fördern • führen • inspirieren

Ostbayerische Technische Hochschule
Amberg-Weiden

Die Hochschule im Dialog:

Monetary and Macroprudential Policies with Direct and Indirect Financing: Implications for Macroeconomic Stability

Jan Bruch
Franz Seitz
Uwe Vollmer

Weidener Diskussionspapiere Nr. 91, Mai 2024

Monetary and Macroprudential Policies with Direct and Indirect Financing: Implications for Macroeconomic Stability

Jan Bruch[*], Franz Seitz[†], Uwe Vollmer[‡]

May 2024

Abstract

We assess the impact of macroprudential measures on macroeconomic stability using a DSGE model in which firms can access both direct and indirect financing. The model is calibrated with data from the euro area. We compare two different macroprudential rules (time-invariant and counter-cyclical) in the presence of a monetary policy shock and a macroprudential policy shock. We find that the macroprudential rule has little impact on the adjustment dynamics to a monetary and macroprudential shock. Direct financing increases the impact of monetary shocks on the volatility of financial variables but not on output and inflation. Simultaneous monetary policy and macroprudential policy shocks do not alter the reaction of inflation compared to a monetary policy shock but cause permanent output losses.

Keywords— Monetary Policy, Macruprudential Policy, Inflation, Business Cycle, DSGE
JEL Code: E12, E31, E32, E58

[*]Leipzig University, Economics Department, Institute for Theoretical Economics, Grimmaische Straße 12, D-04109 Leipzig, Germany (E-Mail address: bruch@wifa.uni-leipzig.de).

[†]Weiden Technical University of Applied Sciences, Department of Business Administration, (Tel. +49 961 382-1318, E-Mail address: f.seitz@oth-aw.de).

[‡]Leipzig University, Economics Department, Institute for Theoretical Economics, Grimmaische Straße 12, D-04109 Leipzig, Germany (E-Mail address: vollmer@wifa.uni-leipzig.de).

Abstract

Wir untersuchen die Auswirkungen makroprudenzieller Maßnahmen auf die makroökonomische Stabilität mit Hilfe eines DSGE-Modells, in dem Unternehmen sowohl Zugang zu direkter als auch zu indirekter Finanzierung haben. Das Modell wird mit Daten des Euroraums kalibriert. Wir vergleichen zwei verschiedene makroprudenzielle Regeln (zeitinvariant und antizyklisch) in Gegenwart eines geldpolitischen Schocks und eines makroprudenziellen Schocks. Wir stellen fest, dass die makroprudenzielle Regel kaum Auswirkungen auf die Anpassungsdynamik bei einem geldpolitischen und makroprudenziellen Schock hat. Die direkte Finanzierung erhöht die Auswirkungen von monetären Schocks auf die Volatilität der Finanzvariablen, nicht aber der Produktion und Inflation. Gleichzeitige geldpolitische und makroprudenzielle Schocks verändern die Reaktion der Inflation im Vergleich zu einem geldpolitischen Schock nicht, verursachen aber dauerhafte Produktionsverluste.

1 Introduction

Since the outbreak of the financial crisis in 2008, the toolbox of central banks has expanded considerably. Unconventional instruments have supplemented conventional monetary policy instruments through forward guidance, quantitative easing and even negative interest rates. In addition, central banks have been given several new macroprudential tools, such as refined capital requirements for commercial banks, which now include a counter-cyclical capital buffer, a capital conservation buffer, a systemic risk buffer and a surcharge for globally active financial institutions, for example as codified for the Eurozone in the Capital Regulation Directive IV (CRD IV) and the Capital Requirements Regulation II (CRR II) (European Parliament and of the Council 2013a,b).[1] Banks must also meet certain liquidity coverage ratios and minimum requirements for their funds and eligible liabilities.

While macroprudential instruments aim to ensure financial stability and protect the financial sector from severe crises (Angeloni and Faia 2013; ECB 2016), they also affect macroeconomic stability. To the extent that these instruments are suitable for preventing financial market instability, macroprudential tools such as higher capital requirements affect the ability of commercial banks to lend to firms and households.[2] They raise the cost of banking operations and drive a wedge between the risk-free interest rate set by monetary policy and banks' lending rate (Kannan et al. 2012). On the other hand, larger capital requirements incentivise firms to reduce their dependence on bank financing. However, whether more stringent macroprudential measures will increase or decrease the lending rate remains uncertain.

Central banks need to assess the impact of macroprudential instruments on macroeconomic stability to fulfil their mandate, often to guarantee price stability, sometimes supplemented by high employment and a zero output gap. Such an assessment must consider that firms can access bank financing (indirect finance) and financial markets (direct finance), depending on their capital endowment. Thus, macroprudential instruments influence macroeconomic activity directly through changes in intermediary lending and indirectly through changes in financial market funding, often a substitute for bank financing.[3]

---

1 The regulation is also applied in non-Eurozone member states if they choose to follow these regulations.

2 It is disputed whether macroprudential tools alone are sufficient to ensure financial stability or whether monetary policy should also consider stability goals (Angeloni and Faia 2013; Dybowski and Kempa 2019). Similarly, Dautