framework.

We find that the post-COVID increase in interest rates was driven by a combination of consumption catch-up and cost-push shocks. Importantly, while standard markup shocks account for a non-negligible share of these cost-push shocks, the model attributes a substantial role to shocks to the marginal efficiency of investment (MEI) for nonfinancial corporations. This reflects the coexistence of high inflation and policy rates with resilient investment activity, a pattern that MEI shocks can naturally rationalize. By contrast, risk shocks in the spirit of Christiano, Motto, and Rostagno (2014) play only a limited role, consistent with the subdued volatility of bank credit. The MEI shock is typically interpreted as capturing variations in the effectiveness of financial intermediation (Justiniano, Primiceri, and Tambalotti 2011). In the present context, it may reflect, among other factors, the widening of banks' net interest margins and the growing role of nonbank intermediaries during the monetary tightening, consistent with the deposit channel of monetary policy (Drechsler, Savov, and Schnabl 2017).

Against this backdrop, our counterfactual exercise indicates that time-invariant capital requirements act as effective automatic stabilizers. While they slightly dampened gross domestic product (GDP) growth during the 2022 expansion, they also reduced banks' probability of default at the start of 2023, thereby supporting credit and activity during the subsequent slowdown. These results stem from the specific combination of shocks characterizing this episode: although capital requirements somewhat attenuated the transmission of positive MEI shocks to GDP, they also limited the macroeconomic cost of banks' and firms' risk shocks. Even though risk shocks played a modest role during the period under study, this finding underscores the effectiveness of capital requirements in mitigating financial risks at a low macroeconomic cost. Moreover, we find that capital requirements generate heterogeneous effects across savers and borrowers, emphasizing their role in intertemporal risk sharing. Finally, we show that sectoral capital requirements on housing loans (such as those implemented in several European jurisdictions) are particularly effective: during the episode we analyze, they (would have) alleviated the dampening impact of broad-based capital requirements on the propagation of positive MEI shocks. Overall, our results highlight the role of capital requirements in ensuring macroeconomic resilience over the business cycle.

Literature Review. We contribute to a growing literature examining the link between monetary policy tightening and financial stress by highlighting the mitigating role of capital requirements. Boissay et al. (2021) and Jiménez et al. (2022) show that abrupt increases in interest rates following prolonged monetary accommodation tend to trigger financial stress. Boissay et al. (2025) further emphasize that the nature of inflationary shocks matters: supply-driven inflation raises financial stress, whereas demand-driven inflation does not. In contrast, we stress the role of a stabilizing factor in this relationship, namely, the level of bank capital requirements.

Our analysis also relates to the literature on the interaction between monetary and macroprudential policies, with a particular focus on a high-interest-rate environment. Much of the existing work studies *countercyclical* capital requirements in low-rate environments (Rubio and Carrasco-Gallego 2016; Rubio and Yao 2020). We instead focus on the dynamic properties of a *time-invariant* capital requirement in a context of high interest rates, when policymakers have reconsidered the macroprudential stance. Revelo and Levieuge (2022) show that monetary and macroprudential policies may conflict in the presence of supply-side or bank-capital shocks. By contrast, our framework emphasizes how banks' resilience shapes macroeconomic dynamics, leading us to conclude that these policies can be complementary in such cases. Consistent with Boissay et al. (2023), we find that tighter capital requirements provide greater room for monetary policy to combat inflation.

We further contribute to the literature studying capital requirements in structural general equilibrium models by identifying which shocks are most affected by these prudential instruments. While these models necessarily simplify banks' balance sheets compared with stress-testing frameworks, they allow for the analysis of second-round effects of financial shocks on macroeconomic stability and enable normative evaluation of prudential tools (Jondeau and Sahuc 2022). Most existing studies focus on the effects of *changes* in capital requirements, either in the long run or in response to specific shocks (Clerc et al. 2015; Poutineau and Vermandel 2017; Mendicino et al. 2018, 2020; de Bandt et al. 2022; Bratsiotis and Pathirage 2023; Gasparini et al. 2024). In contrast, we examine the role of a given, *time-invariant level* of capital requirements in the propagation of a broad set of real and financial shocks, thereby identifying which shocks are most sensitive to prudential constraints.

Finally, we also contribute to the literature on the drivers of post-COVID inflation, though our focus is primarily on interest rate dynamics. Recent empirical work highlights the roles of price and wage rigidities (Arce et al. 2024; Giannone and Primiceri 2024; Bernanke and Blanchard 2025; Eickmeier and Hofmann 2025). We complement this evidence by estimating a New Keynesian DSGE model for the euro area that embeds financial frictions. In line with the literature, we find that the surge in inflation and interest rates resulted from a complex mix of supply and demand shocks. However, our results underscore the importance of positive MEI shocks, which help rationalize the resilience of investment and growth in the euro area despite the sharp monetary tightening.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 describes the data and estimation strategy. Section 4 discusses the estimation results and the identified structural shocks, with a focus on the 2021–24 period. Section 5 quantifies the role of capital requirements in the transmission of these shocks. Section 6 concludes.

2. Model

This section presents an overview of the model, which extends Clerc et al. (2015) to analyze the transmission mechanisms of capital requirements under various shocks. We describe the optimization problems faced by each type of agent. The complete set of equilibrium conditions, including optimality and market-clearing relations, is provided in the appendix.

The economy is populated by two dynasties of infinitely lived households (HH), patient (p) and impatient (i), which differ in their discount factors ($\beta^i < \beta^p$). Within each dynasty, members perfectly share risk. Both types of households consume, supply labor, and accumulate housing. Patient households additionally accumulate productive capital and save through bank deposits. They own all firms in the economy and pay a lump-sum tax to finance the partial deposit insurance provided by the government. Impatient households, by contrast, borrow from banks and are subject to idiosyncratic housing-quality shocks that can lead to default, thereby giving rise to a borrowing constraint.

A continuum of monopolistic intermediate goods firms produce differentiated goods using rented physical capital and labor. Prices are sticky due to Calvo-type rigidity. Perfectly competitive final-good producers combine these intermediate goods into a homogeneous final output, which is either consumed or used by capital and housing producers who face dynamic adjustment costs. Productive capital is owned by both capital management firms and nonfinancial corporations (NFCs). NFCs, which are owned by entrepreneurs belonging to patient households, rely on bank loans and are exposed to idiosyncratic capital-quality shocks that can lead to default, thereby inducing a borrowing constraint.

There are two types of competitive banks. Both collect deposits from patient households and raise equity from bankers. One type extends loans to impatient households, while the other lends to NFCs.[2] Each bank faces portfolio management costs that may result

[2]This specialization simplifies the pricing problem of each bank type and allows for a heterogeneous transmission of risks across sectors within a period, while still preserving intertemporal transmission through bankers' portfolio reallocation between the two bank types.

in default. Since savers are myopic to banks' individual risk profiles, they do not impose participation constraints. Consequently, banks have an incentive to overleverage, which calls for policy intervention through a capital requirement, limiting loans to a fixed fraction of equity. Banks are owned by bankers, who are members of the patient household and allocate resources so as to equalize expected returns across the two bank types. Banks' balance sheets affect the economy through two main channels: the *net worth channel*, whereby bank profitability influences the income accruing to patient households, and the *credit supply channel*, whereby bank profitability determines the tightness of borrowing constraints faced by debtors.

Finally, the public sector comprises three authorities. The government finances a stochastic stream of expenditures and the deposit insurance scheme through lump-sum taxation. The deposit insurance agency guarantees a fixed share of deposits. The monetary authority sets the short-term nominal interest rate according to a standard Taylor rule.

The model is subject to 11 structural shocks. Following Smets and Wouters (2007), six are standard real shocks: total factor productivity, labor productivity, price markup, monetary policy, time preference, and government spending shocks. In addition, five financial shocks are introduced: two shocks to the marginal efficiency of investment in housing and productive capital, and three risk shocks affecting housing, productive capital, and banks' portfolios. MEI shocks represent exogenous changes in the efficiency with which investment goods are transformed into productive capital, thereby capturing the overall effectiveness of the financial system's intermediation function, as in Justiniano, Primiceri, and Tambalotti (2011). Risk shocks correspond to shocks to the cross-sectional distribution of capital quality and are best interpreted as volatility shocks (Christiano, Motto, and Rostagno 2014).

2.1 Households

Patient Households. The economy features a mass $m^p \in (0,1)$ of infinitely lived patient households. Each household comprises a mass m^e of entrepreneurs, a mass m^b of bankers, and a mass $m^w = m^p - m^e - m^b$ of workers. In every period, an entrepreneur becomes a worker with probability $1 - \theta^e$, and a banker becomes a worker with probability $1-\theta^b$. A corresponding mass of workers is drawn to replace the exiting entrepreneurs and bankers, ensuring that the relative shares of each household member type remain constant over time. The household collects income from all of its members and provides perfect risk sharing among them.

The representative patient households has utility given by

$$\mathbb{E}_t\left[\sum_{s=0}^{\infty}(\beta^p)^s \mathrm{e}^{\zeta_{c,t+s}}\left(\log(c^p_{t+s}-\psi\bar{c}^p_{t+s-1})+\upsilon^p\log(h^p_{t+s}) - \frac{\varphi^p}{1+\eta}\Theta^p_{t+s}(\ell^p_{t+s})^{1+\eta}\right)\right],$$

where c^p_t denotes consumption of nondurable goods at time t, Ψ is the consumption-smoothing parameter, $\bar{c}^p_t$ is the aggregate counterpart of c^p_t, h^p_t is the total stock of housing held by the household's members, and ℓ^p_t denotes labor supply. The parameter $\varphi>0$ is a scale factor, and $\eta>0$ is the inverse of the Frisch elasticity of labor supply. The consumption preference parameter $\zeta_{c,t}$ is an exogenous taste shifter following an AR(1) process. Finally, we introduce an endogenous taste shifter Θ^p_t, which is taken as given by patient households and evolves according to

$$\Theta^p_t = \frac{J^p_t}{\bar{c}^p_t-\psi\bar{c}^p_{t-1}}, \tag{1}$$

where

$$J^p_t = (J^p_{t-1})^{1-\zeta_J}[(\bar{c}^p_t-\psi\bar{c}^p_{t-1})]^{\zeta_J}. \tag{2}$$

The specification of the endogenous taste shifter follows Galí (2011) and Galí, Smets, and Wouters (2012). Compared with Jaimovich-Rebelo preferences (Jaimovich and Rebelo 2009), it introduces a distinction between the short-run wealth effect on labor supply and its long-run counterpart, through the endogenous taste shifter parameter ζ_J.

The household maximizes the above objective subject to the sequence of budget constraints:

$$P_t c_t^p + D_t^p + Q_t^H h_t^p + (Q_t^K + P_t s_t^K) k_t^p + T_t^p \leq W_t \ell_t^p + \tilde{R}_t D_{t-1}^p$$
$$+ Q_t^H (1 - \delta^H) h_{t-1}^p + (P_t r_t^K + (1 - \delta^K) Q_t^K) k_{t-1}^P + \frac{1}{m^p} P_t \mathrm{Div}_t, \quad (3)$$

where P_t denotes the price of nondurable goods; Q_t^H and Q_t^K the prices of housing and capital goods, respectively; and W_t the nominal wage rate. T_t^p represents a lump-sum tax, and s_t^K is a per-unit real management cost, taken as given by the household and paid to capital management firms. Div_t denotes the total real dividends received by patient households from capital good producers, monopolistic firms, entrepreneurs, financial intermediaries, and capital management firms.

D_t denotes the stock of nominal deposits held at time t, which pay a gross nominal interest rate $\tilde{R}_t$. This return has two components. A fraction $\kappa \in [0, 1]$ represents insured deposits, remunerated at the contractual nominal rate R_{t-1}. The remaining fraction corresponds to uninsured debt, which pays (i) R_{t-1} in the absence of default, and (ii) the net recovery value of bank assets in the event of default. Because savers cannot observe individual banks' risk profiles, they value bank debt according to the expected credit risk of an average unit of bank liabilities. It follows that

$$\tilde{R}_t = R_{t-1} - (1 - \kappa)\Omega_t, \quad (4)$$

where Ω_t is the average default loss per unit of bank debt.

Impatient Households. There is a mass $m^i = 1 - m^p$ of infinitely lived, identical, impatient households. The representative impatient households has utility given by

$$\mathbb{E}_t \left[\sum_{s=0}^{\infty} (\beta^i)^s \mathrm{e}^{\zeta_{c,t+s}} \left(\log(c_{t+s}^i - \psi \bar{c}_{t+s-1}^i) + \upsilon^i \log(h_{t+s}^i) - \frac{\varphi^i}{1+\eta} \Theta_{t+s}^i (\ell_{t+s}^i)^{1+\eta} \right) \right],$$

where the utility function and notations are identical to those introduced for patient households. Impatient households differ, however, in their budget constraint. At time t, the representative impatient household borrows a nominal amount B_t^i from banks, which is evenly distributed across its members. Each household member purchases h_t^i units of housing at the nominal price Q_t^H. At the beginning of period $t+1$, the housing stock is subject to an idiosyncratic shock ω_{t+1}^i, drawn from a log-normal distribution with mean $-\frac{1}{2}\exp(\zeta_{i,t})\bar{\sigma}_i^2$ and standard deviation $\exp(\zeta_{i,t})\bar{\sigma}_i$, where $\zeta_{i,t}$ follows an AR(1) process. These shocks are i.i.d. across time and household members. At time $t+1$, the household member sells the undepreciated portion of the housing stock, earning the nominal amount $(1-\delta^H)Q_{t+1}^H h_t^i$, and repays debt at the noncontingent gross nominal interest rate R_t^i. The household member retains the option to default on debt. The impatient household therefore maximizes expected lifetime utility subject to the following resource constraint:

$$\begin{aligned} P_t c_t^i + Q_t^H h_t^i &\leq P_t w_t \ell_t^i + B_t^i \\ &+ \int_0^\infty \max\{\omega^i(1-\delta^H)Q_{t+1}^H h_t^i - R_t^i B_t^i; 0\} f_{t+1}^i(\omega^i) d\omega^i \end{aligned}$$

and banks' participation constraint.

2.2 Production

Final Good Production. The final good is produced by perfectly competitive firms by combining a continuum of intermediate goods according to the constant-returns-to-scale (CES) production technology

$$y_t = \left(\int_0^1 y_t(f)^{\frac{1}{\mu_t}} df \right)^{\mu_t}, \tag{5}$$

where $\mu_t = \mu e^{\zeta_{\mu,t}}$ is the markup of intermediary good producers with $\zeta_{\mu,t} \sim ARMA(1,1)$. Let P_t denote the nominal price of the final good and let $P_t(f)$ denote the nominal price of good f. Firms are price takers and seek to maximize nominal profits

$$P_t y_t - \int_0^1 P_t(f) y_t(f) df.$$

Intermediary Goods Production. Intermediate good f is produced by monopolist f by combining labor and capital according to

$$y_t(f) = \mathrm{e}^{\zeta_{a,t}}(k_t(f))^{\alpha}(\mathrm{e}^{\zeta_{z,t}}\ell_t(f))^{1-\alpha}, \tag{6}$$

where $\alpha \in (0,1)$ is the elasticity of gross production with respect to capital, $\zeta_{a,t}$ a stochastic total factor productivity, and $\zeta_{z,t}$ a stochastic labor productivity. Both these variables follow an $AR(1)$ process. The rental rate of capital r_t^K and the wage rate w_t are taken as given by firm f. In a first step, firm f seeks to minimize production costs, given a production level $y_t(f)$:

$$\begin{aligned} &\min_{k_t(f),\ell_t(f)} \{r_t^K k_t(f) + w_t \ell_t(f)\} \\ &\text{s.t.} \quad \mathrm{e}^{\zeta_{a,t}}(k_t(f))^{\alpha}(\mathrm{e}^{\zeta_{z,t}}\ell_t(f))^{1-\alpha} = y_t(f), \\ &\qquad\quad k_t(f) \geq 0, \quad \ell_t(f) \geq 0. \end{aligned}$$

In a second step, firm f chooses its nominal price $P_t(f)$ to maximize the value to its shareholders (the patient households), taking into account the demand schedule of final good producers. At time t, firms discount payoffs at $t+s$ by $(\beta^p)^s\lambda_{t+s}^p$, where λ_{t+s}^p denotes the marginal utility of consumption of patient households at $t+s$. Firm f faces nominal rigidities à la Calvo: in each period, it can reset its price with probability $1-\xi$, where $\xi \in (0,1)$. If not allowed to reset its price at t, firm f mechanically updates its price according to

$$P_t(f) = (\Pi_*)^{1-\iota}(\Pi_{t-1})^{\iota}P_{t-1}(f),$$

where $\iota \in (0,1)$, $\Pi_t \equiv P_t/P_{t-1}$, and Π_* denotes the steady-state inflation rate. Accordingly, firm f selects $P_t^\star(f)$ to maximize. Firm f thus selects $P_t^\star(f)$ so as to maximize

$$\begin{aligned} \mathbb{E}_t \sum_{s=0}^{\infty} (\beta^p\xi)^s \frac{\lambda_{t+s}^p}{\lambda_t^p} y_{t+s} \Bigg[& \left(\frac{\Delta_{t,t+s}P_t^\star(f)}{P_{t+s}}\right)^{\frac{1}{1-\mu_t}} \\ & - mc_{t+s}\left(\frac{\Delta_{t,t+s}P_t^\star(f)}{P_{t+s}}\right)^{\frac{\mu_t}{1-\mu_t}} \Bigg], \end{aligned}$$

where

$$\Delta_{t,t+s} = \prod_{j=t}^{t+s-1} (\Pi_*)^{1-\iota}(\Pi_j)^{\iota},$$

and where mc_t is the real marginal cost solution to the cost minimization problem.

Housing Good and Capital Good Production. Capital and housing goods producers face a similar problem. Let $J \in \{K, H\}$ denote the type of durable good produced, H standing for housing and K for capital. These firms produce i_t^J new units sold at nominal price Q_t^J and are owned by the patient households. The firm's technology is characterized by adjustment costs. In order to produce i_t^J units of new durable goods, the firm must spend

$$\left(1 + S_J\left(\frac{i_t^J}{i_{t-1}^J}\right)\right) i_t^J \mathrm{e}^{\zeta_{i_J,t}}$$

units of final good, where

$$S_J(X) = \frac{\psi_J}{2}\left(X-1\right)^2, \ \psi_J > 0, \zeta_{i_J,t} \sim AR(1).$$

Letting $q_t^J \equiv Q_t^J / P_t$, the typical capital producer seeks to maximize the value to their shareholders

$$\mathbb{E}_t\left\{\sum_{t=0}^{\infty}(\beta^p)^t\lambda_t^p\left[q_t^J i_t^J - \left(1 + S_J\left(\frac{i_t^J}{i_{t-1}^J}\right)\right) i_t^J \mathrm{e}^{\zeta_{i_J,t}}\right]\right\}.$$

The marginal efficiency of investment shock $\zeta_{i_J,t}$ reflects an exogenous change in the efficiency with which investment goods are transformed into capital ready for use in production as in Justiniano, Primiceri, and Tambalotti (2011).

Capital Management Firms. Households acquire units of physical capital through financial intermediaries that charge a management fee, thereby capturing the role of nonbank financial intermediation. The capital management cost s_t associated with households' direct holdings of capital k_t^p is a fee collected by a continuum of measure-one firms operating under decreasing returns to scale. Each firm faces a convex cost function $z(m^p k_t^p)$, where $z(0) = 0$,

$z'(\cdot) > 0$, and $z''(\cdot) > 0$. Capital management firms maximize profits according to

$$\text{Div}_t^c = s_t^K m^p k_t^p - z(m^p k_t^p).$$

We assume a quadratic cost function

$$z(x) = \frac{\xi_s}{2}(x)^2 \tag{7}$$

with $\xi_s > 0$.

Entrepreneurs. At the beginning of period t, entrepreneur j has net worth $N_t^e(j)$. The period $t+1$ gross nominal return on investment projects is Z_{t+1}^e. The individual entrepreneur seeks to solve the program

$$V_t^e = \max_{\widetilde{\text{Div}}_t^e, E_t^e} \left\{ \widetilde{\text{Div}}_t^e + \mathbb{E}_t \left[\beta^p \frac{\Lambda_{t+1}^p}{\Lambda_t^p} [(1-\theta^e) N_{t+1}^e + \theta^e V_{t+1}^e] \right] \right\}$$

$$\text{s.t.} \quad \widetilde{\text{Div}}_t^e + E_t^e \leq N_t^e,$$

$$N_{t+1}^e = Z_{t+1}^e E_t^e,$$

$$\widetilde{\text{Div}}_t^e \geq 0,$$

where Λ_t^p is the Lagrange multiplier associated with patient households' budget constraint.

Nonfinancial Corporations. Investment project j receives equity $E_t^e(j)$ from entrepreneurs, together with debt $B_t^e(j)$ from banks. These funds are used to acquire $k_t^e(j)$ units of capital at price Q_t^K. The balance sheet of investment project j is thus

$$E_t^e(j) + B_t^e(j) = Q_t^K k_t^e(j).$$

The capital stock is then subject to a quality shock ω_{t+1}^e at time $t+1$, drawn from a log-normal distribution with mean $-\frac{1}{2}\exp(\zeta_{e,t})\bar{\sigma}_e^2$ and standard deviation $\exp(\zeta_{e,t})\bar{\sigma}_e$, where $\zeta_{e,t}$ follows an AR(1) process. After the realization of the quality shock, the effective capital stock is rented to intermediate goods producers at the nominal rental rate $P_{t+1} r_{t+1}^K$. The capital depreciates at rate δ^K, and the undepreciated portion is sold back to capital producers at the price Q_{t+1}^K. At the end of period $t+1$, the entrepreneurial firm repays its gross debt obligations at rate R_t^e. Hence, the entrepreneurial firm maximizes the expected discounted value of net profits:

$$\mathbb{E}_t\left[\beta^p \frac{\Lambda_{t+1}^p}{\Lambda_t^p}(1-\theta^e+\theta^e v_{t+1}^e)\max\left\{\omega_{t+1}^e R_{t+1}^K Q_t^K k_t^e(j) \right.\right.$$
$$\left.\left. - R_t^e B_t^e(j); 0\right\}\right] - v_t^e E_t^e(j)$$

subject to banks' participation constraint, denoting

$$R_{t+1}^K = \frac{P_{t+1} r_{t+1}^K + (1-\delta)Q_{t+1}^K}{Q_t^K},$$

and where v_t^e is the Lagrange multiplier associated with entrepreneurs' balance sheet constraint.

2.3 Bankers and Banks

Bankers. An individual banker starts period t with net worth N_t^b, which is invested as equity (i) in a continuum of investment projects E_t^F and (ii) a continuum of housing projects E_t^M. The period $t+1$ aggregate gross nominal return on these projects is Z_{t+1}^b. The individual banker seeks to solve the program

$$V_t^b = \max_{\widetilde{\mathrm{Div}}_t^b, E_t^M, E_t^F} \left\{\widetilde{\mathrm{Div}}_t^b + \mathbb{E}_t\left[\beta^p \frac{\Lambda_{t+1}^p}{\Lambda_t^p}[(1-\theta^b)N_{t+1}^b + \theta^b V_{t+1}^b]\right]\right\}$$

$$\text{s.t.} \quad \widetilde{\mathrm{Div}}_t^b + E_t^M + E_t^F \leq N_t^b,$$

$$N_{t+1}^b = Z_{t+1}^M E_t^M + Z_{t+1}^F E_t^F,$$

$$\widetilde{\mathrm{Div}}_t^b \geq 0,$$

where Λ_t^p is the Lagrange multiplier associated with patient households' budget constraint.

Banks. At time t, a bank of type $j \in \{M, F\}$ takes equity E_t^j from bankers and borrows D_t^j at gross rate R_t from households to extend loans B_t^j. Hence the balance sheet constraint:

$$E_t^j + D_t^j = B_t^j.$$

The return at time $t + 1$ on a well-diversified portfolio of loans is denoted R_{t+1}^j. This portfolio is subject to a performance shock ω_{t+1}^j at $t + 1$, drawn from a log-normal distribution with mean $-\frac{1}{2}\exp(\zeta_{B,t})\bar{\sigma}_j^2$ and standard deviation $\exp(\zeta_{B,t})\bar{\sigma}_j$,[3] where $\zeta_{B,t}$ is common to both bank types and follows an AR(1) process. At the end of period $t+1$, the bank pays the gross interest rate on deposits. A bank of type j thus maximizes

$$\mathbb{E}_t\left[\beta^p \frac{\Lambda_{t+1}^p}{\Lambda_t^p}(1 - \theta^b + \theta^b v_{t+1}^b)\max\left\{\omega_{t+1}^j R_{t+1}^j B_t^j - R_t D_t^j; 0\right\}\right] - v_t^b E_t^j,$$

where v_t^b is the Lagrange multiplier associated with bankers' balance sheet constraint.

Because of limited liability, shareholders' payoffs cannot be negative. Whenever $\omega_{t+1}^j R_{t+1}^j B_t^j < R_t D_t$, the bank defaults. In this event, its equity is written down to zero, and deposits are taken over by the deposit insurance agency (DIA), which reimburses an exogenous fraction κ of deposits. The DIA partially recovers these payments by seizing the failed bank's loan portfolio net of resolution costs, assumed to amount to a fraction μ^j of recovered assets.

Finally, the bank faces a regulatory capital constraint

$$E_t^j \geq \phi_t \gamma_t^j B_t^j, \tag{8}$$

which states that the capital-to-asset ratio must exceed a (possibly) time-varying level set exogenously by the prudential authority. This requirement is decomposed into two components: a broad-based risk-weighted capital requirement ϕ_t, common to all banks, and a risk weight γ_t^j, specific to each bank type. Both are assumed to be set exogenously by the prudential authority, consistent with the Basel

[3]This parameterization ensures that $\mathbb{E}_t[\omega_{t+1}^j] = 1$.

standardized approach to risk.[4] In equilibrium, this constraint binds with equality since deposits, being partially insured, are cheaper than equity (Mendicino et al. 2020). Hence, loans can be written as $B_t^j = \frac{E_t^j}{\phi_t \gamma_t^j}$.

Macroeconomic Shocks, Banks Balance Sheets, and Capital Requirements. Capital requirements affect the transmission of macroeconomic shocks to credit through two channels. A first channel goes through the denominator of the above ratio: the higher $\phi_t \gamma_t^j$, the lower the share of loans in the balance sheet, and the lower the financial accelerator. This suggests that capital requirements may act as automatic stabilizers across the business cycle. The bank net worth is a second channel. It follows the aggregate law of motion:

$$N_t^b = [(\theta^b + \chi_b(1 - \theta^b)](Z_t^M E_{t-1}^M + Z_t^F E_{t-1}^F),$$

where θ_b is the proportion of net worth left by retiring bankers to new bankers. Z_t^i is the aggregate return on equity:

$$Z_t^i = \frac{1}{\phi_t} R_t^i \Upsilon(\bar{\omega}_t^i),$$

where $\Upsilon(\cdot)$ denotes the aggregate value of banks' idiosyncratic shocks. This function depends on $\bar{\omega}_t^i$, the threshold below which banks default. A higher capital requirement lowers this threshold, thereby increasing banks' net worth. In addition, for a given reduction in bank risk, capital requirements alter the transmission of macroeconomic shocks to banks' portfolio returns R_t^i. For instance, holding risk constant, consumption-preference or marginal-efficiency shocks affect the return on bank portfolios R_t^i more strongly than risk shocks that directly affect the default threshold $\bar{\omega}_t^i$. Changes in net worth thus result from the interplay between two opposing effects: risk mitigation and reduced loan profitability. When net

[4]In practice, many banks use internal models where risk weights depend on estimated default probabilities. This simplification can still be justified: (i) the mapping between default probabilities and risk weights is nonlinear and would complicate the model; (ii) empirical default probabilities differ from banks' internal estimates due to portfolio selection and model optimization; and (iii) capital regulation allows supervisors to impose additional buffers or risk weights by asset class, which can be interpreted as an exogenous process.

worth remains positive, bankers reinvest it as equity to finance new loans. The relative strength of these two effects depends on the configuration of shocks hitting the economy. The remainder of the paper investigates this mechanism over the 2021–24 episode by solving and estimating the model.

2.4 Public Authorities

Government. The government levies lump-sum taxes $T_t = m^p T_t^p$ to finance the DIA and a stochastic flow of expenditures g_t. The budget is assumed to be balanced so that $T_t = T_t^{DIA} + P_t g_t$. Government expenditures follow the process $g_t = g e^{\zeta_{g,t}}$, with $\zeta_{g,t}$ following an $AR(1)$ process. We impose that in steady state $g/y = s_g$.

Deposit Insurance Agency. The DIA collects all payments from banks on the deposit market. The gross return on deposits from nondefaulting banks is recovered in full by the DIA. There is a fraction $1 - F_t^j(\bar{\omega}_t^j)$ of such deposits in the banking sector j. The remaining fraction is subject to default. In case of default, the DIA recovers the assets of the defaulting bank, net of a fraction μ^j due to recovery costs. The average default loss per unit of bank debt in sector j is thus

$$\Omega_t^j = \left(\int_0^{\bar{\omega}_t^j} f_{t+1}^j(\omega^j) d\omega^j \right) R_{t-1} - (1 - \mu^j) \left(\int_0^{\bar{\omega}_t^j} \omega^j f_t^j(\omega^j) d\omega^j \right) R_t^j \frac{B_{t-1}^j}{D_{t-1}^j}.$$

Let us define the aggregate average default loss per unit of bank debt:

$$\Omega_t = \frac{d_{t-1}^M}{d_{t-1}} \Omega_t^M + \frac{d_{t-1}^F}{d_{t-1}} \Omega_t^F. \quad (9)$$

The DIA insures a fraction κ of deposits and then redistributes the recovered net assets to the depositors, so that

$$\tilde{R}_t = \kappa R_{t-1} + (1 - \kappa)(R_{t-1} - \Omega_t) = R_{t-1} - (1 - \kappa)\Omega_t.$$

It follows that the total cost for the DIA of insuring deposits, and hence the total amount of lump-sum taxes, is

$$T_t^{DIA} = \kappa \Omega_t d_{t-1}.$$

Monetary Policy. The central bank sets the (gross) short-term nominal interest rate R_t according to the following monetary policy rule:

$$\log\left(\frac{R_t}{R_*}\right) = \rho_R \log\left(\frac{R_{t-1}}{R_*}\right) + (1-\rho_R)\left[a_\Pi \log\left(\frac{\Pi_t}{\Pi_*}\right) + a_y \log\left(\frac{GDP_t}{GDP_{t-1}}\right)\right] + \zeta_{R,t}, \quad (10)$$

where star values denote steady-state counterparts, ρ_R measures the degree of interest rate smoothing, a_Π measures the reaction to inflation, a_y measures the reaction to GDP, and $\zeta_{R,t}$ a white noise shock.

3. Data and Estimation

A key contribution of this paper is to bring a medium-scale DSGE model with a rich set of financial frictions and shocks to euro-area (EA) data. Identifying which shocks are most affected by capital requirements is essential, since their impact depends on the underlying source of macroeconomic fluctuations. Estimating the model allows us to disentangle these channels and to assess the macroeconomic consequences of the prevailing prudential stance, conditional on the nature of the business cycle.

The model is estimated using quarterly euro-area data spanning 2002:Q1–2024:Q2. Although this sample is relatively short and constrained by data availability, it covers nearly the entire lifetime of the euro area.[5] Parameters determining the steady state are calibrated independently of the model's dynamic properties, while the remaining parameters are estimated. Data sources are detailed in Table 1.

[5] Calibration targets are computed from the inception of the euro area whenever possible.

Table 1. Data Sources

Series	Source
Shadow Short-Term Interest Rate	Krippner (2013, 2015)
3-Month EURIBOR	ECB, FM, Q.U2.EUR.RT.MM.EURIBOR3MD_HSTA
Implicit GDP Price Index	Eurostat, MNA, Q.PD15_EUR.SCA.BIGQ.EA
Real GDP	Eurostat, MNA, Q.CLV15_MEUR.SCA.BIGQ.EA
Real Household Consumption	Eurostat, MNA, Q.CLV15_MEUR.SCA.P31_S14_S15.EA
Nominal Households' Investment	ECB, QSA, Q.Y.I9.W0.S1M.S1.N.D.P51G._Z._Z._Z.XDC._T.S.V.N._T
Nominal Firms' Investment	ECB, QSA, Q.Y.I9.W0.S11.S1.N.D.P51G._Z._Z._Z.XDC._T.S.V.N._T
Hours Worked	ECB, ENA, Q.Y.U2.W2.S1.S1._Z.EMP._Z._T._Z.HW._Z.N
EA Population (Changing Composition)	ECB, ENA, Q.N.U2.W0.S1.S1._Z.POP._Z._Z._Z.PS._Z.N
EA 20 Population (Fixed Composition)	ECB, ENA, Q.N.I9.W0.S1.S1._Z.POP._Z._Z._Z.PS._Z.N
Nominal Credit to Households	ECB, BSI, Q.U2.N.A.A20.A.1.U2.2250.Z01.E
Nominal Credit to Firms	ECB, BSI, Q.U2.N.A.A20.A.1.U2.2240.Z01.E
Real House Prices	OECD, House Prices, Q.EA.RHP
Banks' 5-Year CDS Premium	Bloomberg, Conversion into Default Probabilities (40% Recovery Rate)
Return on Equity, Banks	ECB, CBD2, Q.U2.W0.57._Z._Z.A.A.I2003._Z._Z._Z._Z._Z._Z.PC
Price-to-Book Ratio of Banks	Datastream
General Government Final Consumption Expenditure (% GDP)	Eurostat, Government Revenue, Expenditure and Main Aggregates, A.PC_GDP.S13.P3.EA19
Nominal GDP	ECB, MNA, Q.N.U2.W2.S1.S1.B.B1GQ._Z._Z._Z.EUR.V.N
Household Interest Rate	ECB, MIR, M.U2.B.A2C.A.R.A.2250.EUR.N
NFC Interest Rate	ECB, MIR, M.U2.B.A2A.A.R.A.2240.EUR.N
Lending for House Purchases: Up to 1 Year	ECB, BSI, M.U2.N.A.A22.F.1.U2.2250.Z01.E
Lending for House Purchases: Over 1 Year and Up to 5 Years	ECB, BSI, M.U2.N.A.A22.I.1.U2.2250.Z01.E
Lending for House Purchases: Over 5 Years	ECB, BSI, M.U2.N.A.A22.J.1.U2.2250.Z01.E
Loans to NFC: Up to 1 Year	ECB, BSI, M.U2.N.A.A20.F.1.U2.2240.Z01.E
Loans to NFC: Over 1 Year and Up to 5 Years	ECB, BSI, M.U2.N.A.A20.I.1.U2.2240.Z01.E
Loans to NFC: Over 5 Years	ECB, BSI, M.U2.N.A.A20.J.1.U2.2240.Z01.E
EURIBOR 3-Month	ECB, FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA
German Bond 3 Years	ECB, FM.B.DE.EUR.RT.BB.DE3YT_RR.YLD
German Bond 7 Years	ECB, FM.B.DE.EUR.RT.BB.DE7YT_RR.YLD
German Bond 20 Years	ECB, FM.B.DE.EUR.RT.BB.DE20YT_RR.YLD
Bank Loans in NFC Total Debt	BDF, CFT, Q.S.I8.W0.S11.S1.N.L.LE.F401.T._Z.XDC_R_DEBT._T.S.V.N._T

We implicitly assume that the structural features of the economy remain stable throughout the two decades of data used for calibration and estimation, a strong assumption made for tractability. Moreover, since the next section focuses on a counterfactual analysis of the post-COVID episode, our main interest lies in obtaining reasonable end-of-sample estimates for the parameters and shocks. Potential misspecifications at the beginning of the sample are therefore not excessively concerning. Finally, we assume that prudential authorities do not follow any preannounced rule known to all agents, as there was no mechanical adjustment of capital requirements across euro-area countries over the sample period.

3.1 Calibrated Parameters

A first subset of parameters is set prior to estimation. Some are commonly used in the literature, while others are chosen to simultaneously match a series of steady-state moments. These parameters are presented in Table 2. Targeted moments and their theoretical counterparts are presented in Table 3.

Demographics, Preferences, and Government. The share of impatient households m_i corresponds to the share of households with debt (Finance and Network 2013). The inverse Frisch elasticity is set to 4, following Galí (2010) and Chetty et al. (2011). The labor disutility parameters φ_p and φ_i are normalized to 1, as they only affect the scale of the economy. The discount factor of patient households is set to $\beta_p = 0.997$, targeting the risk-free rate.[6] The share of final government expenditure s_g is directly set from the data to 21 percent.

Production. The markup rate is set to 20 percent, implying $\mu = 1.2$. The depreciation rate of capital is set to $\delta_K = 0.03$. The capital share in production is $\alpha = 0.3$. The survival rate of entrepreneurs θ_e is set to 0.975, as in Gertler and Kiyotaki (2010). Transfers from households to entrepreneurs are calibrated to match the NFC debt-to-GDP ratio. The standard deviation of idiosyncratic shocks affecting entrepreneurs, $\bar{\sigma_e}$, is chosen to match the observed default probability of NFCs.

[6] See Iacoviello and Neri (2010) for a discussion of patient households' discount factor.

Table 2. Preset and Calibrated Parameters

	Parameter	**Value**
A. Preset Parameters		
Inverse Frisch Elasticity	η	4
Patient Disutility of Labor	φ^p	1
Impatient Disutility of Labor	φ^i	1
Bank M Bankruptcy Cost	μ_M	0.3
Bank F Bankruptcy Cost	μ_F	0.3
NFC Bankruptcy Cost	μ_e	0.3
HH Bankruptcy Cost	μ_i	0.3
Share of Insured Deposits in Bank Debt	κ	0.54
Consumption Smoothing	ψ	0.14
Productivity	A	1
Steady-State Markup	$1-\mu$	0.2
Capital Share in Production	α	0.3
Depreciation Rate of Capital	δ_K	0.03
Survival Rate of Entrepreneurs	θ_e	0.975
Capital Requirements for Bank F	ϕ_F	0.105
B. Calibrated Parameters		
Impatient Household Discount Rate	β_i	0.982
Patient Household Discount Rate	β_p	0.997
Housing Depreciation Rate	δ_h	0.009
Patient Housing Scale Factor	ν_p	0.064
Impatient Housing Scale Factor	ν_i	0.642
Management Cost	ξ_s	0.005
Survival Rate of Bankers	θ_B	0.873
Std. Idiosyncratic Shocks, Bankers M	$\bar{\sigma}_M$	0.013
Std. Idiosyncratic Shocks, Bankers F	$\bar{\sigma}_F$	0.043
Std. Idiosyncratic Shocks, Entrepreneurs	$\bar{\sigma}_e$	0.397
Std. Idiosyncratic Shocks, HH	$\bar{\sigma}_i$	0.361
Banker's Endowment	χ_b	0.869
Entrepreneur's Endowment	χ_e	0.329
Capital Requirements for Bank M	ϕ_M	0.037

Banks. The share of insured deposits in bank debt κ is set to 0.54, following Demirgüç-Kunt, Kane, and Laeven (2015). The survival rate of bankers θ_b is used to match the price-to-book ratio of

Table 3. Calibration Targets

	Target	Model
Indebted Households Share m_i	0.44	0.44
Final Gov. Consumption Exp. s_g	0.21	0.21
Risk-Free Rate $\bar{r}$	1.34%	1.34%
Yearly Inflation Rate	1.99%	1.99%
Return on Asset Equity	8.78%	8.78%
Housing Investment as a Share of GDP	0.06	0.06
HH Loans to (Quarterly) GDP	1.98	1.97
Housing among Households Capital	0.61	0.58
NFC Loans to (Quarterly) GDP	1.67	1.66
Banks Default Rate	1.22%	1.22%
Price-to-Book Ratio μ_b	1.15	1.12
Loan to Value	37.3%	37.7%
Capital Share of Households	0.16	0.16
Spread NFC Loans	1.38	1.36
Spread Households Loans	1.05	1.05
NFC Default Rate (Untargeted)	2.5%	2.16%
HH Default Rate (Untargeted)	1%	2.28%

euro-area banks, denoted μ_b. Transfers from bankers χ_b are chosen to reproduce banks' return on assets and equity. Capital requirements are assumed to remain constant throughout the calibration period, in line with Basel III standards. Since our primary interest lies in reproducing end-of-period conditions, we set the broad-based capital requirement to $\phi = 10.5\%$. Risk weights γ^F and γ^H are set to 0.35 and 1, respectively. The volatility parameter σ_F is used to match banks' probability of default. The ratio between σ_F and σ_M, which is not observed, is set such that $\frac{PD_F}{PD_M} = \frac{\gamma^F}{\gamma^M}$, ensuring an internally consistent sectoral capital structure. Although banks granting mortgages are therefore less risky than those lending to firms, household loans are not necessarily less risky than NFC loans.

Nonfinancial Corporations and Households. As it is impossible to target both the spread and the default probability of households and NFCs at the steady state (as they depend on the same parameter), we target the spread. The resulting nontargeted default probability remains consistent with the data (see Table 3).[7] The depreciation rate of housing capital δ_h, the discount factor of impatient households β_i, the housing utility scale factors υ_i and υ_p, the standard deviation of idiosyncratic shocks affecting households $\bar{\sigma_i}$, and the management cost ξ_s are set to jointly match: (i) housing investment as a share of GDP, (ii) the spread on household loans, (iii) housing as a share of capital held by patient households, (iv) household credit as a share of GDP, (v) the average loan-to-value ratio, and (vi) the share of capital held by households in total capital.

3.2 Estimated Parameters

The remaining parameters are estimated using 10 quarterly, calendar, and seasonally adjusted series: the GDP implicit price index, real GDP, real household consumption, the short-term interest rate, hours worked, real household investment, real nonfinancial corporations' investment, real credit to households, real credit to NFCs, and banks' default probabilities. Most of these variables are standard observables in the literature. A distinctive feature of the period under study, however, is the historically low level of nominal interest rates, suggesting that the monetary authority may have been constrained by an effective lower bound (ELB). While we do not explicitly model the ELB or unconventional monetary policy tools designed to circumvent it, we use as observable the shadow rate of Krippner (2013, 2015), i.e., the hypothetical short-term interest rate that would prevail if the ELB were not binding. This proxy enables us to analyze the role of capital requirements during the exceptional monetary tightening experienced in the euro area since 2020. When available, series correspond to a changing euro-area composition. In addition, because banks' risk shocks play a central role in assessing the macroeconomic implications of capital requirements,

[7] We compute targeted spreads between a composite interest rate on loans and the composite risk-free rate. The composite loan rate is the weighted average of interest rates by maturity (up to one year, one to five years, and over five years). The composite risk-free rate is the weighted average of the following benchmarks: the three-month eura-area interbank offered rate, or EURIBOR (up to 1 year); the three-year German bond yield (1 to 5 years); the 7-year German bond yield (over 5 years for NFC loans); and a weighted average of the 7-year and 20-year bond yields (over 5 years for housing loans).

we construct a series of banks' expected default probabilities from CDS spreads of a sample of large euro-area banks. All quantities are normalized by total population. With the exception of the short-term interest rate and banks' probability of default, all variables are expressed in demeaned log-differences to focus on cyclical dynamics.[8] Both the short-term interest rate and banks' probability of default are expressed as deviations from their steady-state values.

The estimation follows a Bayesian approach applied to a first-order log-linearized version of the model, using the Kalman filter. Computations are performed with the Dynare toolbox (Adjemian et al. 2024). Prior and posterior distributions are reported in Table 4. As the model expresses shocks in percent of their standard deviation, the estimated standard deviations are scaled accordingly. Priors are set consistently with the literature on New Keynesian models estimated on euro-area data. For parameters related to consumption habits, adjustment costs, price indexation, and the monetary policy rule, we follow Jondeau and Sahuc (2022), whose framework similarly focuses on macrofinancial interactions in the euro area. The prior for the taste-shifter trend follows Galí, Smets, and Wouters (2012). The prior mean for price rigidity is aligned with Smets and Wouters (2003), but we impose a relatively small standard deviation to avoid overestimating rigidity during the COVID episode, which featured a sharp drop in consumption but only a mild fall in inflation. This restriction is consistent with recent empirical evidence on pre-COVID euro-area price rigidity (Gautier et al. 2024). Finally, we adopt an agnostic stance regarding shocks by assigning identical priors to all of them.

One distinctive outcome of our estimation is the relatively low degree of habit formation compared with the literature (around 0.7), implying less consumption inertia. This is partly offset by a lower estimated trend in the endogenous taste shifter relative to the variant without unemployment as an observable variable studied in Galí, Smets, and Wouters (2012): in our case, the marginal rate of substitution between labor and consumption places greater weight on

[8]The series of investment by nonfinancial corporations display irregularities between 2015 and 2019 unrelated to macroeconomic conditions, primarily due to data for the Netherlands and Ireland. Their respective series are therefore excluded from the euro-area aggregate.

Table 4. Estimated Parameters

		Prior Distribution			Posterior Distribution	
		Dist.	Mean	Std.	Mean	Std.
A. Structural Parameters						
Endogenous Taste Shifter	ζ_J	Beta	0.5	0.2	0.0805	0.1205
Habits	ψ	Beta	0.4	0.1	0.1319	0.0423
Housing Adjustment Cost	ψ_H	Gamma	4	1	4.2464	0.8716
Capital Adjustment Cost	ψ_K	Normal	4	1	2.7013	0.5124
Price Rigidity	ξ	Beta	0.75	0.025	0.8681	0.0099
Price Indexation	ι	Beta	0.4	0.1	0.2917	0.0870
Monetary Policy Smoothing	ρ_R	Beta	0.8	0.1	0.8364	0.0146
MP Reaction to Inflation	a_Π	Normal	1.7	0.1	2.0256	0.0954
MP Reaction to GDP Growth	a_y	Normal	0.125	0.05	0.1206	0.0362
B. Shocks Standard Deviation						
Total Productivity	σ_a	Inv. Gam.	0.5	2	3.6483	0.8429
Labor Productivity	σ_z	Inv. Gam.	0.5	2	0.7786	0.0596
Markup	σ_μ	Inv. Gam.	0.5	2	23.1760	3.0251
Housing Adjustment	σ_{i_H}	Inv. Gam.	0.5	2	2.7875	0.2161
Capital Adjustment	σ_{i_K}	Inv. Gam.	0.5	2	5.0465	0.4658
Monetary Policy	σ_R	Inv. Gam.	0.5	2	0.1460	0.0129
Government Spending	σ_g	Inv. Gam.	0.5	2	2.1734	0.1672
Preference	σ_c	Inv. Gam.	0.5	2	2.4774	0.2556
NFC Risk	σ_e	Inv. Gam.	0.5	2	2.0718	0.2267
HH Risk	σ_i	Inv. Gam.	0.5	2	1.3335	0.1409
Bank Risk	σ_B	Inv. Gam.	0.5	2	4.1870	0.3169
C. Shocks Autocorrelation						
Total Productivity	ρ_a	Beta	0.5	0.2	0.8972	0.0317
Labor Productivity	ρ_z	Beta	0.5	0.2	0.9307	0.0195
Markup Shock	ρ_μ	Beta	0.5	0.2	0.0961	0.0519
Housing Adjustment Shock	ρ_{i_H}	Beta	0.5	0.2	0.6017	0.0547
Capital Adjustment Shock	ρ_{i_K}	Beta	0.5	0.2	0.7510	0.0354
Government Spending Shock	ρ_g	Beta	0.5	0.2	0.5761	0.0841
Time Preference Shock	ρ_c	Beta	0.5	0.2	0.4044	0.0930
NFC Risk Shock	ρ_e	Beta	0.5	0.2	0.9580	0.0209
HH Risk Shock	ρ_i	Beta	0.5	0.2	0.9685	0.0177
Bank Risk Shock	ρ_B	Beta	0.5	0.2	0.8970	0.0344

past consumption. Both features appear to reflect the inclusion of the COVID period. A variant estimated over the subsample ending in 2019:Q4 (although not perfectly comparable due to the nonstationarity of the short-term interest rate) yields a more conventional combination of these parameters. Adjustment costs are also somewhat lower for similar reasons but remain consistent with previous studies. Other estimated parameters are broadly standard. The monetary policy coefficients suggest that the shadow interest rate successfully captures the stance of unconventional policy at the ELB. As in Christiano, Motto, and Rostagno (2014), risk shocks—whether for households, nonfinancial corporations, or banks—are among the most persistent, together with total factor productivity and labor productivity shocks. The price markup shock displays high variance and short persistence, capturing high-frequency movements in inflation and the euro area's exposure to import price fluctuations. Other shocks, such as preference, government spending, and adjustment cost shocks, fall within intermediate ranges of persistence and volatility.

3.3 Model Evaluation

The resulting theoretical variance decomposition is reported in Table 5. A notable finding is the limited contribution of risk shocks, consistent with Pfeifer (2016). Most of the variation in macroeconomic aggregates is driven by standard sources of fluctuations—in particular, preference shocks. This partly reflects the fact that we use these shocks to match credit dynamics rather than credit spreads, in order to replicate the empirical behavior of the credit-to-GDP ratio, a key variable for macroprudential policymakers. It also reflects the estimation window, during which macroeconomic disturbances played a particularly prominent role. One might nevertheless question the relatively small contribution of bank risk shocks, despite the inclusion of the 2008–09 period in the estimation sample and the explicit use of banks' probability of default as an observable. This pattern stems from the fact that euro-area banks' default probabilities did not rise markedly in 2008, but rather in 2011, during the sovereign debt crisis. Although that episode was associated with below-trend growth, it did not exhibit the same crisis dynamics as 2008–09. In the model, therefore, risk shocks primarily capture the medium-run

Table 5. Variance Decomposition, in Percent

	σ_a	σ_z	σ_μ	σ_{i_K}	σ_{i_H}	σ_R	σ_g	σ_c	σ_e	σ_i	σ_B
GDP	4.38	3.66	6.54	15.31	1.05	4.42	8.49	56.01	0.06	0.04	0.04
Consumption	0.39	2.47	4.88	1.45	0.07	4.08	0.25	86.28	0.05	0.06	0.02
Hours Worked	4.07	4.74	6.56	13.58	1.03	3.81	8.69	56.88	0.14	0.02	0.49
Policy Rate	25.58	5.58	9.42	31.59	0.26	6.95	2.19	15.25	1.08	0.4	1.72
Inflation Rate	7.87	4.21	36.48	17.37	0.17	12.27	2.01	18.36	0.35	0.12	0.79
NFC Investment	15.14	1.36	2.82	77.96	0.04	1.27	0.05	0.47	0.86	0.02	0.01
HH Investment	5.28	6.57	1.46	14.07	68.68	0.66	0.19	1.58	0.85	0.48	0.17
NFC Credit	9.63	0.42	5.48	11.69	0.13	2.26	0.2	6.08	58.29	4.6	1.33
HH Credit	5.58	0.73	13.27	3.13	0.68	7.89	0.06	2.57	11.22	54.36	0.5
PD Banks	0.24	0.01	0.05	0.06	0	0.17	0	0.05	0.95	0.13	98.34

consequences of crises rather than their initial triggers. Overall, standard macroeconomic shocks remain the main drivers of both business and financial cycles in the estimated model.

Table 6 reports selected empirical and theoretical moments. The model replicates reasonably well the high variance observed in the data for most variables. While empirical GDP volatility exceeds model-implied volatility, the opposite holds for credit, partly because the model only features one-period debt. Empirical covariances and autocorrelations, however, deviate more substantially from their theoretical counterparts, reflecting the extraordinary nature of the COVID episode. This also suggests that the structural parameters were not excessively distorted by this period. Finally, empirical autocorrelations are qualitatively consistent with model-implied ones, except for household credit, which exhibits substantially greater persistence, partly because house prices are not included as an observable in the estimation.

4. The Anatomy of Monetary Tightening

To assess the effects of capital requirements on the macroeconomic impact of the 2021–23 monetary tightening, we first identify the structural shocks that triggered this unprecedented episode. The 11 shocks included in the model exert distinct influences on inflation, interest rates, and default probabilities. Their joint dynamics therefore shape how capital requirements propagate through the economy, underscoring that the origin of the shock is critical.

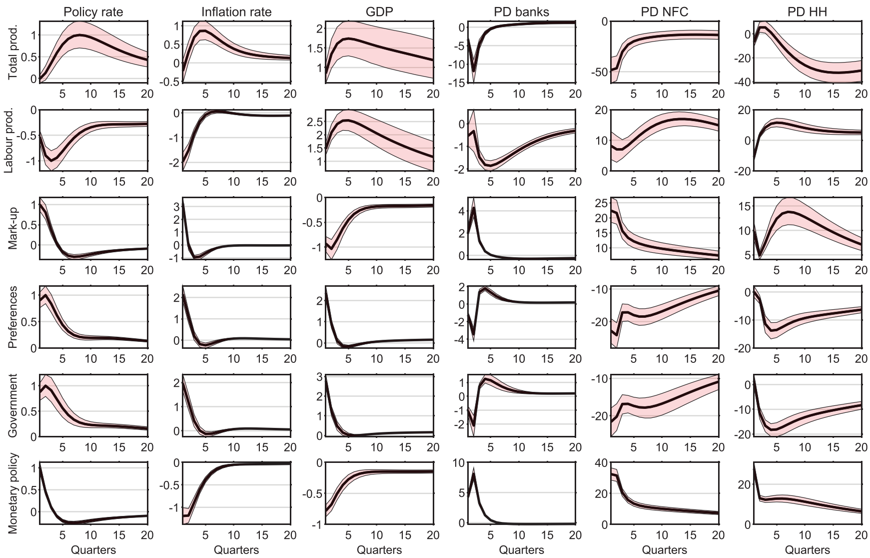
4.1 Impulse Response Functions

Figure 2 displays the impulse response functions of the policy rate, inflation, GDP, and the three probabilities of default following macroeconomic shocks. We consider three supply shocks (total factor productivity, labor productivity, and the markup of intermediate goods producers), two demand shocks (households' preference and government spending), and one monetary policy shock. Each shock is calibrated to generate a 1 percent increase in the policy rate, in absolute value. Productivity shocks lead to a more gradual adjustment in the policy rate compared with other disturbances. Policy rate, firms' markup, and labor productivity shocks all depress

Table 6. Data and Model Moments

		Model		
	Data	**Mean**	**90%**	**CI**
A. Variance				
GDP	3.53	2.61	2.07	3.09
Consumption	4.75	5.65	4.01	7.24
Hours Worked	4.93	4.95	3.92	5.89
MP Rate	5.41	4.43	2.97	5.72
Inflation	0.16	0.36	0.28	0.46
NFC Investment	12.34	20.31	14.63	26.63
HH Investment	8.21	9.43	7.6	11.58
NFC Credit	1.7	2.72	2.2	3.19
HH Credit	0.91	3.49	2.84	4.17
PD Banks	1.33	1.1	0.45	1.6
B. Covariance with GDP				
GDP	3.53	2.61	2.07	3.09
Consumption	3.87	3.11	2.14	3.92
Hours Worked	4.04	3.35	2.58	4
MP Rate	–0.14	–0.17	–0.37	0.03
Inflation	–0.29	0.08	–0.04	0.2
NFC Investment	4.87	3.47	2.55	4.44
HH Investment	4.62	0.73	0.57	0.9
NFC Credit	0.01	–0.3	–0.51	–0.09
HH Credit	0.67	0.92	0.71	1.16
PD Banks	–0.24	–0.03	–0.04	–0.02
C. First-Order Autocorrelation				
GDP	–0.2	–0.13	–0.19	–0.06
Consumption	–0.29	–0.19	–0.25	–0.12
Hours Worked	–0.28	–0.17	–0.23	–0.11
MP Rate	0.98	0.91	0.88	0.94
Inflation	0.49	0.51	0.42	0.6
NFC Investment	–0.11	0.22	0.08	0.34
HH Investment	–0.02	0.21	0.07	0.36
NFC Credit	0.67	0.49	0.45	0.53
HH Credit	0.56	0	–0.03	0.03
PD Banks	0.93	0.9	0.84	0.95

Figure 2. Impulse Response to Macroeconomic Shocks

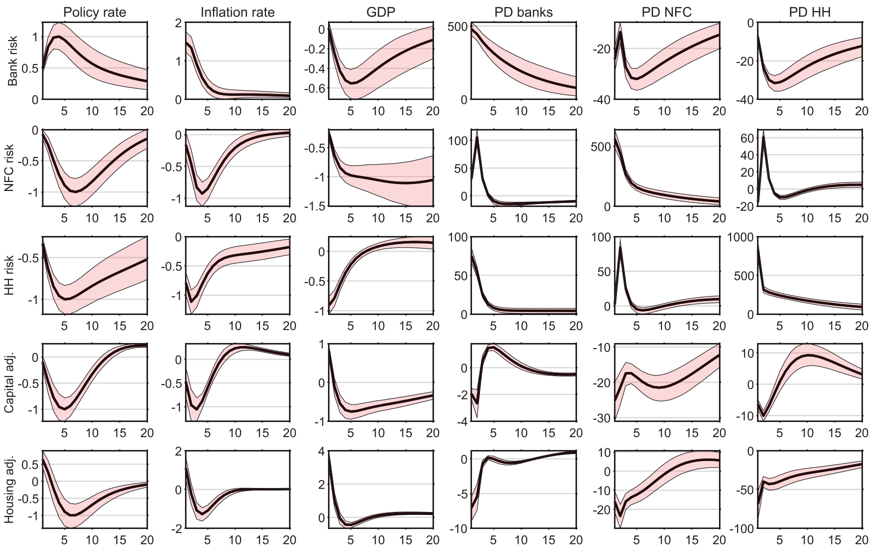


Note: All variables are expressed as deviations from their steady state: in percentage points for the policy and inflation rates, in percent for GDP, and in basis points for default probabilities. All shocks are calibrated to generate a 1 percent increase in the policy rate (in absolute value). Ninety-percent confidence intervals are based on 2,000 simulated draws from the parameter distributions.

GDP, while inflationary government spending, preference, and total productivity shocks raise it. Across all cases, banks' default probabilities respond less strongly than those of nonfinancial actors, a direct consequence of the assumption of perfect portfolio diversification. Among macroeconomic shocks, markup and monetary policy shocks are the most prone to generate financial stress. By contrast, productivity shocks display the greatest uncertainty regarding their macrofinancial impact, while uncertainty remains limited for the others.

Figure 3 presents the corresponding impulse response functions for sectoral shocks. These include three risk shocks—affecting nonfinancial corporations' capital, impatient households' housing, and banks' portfolios—along with two MEI shocks for productive capital and housing. An increase in NFC and household risk induces

Figure 3. Impulse Response to Sectoral Shocks



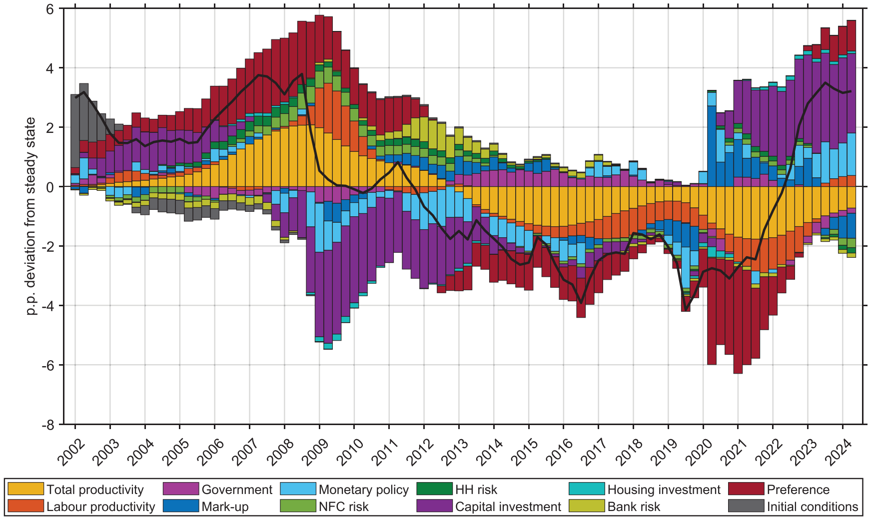
Note: All variables are expressed as deviations from their steady state: in percentage points for the policy and inflation rates, in percent for GDP, and in basis points for default probabilities. All shocks are calibrated to generate a 1 percent increase in the policy rate (in absolute value). Ninety-percent confidence intervals are based on 2,000 simulated draws from the parameter distributions.

deflationary pressures, whereas an increase in banks' risk produces inflationary pressures by fostering temporary overproduction. A reduction in capital or housing adjustment costs initially lowers GDP, as firms face greater demand, but subsequently raises it as investment adjusts more easily. This accelerates inflation and, in turn, prompts a tightening of the policy rate.

4.2 Historical Decomposition

These shocks enable one to capture the origins of the empirical variations in inflation, interest rate, and GDP. Figure 4 plots the decomposition of the policy rate, in deviation from its steady-state value. The rise of interest rates of 2006-07 is thus mainly explained by positive supply (total productivity shocks) and demand (positive preference shocks) factors. The sudden decrease of 2008 is mostly explained by a negative investment (MEI) shock, supplemented by

Figure 4. Decomposition of Short-Term Interest Rate

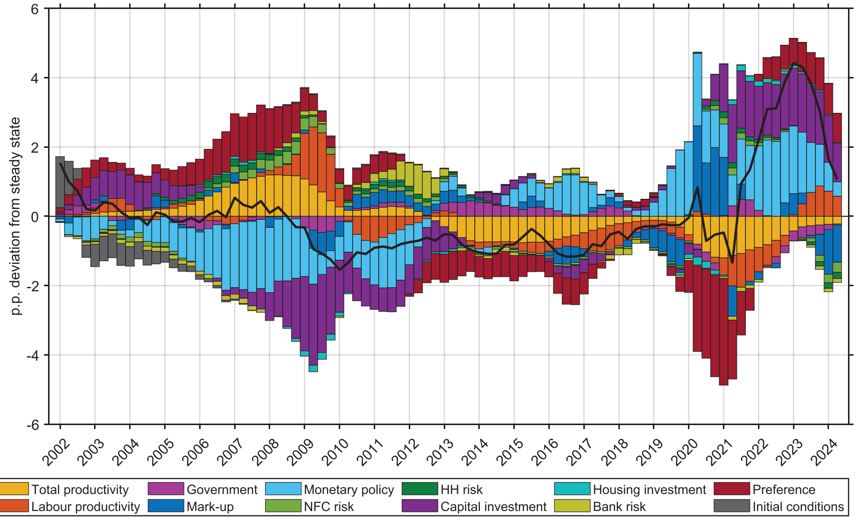


Note: Deviations from steady state in percentage points.

a particularly aggressive monetary policy. The low-rate environment that followed is then explained by a reversal in supply-side cycles, with strong and persistent negative productivity shocks, supplemented by negative preference shocks. At the beginning of this subperiod, decrease in firms' markup as well as government policy shock are the only inflationary pressures that contribute positively to GDP. Starting from 2016, total productivity begins to recover, but labor productivity and government spending firms' markup decrease, maintaining interest rates at a low level.

The COVID period set the seed of inflationary pressures, with sizable cost-push shocks countered by negative demand shocks. However, once the latter receded, inflationary pressures did not disappear. The markup shock left the stage for an increase in the marginal efficiency of investment, which contributed positively to GDP and inflation. This shock stands for sharp decrease in the relative price of tangible assets in 2021–23, as consumption prices rose more than investment prices, thus giving firms an incentive to invest and leading to overdemand in the final good market. This may capture, among others, the increase in banks' net interest rate margin and the increasing role of nonbank intermediaries during the rise

Figure 5. Decomposition of Year-on-Year Inflation Rate



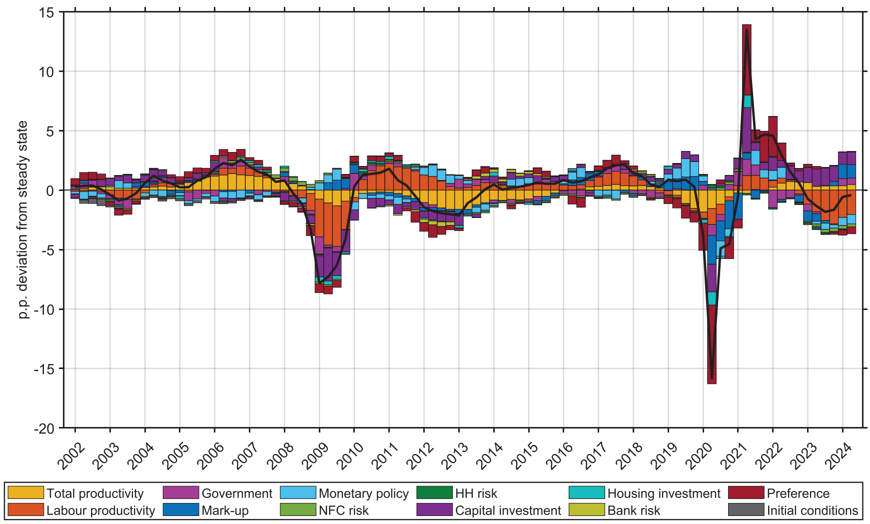
Note: Deviations from steady state in percentage points.

in interest rates, consistently with the deposit channel of monetary policy (Drechsler, Savov, and Schnabl 2017). As this shock is persistent and expansionary, it warrants a stronger reaction of monetary policy compared with a cost-push shock, which is short-lived and recessionary.

As mentioned by Licchetta and Meyermans (2022), gross fixed capital has rebounded at a significantly faster rate after COVID compared with the aftermath of the financial crisis. Public investment was more important in the post-COVID period than in the post-GFC time to support the recovery. Investment also benefited from a real cost of financing which remains relatively low at the end of our estimation period. The important contribution of the shock to the cost of investment reflects this relatively strong recovery of real investment for the period.

The decomposition of year-on-year inflation is plotted in Figure 5 and shows notably the action of monetary policy on inflation. While monetary policy appears relatively tight until 2012, expansionary shocks are the norm between 2014 and 2019 to fight below average inflation. However, once deflationary pressures disappeared after COVID, past accommodative monetary policy continued to

Figure 6. Decomposition of Year-on-Year GDP Growth Rate



Note: Deviations from steady state in percentage points.

push inflation up, despite the exogenous increase in the policy stance exemplified in Figure 4. Figure 6 plots the decomposition of year-on-year GDP growth, and shows that these shocks brought down GDP growth below its average in 2023, starting from the strong post-COVID context driven by positive demand shocks.

This decomposition thus indicates that the strong rise in interest rates of 2021–23 finds its roots in mostly supply-side shocks, complemented by a positive demand shock and the lagged effect of accommodative monetary policy, with an overall ambiguous effect on GDP. We recover this combination of shocks to assess how the level of capital requirements affected their transmission in the euro area.

5. Capital Requirements and the Transmission of Monetary Tightening

5.1 Basel III and Monetary Tightening

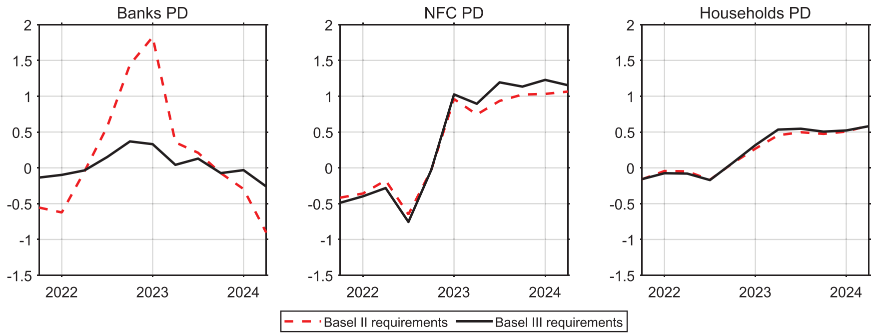
To what extent do capital requirements affect the transmission of monetary tightening? European prudential authorities strengthened capital regulation during the 2010s, transitioning from Basel II to Basel III. In particular, the minimum 8 percent risk-weighted assets (RWA) capital requirement under Basel II was supplemented by a 2.5 percentage point capital conservation buffer (CCoB). This new prudential environment calls for a reassessment of how monetary tightening interacts with financial stability. On the one hand, higher buffers increase banks' resilience to adverse shocks. On the other hand, by constraining credit supply in times of crisis, they may amplify those shocks. This section quantifies the impact of higher capital requirements, by 2.5 percentage points, on the transmission of the 2021–23 inflation surge and monetary tightening in the euro area, by constructing a counterfactual scenario in which capital requirements remained at 8 percent of RWA.

To assess the state of the economy, we define both an *observed* and a *counterfactual* scenario over the simulation period (2021:Q3–2024:Q2):

- The *observed scenario* is simulated using the calibrated and estimated parameters for the full sample, together with the shocks recovered for the 2021:Q3–2024:Q2 period. In this case, the capital requirement ratio is set at 10.5 percent. We assume that, in the initial steady state, the structural increase in capital requirements from Basel II (8 percent) to Basel III (10.5 percent) has been fully transmitted. Given that the reform was announced in 2012 and completed by 2019, this assumption appears reasonable.
- The *counterfactual scenario* differs only by the level of the capital requirement ratio, which is set at 8 percent, consistent with Basel II. Using the structural model, we isolate the effect of this single parameter change while holding constant the shocks estimated during the post-COVID monetary tightening episode.

Figure 7 reports the probability of default of banks under two scenarios: (i) the sum of all estimated shocks between 2021:Q3 and 2024:Q2 under Basel III regulation (black line), and (ii) the same shocks under Basel II regulation (dashed red line). Higher capital requirements under Basel III dampen the volatility of banks' probability of default. Under Basel II, the inflationary surge and

Figure 7. Probabilities of Default: Basel III vs. Basel II Capital Requirements



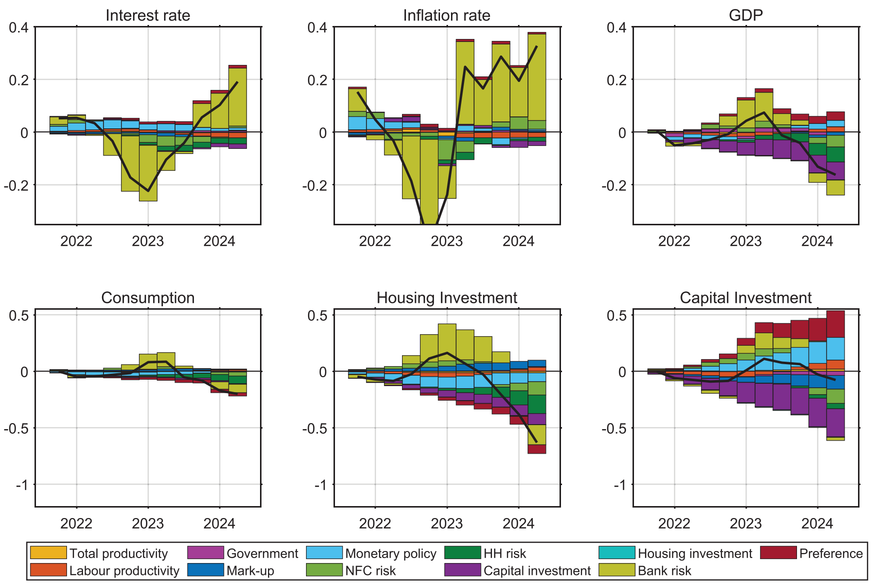
Note: The y-axis represents deviations from steady state in percentage point. The x-axis represents quarters, the first one being 2021:Q4.

subsequent monetary tightening would have raised the deviation of banks' probability of default from its long-term trend by about 100 basis points.

These results indicate that capital requirements do not need to be explicitly countercyclical to be effective. In an inflationary environment, they act as automatic stabilizers by curbing the amplitude of both expansionary and contractionary shocks. In Figure 8 and Figure 9, the black line shows the difference in macroeconomic and financial variables under Basel III relative to Basel II, while the colored bars display the contribution of each structural shock to this difference. The contribution of the bank risk shock dominates the divergence between the two regimes. As shown in Figure 4, this shock exerts a negative contribution to the evolution of the policy rate over the period considered.

Figure 8 further shows that, with Basel III, the policy rate was higher during the immediate post-COVID expansion and lower in early 2023 than it would have been under Basel II. During the post-COVID phase, higher capital requirements increased inflation, as aggregate supply was restrained by tighter credit supply and lower net worth for savers, weighing on GDP. Conversely, at the beginning of 2023, aggregate supply contracted less because credit supply remained resilient, implying higher supply relative to demand, thereby reducing inflation and the policy rate. Hence, higher

Figure 8. Impact of Basel III from 2021:Q3 to 2024:Q2—Macroeconomic Variables

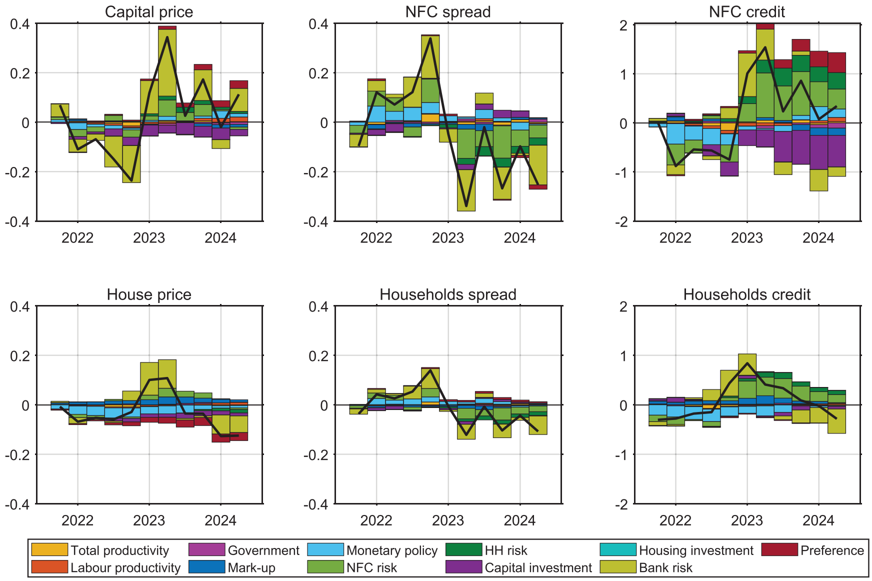


Note: The black line shows the difference between the actual and the counterfactual paths. The colored bars indicate the contribution of each shock to this overall effect. The x-axis reports quarters, with the first corresponding to 2021:Q4. All variables are expressed as deviations from their steady state in percent, except for the interest rate and inflation rate, which are in percentage points.

capital requirements smooth the cycle by moderating expansions and supporting credit during downturns.

The bank risk shock is the main contributor to the difference between the Basel II and Basel III scenarios, even though this shock remains relatively small during the simulation period. Indeed, ECB Financial Stability Reviews (European Central Bank 2023a, 2023b) describe banking risk in the euro area as contained, especially when compared with other advanced economies. This simulation suggests that the automatic stabilization role of capital requirements could be even stronger in a counterfactual scenario with larger bank risk shocks, underscoring the importance of precisely identifying the composition of shocks. For instance, the bank risk shock is almost negligible in the post-COVID period in Figure 4, while it was relatively

Figure 9. Impact of Basel III from 2021:Q3 to 2024:Q2—Financial Variables



Note: The black line shows the difference between the actual and the counterfactual paths. The colored bars indicate the contribution of each shock to this overall effect. The x-axis reports quarters, with the first corresponding to 2021:Q4. All variables are expressed as deviations from their steady state in percent, except for the interest rate and inflation rate, which are in percentage points.

large between 2010 and 2014. While the impact on inflation and the policy rate is mainly driven by the bank risk shock, capital requirements contributed negatively to the transmission of the MEI shock by constraining credit supply and dampening its expansionary effects. Toward the end of the period, higher capital requirements shielded the economy from the adverse effects of bank risk shocks on consumption and investment. They also appear to mitigate the negative impact of the markup shock on consumption and to stimulate capital accumulation by moderating the rise in the policy rate.

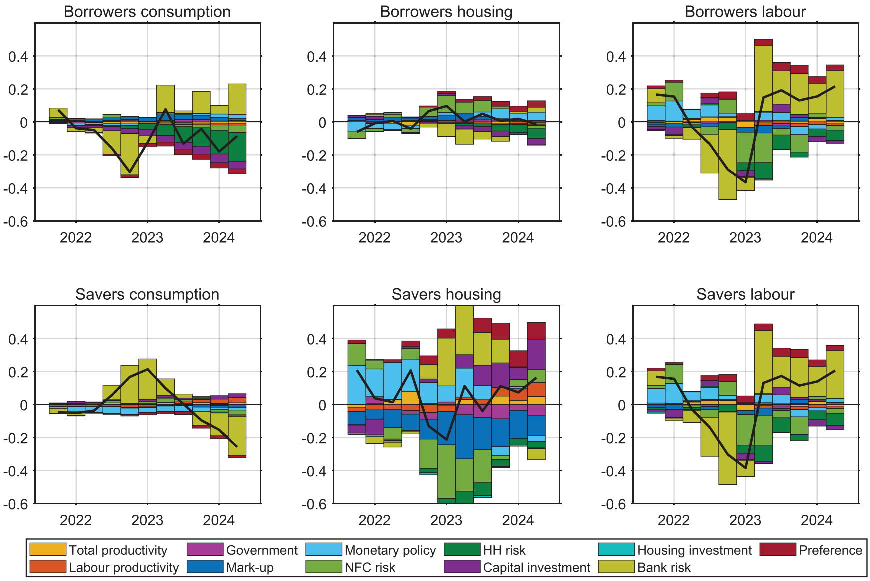
The same automatic-stabilizer mechanism applies to asset prices. Under Basel III, banks curtailed lending during the expansion but expanded it during the downturn. During the recovery phase, to meet capital requirements, banks adjusted their lending behavior by reducing loan volumes and raising lending spreads to rebuild retained earnings, thereby sharing the cost of regulation with borrowers. Figure 9 shows that higher capital requirements implied lower capital and housing prices during the post-COVID expansion, but relatively higher asset prices when bank risk increased toward the end of the period, reflecting tighter credit supply during the recovery and looser supply during the riskier phase.

Household and NFC risk was only slightly affected by higher capital requirements. While the tighter Basel III requirements proved costly during the post-COVID recovery, they reduced households' and NFCs' leverage, thereby limiting their risk exposure over this period. Conversely, by supporting credit supply in subsequent phases of expansion, higher capital requirements implied a slightly higher probability of default for borrowers.

The quantitative effects were larger for firms than for households. During the 2022 expansion, the impact on credit supply and lending spreads was stronger for NFCs than for households because risk weights were higher for NFC exposures. In addition, the investment and firm risk shocks, which played a key role in the unfolding of the monetary tightening, directly affected firms rather than households. Yet, housing investment declined more than business investment. Investment was influenced not only by credit supply but also by demand: as patient households bore the cost of bank losses, they reduced their demand for housing. When borrowing costs rose, households cut housing investment relatively more than firms reduced their NFC investment. This effect was further amplified by another channel: capital requirements also influenced savers' demand for assets through their effect on banks' profitability.

In conclusion, the abrupt rise in interest rates could have had large macroeconomic effects through risk shocks. As discussed by Hoffmann et al. (2019), the transmission of a monetary tightening may operate through the balance sheet channel, either via banks' net worth or borrowers' leverage, with implications for consumption and investment. The potential materialization of these risks depends on which agents bear the interest rate risk. In particular, leveraged actors could have faced tighter borrowing constraints if they were imperfectly hedged against interest rate risk or held concentrated portfolios. However, our historical decompositions attribute a relatively small role to such shocks in 2023, as capital requirements

Figure 10. Impact of Basel III from 2021:Q3 to 2024:Q2—Distributive Effects



Note: The black line shows the difference between the actual and the counterfactual paths. The colored bars indicate the contribution of each shock to this overall effect. The x-axis reports quarters, with the first corresponding to 2021:Q4. All variables are expressed as deviations from their steady state in percent.

were sufficiently high to absorb a moderate risk shock. The benefits of higher capital requirements would have been even larger in the case of a stronger bank risk shock, similar to that estimated for 2011, for instance.

5.2 Redistributive Effects of Capital Requirements

As suggested in the previous subsection, the mitigating impact of capital requirements operated through both savers' net worth and borrowers' credit constraints. This implies that capital requirements had pronounced heterogeneous effects across households. Figure 10 displays the differential evolution of each household's choice variables under Basel III and Basel II. For instance, under Basel III, savers' consumption was 0.2 percentage points higher in 2023:Q1. More generally, higher capital requirements smoothed savers' consumption, a result largely driven by the bank risk shock. When bank risk was low, capital requirements weighed on banks' profitability, reducing savers' income flows. Conversely, when bank risk materialized, the opposite occurred, boosting savers' consumption. In contrast, borrowers' consumption was temporarily constrained by capital requirements when the bank risk shock hit: higher capital buffers protected banks' owners rather than their borrowers. However, the contribution of capital requirements turned positive by the end of the period, once bank risk subsided. By strengthening banks' balance sheets, capital requirements ensured a faster recovery. Deposit insurance, financed by patient households, already helped smooth the impact of shocks, and was complemented by capital requirements, which reduced households' overall losses.

Regarding housing, capital requirements helped preserve borrowers' access to credit, with housing investment growth 0.1 percentage points higher in 2023:Q1. Interestingly, the contribution of nearly every shock was of opposite sign for savers and borrowers. For example, while capital requirements amplified the negative impact of monetary policy shocks on savers' housing, they mitigated it for borrowers. However, the quantitative effects of capital requirements on housing investment were roughly five times larger for savers than for borrowers, highlighting that their macroeconomic influence mainly operated through savers' net worth.

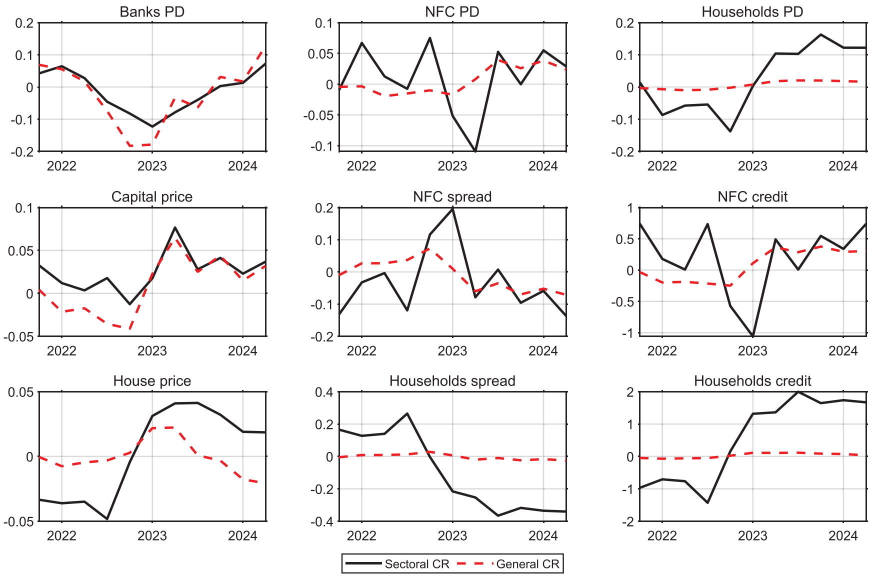
Finally, capital requirements had no economically significant heterogeneous effects on hours worked across households. This reflects the low short-run wealth effects in the model, implying that labor supply plays a negligible role in the adjustment process. As both households face identical labor demand, capital requirements generate no heterogeneity in employment outcomes.

These heterogeneous and redistributive effects of capital requirements help explain cross-country differences in macroprudential stances within the euro area. Countries with a larger share of borrowers have less incentive to raise capital requirements above the Basel III minimum.

5.3 Macroprudential Policies and Monetary Tightening

In recent years, several European macroprudential authorities have increased risk weights on mortgage exposures or introduced sectoral

Figure 11. Impact of Macroprudential Policies—Financial Variables



Note: All lines show the difference between the actual and the counterfactual paths. The x-axis reports quarters, with the first corresponding to 2021:Q4. All variables are expressed as deviations from their steady state in percent, except for the interest rate and the inflation rate, which are in percentage points.

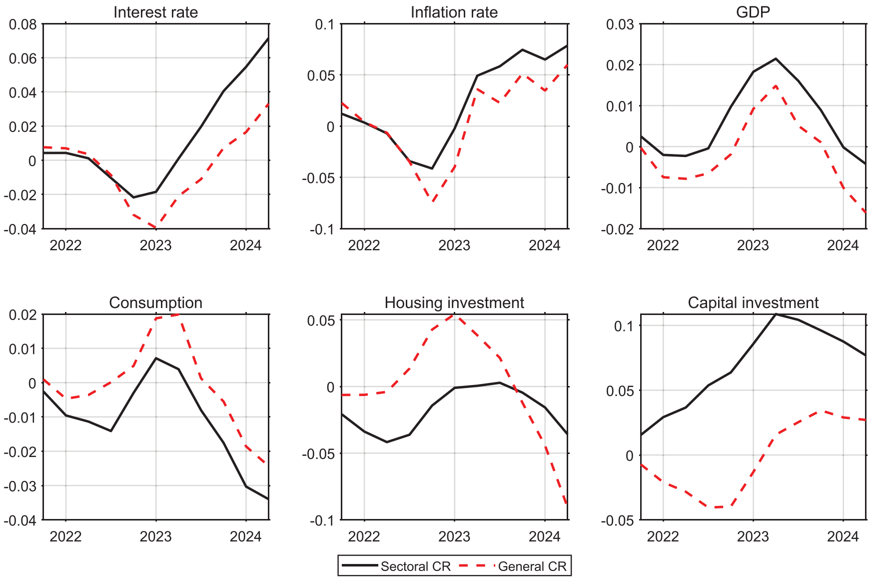
buffers on housing loans.[9] In this section, we analyze the macroeconomic and financial effects of such policies. We adopt a conservative scenario in which banks' equity-to-risk-weight ratios are kept constant at their pre-crisis level throughout the entire episode. While banks are formally allowed to draw down these buffers in times of stress, past experience suggests they rarely do so, due to market stigma and the expectation that buffers will need to be rebuilt later.[10]

Figure 11 displays the response of banks' probabilities of default under two alternative policy scenarios: (i) *sectoral capital requirements*, where total capital requirements remain at their Basel III level (10.5 percent) and the authority raises the mortgage risk weight

[9]See ESRB risk-weight measures and ESRB systemic risk buffer measures

[10]See ECB Macroprudential Bulletin.

Figure 12. Impact of Macroprudential Policies—Macroeconomic Variables



Note: All lines show the difference between the actual and the counterfactual paths. The x-axis reports quarters, with the first corresponding to 2021:Q4. All variables are expressed as deviations from their steady state in percent, except for spreads and probabilities of default, which are in percentage points.

from 35 percent to 100 percent; and (ii) *general capital requirements*, where the authority instead increases the overall capital ratio from 10.5 percent to 11.5 percent. Both policies entail short-run costs but generate medium-term gains in terms of bank stability and GDP.

Sectoral capital requirements turn out to be more efficient at stabilizing GDP (see Figure 12). By offsetting distortions introduced by differential risk weights, they induce a portfolio reallocation toward NFC lending. In particular, the higher mortgage risk weights generate a substitution effect whereby banks redirect part of their lending from households to NFCs, supporting productive investment. Overall, this policy reduces the GDP cost of tighter capital requirements during the post-COVID investment catch-up.

Under the alternative scenario (ii) with higher general capital requirements (red dashed line), the cost–benefit balance is less favorable. This outcome reflects the contribution of capital requirements to capital investment dynamics in the wake of the post-COVID recovery. Compared with a sectoral tightening, the general capital requirement has a smaller negative effect on consumption and housing investment but dampens NFC investment more severely. This result illustrates how higher capital requirements can affect housing and productive investment asymmetrically, given the composition of estimated shocks. Nonetheless, this option remains attractive in terms of financial stability, as it delivers lower volatility in financial variables and could therefore be preferred by households, whose consumption and housing investment are less affected.

6. Conclusion

This paper develops a New Keynesian model with a rich set of financial frictions and structural shocks to assess the role of capital requirements in business cycle dynamics, specifically during the 2021–24 monetary tightening episode. We show that while banks' capital requirements limited post-COVID growth, they successfully prevented the materialization of risks when the ECB raised short-term interest rates. By smoothing the response of banks' net worth to macroeconomic conditions, capital requirements acted as automatic stabilizers and reduced the likelihood of a hard landing during the tightening cycle. Overall, they proved complementary to monetary policy. Hence, even in a period of unprecedented monetary tightening, capital requirements do not need to be countercyclical to be effective. Their impact, however, is heterogeneous across savers and borrowers, and thus across euro-area member states, leaving room for cross-country heterogeneity in the design of macroprudential policies.

That said, while capital requirements helped prevent a hard landing by shifting interest rate risk toward banks, they are not sufficient on their own to ensure financial stability. By enhancing banks' resilience, such policies may, up to a point, encourage greater indebtedness among private agents. Other macroprudential tools, such as borrower-based measures, can therefore play a complementary role by ensuring sound financing conditions and appropriate leverage levels before the onset of a monetary tightening episode.

Appendix. Equilibrium Conditions

To simplify the exposition, we redefine a number of variables:

$$b_t^e \leftarrow m^e b_t^e,$$
$$k_t^e \leftarrow m^e k_t^e,$$
$$n_t^e \leftarrow m^e n_t^e,$$
$$n_t^b \leftarrow m^b n_t^b.$$

We let Φ denote the cumulative distribution function (CDF) of the $\mathcal{N}(0,1)$ distribution. The threshold value of idiosyncratic shock above which an entity defaults is denoted $\bar{\omega}_t^j$, where $j \in \{e, i, F, M\}$.

We also express capital requirements as a leverage ratio combining the broad base capital requirement as well as sector-specific risk weights:

$$f_t^F = \phi_t \gamma_t^F$$

$$f_t^M = \phi_t \gamma_t^M.$$

Intermediary and final good producer:

$$w_t = s_t \mathrm{e}^{\zeta_{a,t}} (1-\alpha) \mathrm{e}^{\zeta_{z,t}} \left(\frac{k_{t-1}}{\mathrm{e}^{\zeta_{z,t}} \ell_t} \right)^{\alpha} \tag{A.1}$$

$$r_t^K = s_t \mathrm{e}^{\zeta_{a,t}} \alpha \left(\frac{k_{t-1}}{\mathrm{e}^{\zeta_{z,t}} \ell_t} \right)^{\alpha - 1} \tag{A.2}$$

$$\bar{P}_t^\star = \frac{K_{1,t}}{K_{2,t}} \tag{A.3}$$

$$K_{1,t} = \mu_t y_t s_t + (\beta^p \xi) \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} \left(\frac{(\Pi_*)^{1-\iota} (\Pi_t)^{\iota}}{\Pi_{t+1}} \right)^{\frac{\mu_t}{1-\mu_t}} K_{1,t+1} \right] \tag{A.4}$$

$$K_{2,t} = y_t + (\beta^p \xi) \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} \left(\frac{(\Pi_*)^{1-\iota} (\Pi_t)^{\iota}}{\Pi_{t+1}} \right)^{\frac{1}{1-\mu_t}} K_{2,t+1} \right] \tag{A.5}$$

$$1 = (1-\xi)(\bar{P}_t^\star)^{\frac{1}{1-\mu_t}} + \xi \left[\frac{(\Pi_*)^{1-\iota} (\Pi_{t-1})^{\iota}}{\Pi_t} \right]^{\frac{1}{1-\mu_t}} \tag{A.6}$$

$$\Upsilon_t^{\frac{\mu_t}{1-\mu_t}} y_t = \mathrm{e}^{\zeta_{a,t}} (k_{t-1})^{\alpha} (\mathrm{e}^{\zeta_{z,t}} \ell_t)^{1-\alpha} \tag{A.7}$$

$$\Upsilon_t^{\frac{\mu_t}{1-\mu_t}} = (1-\xi)(\bar{P}_t^{\star})^{\frac{\mu_t}{1-\mu_t}} + \xi \left(\frac{(\Pi_*)^{1-\iota}(\Pi_{t-1})^{\iota}}{\Pi_t} \right)^{\frac{\mu_t}{1-\mu_t}} \Upsilon_{t-1}^{\frac{\mu_t}{1-\mu_t}} \tag{A.8}$$

Capital production:

$$q_t^K = \mathrm{e}^{\zeta_{i_K,t}} \left(1 + \frac{\psi_K}{2} \left(\frac{i_t^K}{i_{t-1}^K} - 1 \right)^2 + \psi_K \left(\frac{i_t^K}{i_{t-1}^K} - 1 \right) \frac{i_t^K}{i_{t-1}^K} \right) - \beta^p \mathbb{E}_t \left[\mathrm{e}^{\zeta_{i_K,t+1}} \frac{\lambda_{t+1}^p}{\lambda_t^p} \psi_K \left(\frac{i_{t+1}^K}{i_t^K} - 1 \right) \left(\frac{i_{t+1}^K}{i_t^K} \right)^2 \right] \tag{A.9}$$

$$k_t = (1-\delta^K) k_{t-1} + i_t^K \tag{A.10}$$

Housing production:

$$q_t^H = \mathrm{e}^{\zeta_{i_H,t}} \left(1 + \frac{\psi_H}{2} \left(\frac{i_t^H}{i_{t-1}^H} - 1 \right)^2 + \psi_H \left(\frac{i_t^H}{i_{t-1}^H} - 1 \right) \frac{i_t^H}{i_{t-1}^H} \right) - \beta^p \mathbb{E}_t \left[\mathrm{e}^{\zeta_{i_H,t+1}} \frac{\lambda_{t+1}^p}{\lambda_t^p} \psi_H \left(\frac{i_{t+1}^H}{i_t^H} - 1 \right) \left(\frac{i_{t+1}^H}{i_t^H} \right)^2 \right] \tag{A.11}$$

$$h_t = (1-\delta^H) h_{t-1} + i_t^H \tag{A.12}$$

Patient households:

$$\lambda_t^p = \frac{\mathrm{e}^{\zeta_{c,t}}}{c_t^p - \psi c_{t-1}^p} \tag{A.13}$$

$$\mathrm{e}^{\zeta_{c,t}} \varphi^p J_t^p (\ell_t^p)^{\eta} = w_t \tag{A.14}$$

$$J_t^p = (J_{t-1}^p)^{1-\zeta_J} [(c_t^p - \psi c_{t-1}^p)]^{\zeta_J} \tag{A.15}$$

$$\lambda_t^p = \beta^p \mathbb{E}_t \left[\lambda_{t+1}^p \frac{\tilde{R}_{t+1}}{\Pi_{t+1}} \right] \tag{A.16}$$

$$\lambda_t^p (q_t^K + \xi_s m^p k_t^p) = \beta^p \mathbb{E}_t \left[\lambda_{t+1}^p [r_{t+1}^K + (1-\delta^K) q_{t+1}^K] \right] \tag{A.17}$$

$$\lambda_t^p q_t^H = e^{\zeta_{c,t}} \upsilon^p \frac{1}{h_t^p} + \beta^p (1-\delta^H) \lambda_{t+1}^p q_{t+1}^H \tag{A.18}$$

Bankers and banks:

$$v_t^b = \beta^p \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} (1 - \theta^b + \theta^b v_{t+1}^b) \frac{Z_{t+1}^M}{\Pi_{t+1}} \right] \tag{A.19}$$

$$v_t^b = \beta^p \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} (1 - \theta^b + \theta^b v_{t+1}^b) \frac{Z_{t+1}^F}{\Pi_{t+1}} \right] \tag{A.20}$$

$$\bar{\omega}_t^M = (1 - f_{t-1}^M) \frac{R_{t-1}}{R_t^M} \tag{A.21}$$

$$\bar{\omega}_t^F = (1 - f_{t-1}^F) \frac{R_{t-1}}{R_t^F} \tag{A.22}$$

$$Z_t^M = \frac{(1 - \Gamma_t^M) R_t^M}{f_{t-1}^M} \tag{A.23}$$

$$Z_t^F = \frac{(1 - \Gamma_t^F) R_t^F}{f_{t-1}^F} \tag{A.24}$$

$$n_t^b = [\theta^b + \chi^b (1 - \theta^b)] \left(\frac{Z_t^M}{\Pi_t} f_{t-1}^M m^i b_{t-1}^i + \frac{Z_t^F}{\Pi_t} f_{t-1}^F b_{t-1}^e \right) \tag{A.25}$$

$$n_t^b = f_t^M m^i b_t^i + f_t^F b_t^e \tag{A.26}$$

Entrepreneurs and investment firms:

$$v_t^e = \mathbb{E}_t \left[\beta^p \frac{\lambda_{t+1}^p}{\lambda_t^p} (1 - \theta^e + \theta^e v_{t+1}^e) \frac{Z_{t+1}^e}{\Pi_{t+1}} \right] \tag{A.27}$$

$$x_t^e = \frac{R_t^e b_t^e}{q_t^K k_t^e} \tag{A.28}$$

$$\bar{\omega}_t^e = \frac{x_{t-1}^e}{R_t^K} \tag{A.29}$$

$$R_t^K = \Pi_t \frac{r_t^K + (1-\delta)q_t^K}{q_{t-1}^K} \tag{A.30}$$

$$R_t^F = (\Gamma_t^e - \mu^e G_t^e) R_t^K \frac{q_{t-1}^K k_{t-1}^e}{b_{t-1}^e} \tag{A.31}$$

$$Z_t^e = (1-\Gamma_t^e) R_t^K \frac{q_{t-1}^K k_{t-1}^e}{n_{t-1}^e} \tag{A.32}$$

$$\mathbb{E}_t\Bigg[\beta^p \frac{\lambda_{t+1}^p}{\lambda_t^p}\frac{1}{\Pi_{t+1}}\Big((1-\theta^e+\theta^e v_{t+1}^e)\Gamma_{t+1}^{e\prime} - \xi_t^e(1-\theta^b+\theta^b v_{t+1}^b)(1-\Gamma_{t+1}^F)(\Gamma_{t+1}^{e\prime}-\mu^e G_{t+1}^{e\prime})\Big)\Bigg] = 0 \tag{A.33}$$

$$\mathbb{E}_t\Bigg[\beta^p \frac{\lambda_{t+1}^p}{\lambda_t^p}\Big((1-\theta^e+\theta^e v_{t+1}^e)(1-\Gamma_{t+1}^e) + \xi_t^e(1-\theta^b+\theta^b v_{t+1}^b)(1-\Gamma_{t+1}^F)(\Gamma_{t+1}^e-\mu^e G_{t+1}^e)\Big)\frac{R_{t+1}^K}{\Pi_{t+1}}\Bigg] - \xi_t^e f_t^F v_t^b = 0 \tag{A.34}$$

$$n_t^e = [\theta^e + \chi^e(1-\theta^e)](1-\Gamma_t^e)(r_t^K + (1-\delta)q_t^K)k_{t-1}^e, \tag{A.35}$$

$$n_t^e + b_t^e = q_t^K k_t^e \tag{A.36}$$

Impatient households:

$$R_t^M = (\Gamma_t^i - \mu^i G_t^i)\frac{R_t^H q_{t-1}^H h_{t-1}^i}{b_{t-1}^i} \tag{A.37}$$

$$c_t^i + q_t^H h_t^i = w_t \ell_t^i + b_t^i + (1-\Gamma_t^i)(1-\delta^H) q_t^H h_{t-1}^i \tag{A.38}$$

$$R_t^H = \Pi_t \frac{(1-\delta^H)q_t^H}{q_{t-1}^H} \tag{A.39}$$

$$x_t^i = \frac{R_t^i b_t^i}{q_t^H h_t^i} \tag{A.40}$$

$$\bar{\omega}_t^i = \frac{x_{t-1}^i}{R_t^H} \tag{A.41}$$

$$\lambda_t^i = \frac{e^{\zeta_{c,t}}}{c_t^i - \psi c_{t-1}^i} \tag{A.42}$$

$$w_t = e^{\zeta_{c,t}} \varphi^i J_t^i (\ell_t^i)^\eta \tag{A.43}$$

$$J_t^i = (J_{t-1}^i)^{1-\zeta_J} [(c_t^i - \psi c_{t-1}^i)]^{\zeta_J} \tag{A.44}$$

$$\beta^i \mathbb{E}_t \left[\lambda_{t+1}^i \frac{\Gamma_{t+1}^{i\prime}}{\Pi_{t+1}} \right] = \xi_t^i \beta^p \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} (1 - \theta^b + \theta^b v_{t+s+1}^b) \right.$$
$$\left. \times (1 - \Gamma_{t+1}^M) \frac{\Gamma_{t+1}^{i\prime} - \mu^i G_{t+1}^{i\prime}}{\Pi_{t+1}} \right] \tag{A.45}$$

$$\lambda_t^i = \xi_t^i f_t^M v_t^b \tag{A.46}$$

$$\lambda_t^i q_t^H = e^{\zeta_{c,t}} \upsilon^i \frac{1}{h_t^i} + \beta^i \mathbb{E}_t \left[\lambda_{t+1}^i (1 - \Gamma_{t+1}^i)(1 - \delta^H) q_{t+1}^H \right]$$
$$+ \beta^p \xi_t^i \mathbb{E}_t \left[\frac{\lambda_{t+1}^p}{\lambda_t^p} (1 - \theta^b + \theta^b v_{t+s+1}^b)(1 - \Gamma_{t+1}^M) \right.$$
$$\left. \times (\Gamma_{t+1}^i - \mu^i G_{t+1}^i)(1 - \delta^H) q_{t+1}^H \right] \tag{A.47}$$

Market clearing:

$$k_t = k_t^e + m^p k_t^p \tag{A.48}$$

$$h_t = m^p h_t^p + m^i h_t^i \tag{A.49}$$

$$c_t = m^p c_t^p + m^i c_t^i \tag{A.50}$$

$$\ell_t = m^p \ell_t^p + m^i \ell_t^i \tag{A.51}$$

$$y_t = c_t + e^{\zeta_{i_K,t}} \left(1 + \frac{\psi_K}{2} \left(\frac{i_t^K}{i_{t-1}^K} - 1 \right)^2 \right) i_t^K$$
$$+ e^{\zeta_{i_H,t}} \left(1 + \frac{\psi_H}{2} \left(\frac{i_t^H}{i_{t-1}^H} - 1 \right)^2 \right) i_t^H + s_g y_* e^{\zeta_{g,t}}$$
$$+ \mu^i G_t^i (1 - \delta^H) q_t^H m^i h_{t-1}^i + \mu^e G_t^e (r_t^K + (1 - \delta) q_t^K) k_{t-1}^e$$
$$+ \mu^M G_t^M \frac{R_t^M}{\Pi_t} m^i b_{t-1}^i + \mu^F G_t^F \frac{R_t^F}{\Pi_t} b_{t-1}^e + \frac{\xi_s}{2} (m^p k_t^p)^2 \tag{A.52}$$

Deposit insurance:

$$\tilde{R}_t = R_{t-1} - (1-\kappa)\Omega_t \tag{A.53}$$

$$\begin{aligned}\Omega_t d_{t-1} = {} & (\bar{\omega}_t^M - \Gamma_t^M + \mu^M G_t^M) R_t^M m^i b_{t-1}^i \\ & + (\bar{\omega}_t^F - \Gamma_t^F + \mu^F G_t^F) R_t^F b_{t-1}^e \end{aligned} \tag{A.54}$$

$$n_t^b + d_t = b_t^e + m^i b_t^i \tag{A.55}$$

Monetary authority:

$$\begin{aligned}\log\left(\frac{R_t}{R_*}\right) = {} & \rho_R \log\left(\frac{R_{t-1}}{R_*}\right) \\ & + (1-\rho_R)\left[a_\Pi \log\left(\frac{\Pi_t}{\Pi_*}\right) + a_y \log\left(\frac{GDP_t}{GDP_{t-1}}\right)\right] + \zeta_{R,t}\end{aligned} \tag{A.56}$$

Exogenous processes:

$$\zeta_{a,t} = \rho_a \zeta_{a,t-1} + \frac{\sigma_a}{100}\epsilon_{a,t}, \tag{A.57}$$

$$\zeta_{z,t} = \rho_z \zeta_{z,t-1} + \frac{\sigma_z}{100}\epsilon_{z,t}, \tag{A.58}$$

$$\zeta_{i_K,t} = \rho_{i_K} \zeta_{i_K,t-1} + \frac{\sigma_{i_K}}{100}\epsilon_{i_K,t}, \tag{A.59}$$

$$\zeta_{i_H,t} = \rho_{i_H} \zeta_{i_H,t-1} + \frac{\sigma_{i_H}}{100}\epsilon_{i_H,t}, \tag{A.60}$$

$$\zeta_{e,t} = \rho_e \zeta_{e,t-1} + \frac{\sigma_e}{100}\epsilon_{e,t}, \tag{A.61}$$

$$\zeta_{i,t} = \rho_i \zeta_{i,t-1} + \frac{\sigma_i}{100}\epsilon_{i,t}, \tag{A.62}$$

$$\zeta_{B,t} = \rho_B \zeta_{B,t-1} + \frac{\sigma_B}{100}\epsilon_{B,t}, \tag{A.63}$$

$$\zeta_{c,t} = \rho_c \zeta_{c,t-1} + \frac{\sigma_c}{100}\epsilon_{c,t}, \tag{A.64}$$

$$\zeta_{\mu,t} = \rho_\mu \zeta_{\mu,t-1} + \frac{\sigma_\mu}{100}\epsilon_{\mu,t}, \tag{A.65}$$

$$\zeta_{g,t} = \rho_g \zeta_{g,t-1} + \frac{\sigma_g}{100}\epsilon_{g,t}, \tag{A.66}$$

$$\zeta_{R,t} = \frac{\sigma_R}{100}\epsilon_{R,t}, \tag{A.67}$$

Auxiliary variables:

$$\Gamma_t^F = G_t^F + \bar{\omega}_t^F \left[1 - \Phi\left(\frac{\log(\bar{\omega}_t^F) + \frac{1}{2}(\sigma_F \mathrm{e}^{\zeta_{B,t}})^2}{\sigma_F \mathrm{e}^{\zeta_{B,t}}}\right)\right] \tag{A.68}$$

$$G_t^F = \Phi\left(\frac{\log(\bar{\omega}_t^F) - \frac{1}{2}(\sigma_F \mathrm{e}^{\zeta_{B,t}})^2}{\sigma_F \mathrm{e}^{\zeta_{B,t}}}\right) \tag{A.69}$$

$$\Gamma_t^M = G_t^M + \bar{\omega}_t^M \left[1 - \Phi\left(\frac{\log(\bar{\omega}_t^M) + \frac{1}{2}(\sigma_M \mathrm{e}^{\zeta_{B,t}})^2}{\sigma_M \mathrm{e}^{\zeta_{B,t}}}\right)\right] \tag{A.70}$$

$$G_t^M = \Phi\left(\frac{\log(\bar{\omega}_t^M) - \frac{1}{2}(\sigma_M \mathrm{e}^{\zeta_{B,t}})^2}{\sigma_M \mathrm{e}^{\zeta_{B,t}}}\right) \tag{A.71}$$

$$\Gamma_t^e = G_t^e + \bar{\omega}_t^e \left[1 - \Phi\left(\frac{\log(\bar{\omega}_t^e) + \frac{1}{2}(\sigma_e \mathrm{e}^{\zeta_{e,t}})^2}{\sigma_e \mathrm{e}^{\zeta_{e,t}}}\right)\right] \tag{A.72}$$

$$G_t^e = \Phi\left(\frac{\log(\bar{\omega}_t^e) - \frac{1}{2}(\sigma_e \mathrm{e}^{\zeta_{e,t}})^2}{\sigma_e \mathrm{e}^{\zeta_{e,t}}}\right) \tag{A.73}$$

$$\Gamma_t^{e\prime} = 1 - \Phi\left(\frac{\log(\bar{\omega}_t^e) + \frac{1}{2}(\sigma_e \mathrm{e}^{\zeta_{e,t}})^2}{\sigma_e \mathrm{e}^{\zeta_{e,t}}}\right) \tag{A.74}$$

$$G_t^{e\prime} = \frac{1}{\sigma_e \mathrm{e}^{\zeta_{e,t}}}\varphi\left(\frac{\log(\bar{\omega}_t^e) + \frac{1}{2}(\sigma_e \mathrm{e}^{\zeta_{e,t}})^2}{\sigma_e \mathrm{e}^{\zeta_{e,t}}}\right) \tag{A.75}$$

$$\Gamma_t^i = G_t^i + \bar{\omega}_t^i \left[1 - \Phi\left(\frac{\log(\bar{\omega}_t^i) + \frac{1}{2}(\sigma_i \mathrm{e}^{\zeta_{i,t}})^2}{\sigma_i \mathrm{e}^{\zeta_{i,t}}}\right)\right], \tag{A.76}$$

$$G_t^i = \Phi\left(\frac{\log(\bar{\omega}_t^i) - \frac{1}{2}(\sigma_i \mathrm{e}^{\zeta_{i,t}})^2}{\sigma_i \mathrm{e}^{\zeta_{i,t}}}\right) \tag{A.77}$$

$$\Gamma_t^{i\prime} = 1 - \Phi\left(\frac{\log(\bar{\omega}_t^i) + \frac{1}{2}(\sigma_i \mathrm{e}^{\zeta_{i,t}})^2}{\sigma_i \mathrm{e}^{\zeta_{i,t}}}\right) \tag{A.78}$$

$$G_t^{i\prime} = \frac{1}{\sigma_i e^{\zeta_{i,t}}}\varphi\left(\frac{\log(\bar{\omega}_t^i) + \frac{1}{2}(\sigma_i e^{\zeta_{i,t}})^2}{\sigma_i e^{\zeta_{i,t}}}\right) \tag{A.79}$$

$$S_t^b = \beta^p \frac{\lambda_t^p}{\lambda_{t-1}^p}(1 - \theta^b + \theta^b v_t^b) \tag{A.80}$$

$$S_t^e = \beta^p \frac{\lambda_t^p}{\lambda_{t-1}^p}(1 - \theta^e + \theta^e v_t^e). \tag{A.81}$$

$$GDP_t = m^i c_t^i + m^p c_t^p + e^{\zeta_{i_K,t}}\left(1 + \frac{\psi_K}{2}\left(\frac{i_t^K}{i_{t-1}^K} - 1\right)^2\right) i_t^K + e^{\zeta_{i_H,t}}\left(1 + \frac{\psi_H}{2}\left(\frac{i_t^H}{i_{t-1}^H} - 1\right)^2\right) i_t^H + s_g y_* e^{\zeta_{g,t}} \tag{A.82}$$

References

Adjemian, S., M. Juillard, F. Karame, W. Mutschler, J. Pfeifer, M. Ratto, N. Rion, and S. Villemot. 2024. "Dynare: Reference Manual, Version 6." Dynare Working Paper 80, CEPREMAP.

Arce, Ó., M. Ciccarelli, A. Kornprobst, and C. Montes-Galdon. 2024. "What Caused the Euro Area Post-Pandemic Inflation?" ECB Occasional Paper No. 343.

Bernanke, B., and O. Blanchard. 2025. "What Caused the US Pandemic-Era Inflation?" *American Economic Journal: Macroeconomics* 17 (3): 1–35.

Bianchi, J. 2011. "Overborrowing and Systemic Externalities in the Business Cycle." *American Economic Review* 101 (7): 3400–3426.

Boissay, F., C. Borio, C. Leonte, and I. Shim. 2023. "Prudential Policy and Financial Dominance: Exploring the Link." *BIS Quarterly Review* (March): 15–31.

Boissay, F., F. Collard, J. Galí, and C. Manea. 2021. "Monetary Policy and Endogenous Financial Crises." BIS Working Paper No. 991.

Boissay, F., F. Collard, C. Manea, and A. Shapiro. 2025. "Monetary Tightening and Financial Stress during Supply- versus Demand-Driven Inflation." *International Journal of Central Banking* 21 (2, April): 147–220.

Bratsiotis, G. J., and K. D. Pathirage. 2023. "Monetary and Macroprudential Policy and Welfare in an Estimated Four-Agent New Keynesian Model." Forthcoming in *Journal of Money, Credit and Banking.* https://doi.org/10.1111/jmcb.13095.

Chetty, R., A. Guren, D. Manoli, and A. Weber. 2011. "Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins." *American Economic Review* 101 (3): 471–75.

Christiano, L. J., R. Motto, and M. Rostagno. 2014. "Risk Shocks." *American Economic Review* 104 (1): 27–65.

Clerc, L., A. Derviz, C. Mendicino, S. Moyen, K. Nikolov, L. Stracca, J. Suarez, and A. P. Vardoulakis. 2015. "Capital Regulation in a Macroeconomic Model with Three Layers of Default." *International Journal of Central Banking* 11 (3, June): 9–63.

de Bandt, O., C. B. Durou, I. Hibiki, Y. Mimir, J. Mohimont, K. Nikolov, S. Roehrs, J.-G. Sahuc, V. Scalone, and M. Straughan. 2022. "Assessing the Impact of Basel III: Evidence from Structural Macroeconomic Models." Working Paper No. 864, Banque de France.

Demirgüç-Kunt, A., E. Kane, and L. Laeven. 2015. "Deposit Insurance around the World: A Comprehensive Analysis and Database." *Journal of Financial Stability* 20 (October): 155–83.

Drechsler, I., A. Savov, and P. Schnabl. 2017. "The Deposits Channel of Monetary Policy." *Quarterly Journal of Economics* 132 (4): 1819–76.

ECB-ESRB. 2025. "Using the Countercyclical Capital Buffer to Build Resilience Early in the Cycle." Technical Report.

Eickmeier, S., and B. Hofmann. 2025. "What Drives Inflation? Disentangling Demand and Supply Factors." *International Journal of Central Banking* 21 (3, July): 111–84.

European Central Bank. 2023a. "Financial Stability Review." Report, May.

———. 2023b. "Financial Stability Review." Report, November.

Finance, E. H., and C. Network. 2013. "The Eurosystem Household Finance and Consumption Survey—Results from the First Wave." ECB Statistics Paper No. 2.

Galí, J. 2010. "Monetary Policy and Unemployment." In *Handbook of Monetary Economics,* Vol. 3, ed. B. M. Friedman and M. Woodford, 487–546. Elsevier.

———. 2011. “The Return of the Wage Phillips Curve.” *Journal of the European Economic Association* 9 (3): 436–61.

Galí, J., F. Smets, and R. Wouters. 2012. “Unemployment in an Estimated New Keynesian Model.” In *NBER Macroeconomics Annual 2011,* Vol. 26, ed. D. Acemoglu and M. Woodford, 329–60. University of Chicago Press.

Gasparini, T., V. Lewis, S. Moyen, and S. Villa. 2024. “Risky Firms and Fragile Banks: Implications for Macroprudential Policy.” Working Paper No. 944, Banque de France.

Gautier, E., C. Conflitti, R. P. Faber, B. Fabo, L. Fadejeva, V. Jouvanceau, J.-O. Menz, et al. 2024. “New Facts on Consumer Price Rigidity in the Euro Area.” *American Economic Journal: Macroeconomics* 16 (4): 386–431.

Gertler, M., and N. Kiyotaki. 2010. “Financial Intermediation and Credit Policy in Business Cycle Analysis.” In *Handbook of Monetary Economics,* Vol. 3, ed. B. M. Friedman and M. Woodford, 547–99. Elsevier.

Giannone, D., and G. Primiceri. 2024. “The Drivers of Post-Pandemic Inflation.” NBER Working Paper No. 32859.

Hempell, H., V. Scalone, and F. Silva. 2024. “Implications of Higher Inflation and Interest Rates for Macroprudential Policy Stance.” ECB Occasional Paper No. 358.

Hoffmann, P., S. Langfield, F. Pierobon, and G. Vuillemey. 2019. “Who Bears Interest Rate Risk?” *Review of Financial Studies* 32 (8): 2921–54.

Iacoviello, M., and S. Neri. 2010. “Housing Market Spillovers: Evidence from an Estimated DSGE Model.” *American Economic Journal: Macroeconomics* 2 (2): 125–64.

Jaimovich, N., and S. Rebelo. 2009. “Can News about the Future Drive the Business Cycle?” *American Economic Review* 99 (4): 1097–118.

Jimenez, G., D. Kuvshinov, J.-L. Peydro, and B. Richter. 2022. “Monetary Policy, Inflation, and Crises: New Evidence from History and Administrative Data.” CEPR Discussion Paper No. 17761.

Jondeau, E., and J.-G. Sahuc. 2022. “Bank Capital Shortfall in the Euro Area.” *Journal of Financial Stability* 62 (October): Article 101070.

Justiniano, A., G. E. Primiceri, and A. Tambalotti. 2011. "Investment Shocks and the Relative Price of Investment." *Review of Economic Dynamics* 14 (1): 102–21.

Krippner, L. 2013. "Measuring the Stance of Monetary Policy in Zero Lower Bound Environments." *Economics Letters* 118 (1): 135–38.

———. 2015. *Zero Lower Bound Term Structure Modeling: A Practitioner's Guide.* Springer.

Licchetta, M., and E. Meyermans. 2022. "Gross Fixed Capital Formation in the Euro Area during the COVID-19 Pandemic." *Intereconomics* 57 (4): 238–46.

Mendicino, C., K. Nikolov, J. Suarez, and D. Supera. 2018. "Optimal Dynamic Capital Requirements." *Journal of Money, Credit and Banking* 50 (6): 1271–97.

———. 2020. "Bank Capital in the Short and in the Long Run." *Journal of Monetary Economics* 115 (November): 64–79.

Mendoza, E. G. 2010. "Sudden Stops, Financial Crises, and Leverage." *American Economic Review* 100 (5): 1941–66.

Pfeifer, J. 2016. "Macroeconomic Effects of Financial Shocks: Comment." Dynare Working Paper No. 50, CEPREMAP.

Poutineau, J.-C., and G. Vermandel. 2017. "A Welfare Analysis of Macroprudential Policy Rules in the Euro Area." *Revue d'économie politique* 127 (2): 191–226.

Revelo, J. D. G., and G. Levieuge. 2022. "When Could Macroprudential and Monetary Policies Be in Conflict?" *Journal of Banking and Finance* 139 (June): Article 106484.

Rubio, M., and J. A. Carrasco-Gallego. 2016. "The New Financial Regulation in Basel III and Monetary Policy: A Macroprudential Approach." *Journal of Financial Stability* 26 (October): 294–305.

Rubio, M., and F. Yao. 2020. "Bank Capital, Financial Stability and Basel Regulation in a Low Interest-Rate Environment." *International Review of Economics and Finance* 67 (May): 378–92.

Smets, F., and R. Wouters. 2003. "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area." *Journal of the European Economic Association* 1 (5): 1123–75.

———. 2007. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97 (3): 586–606.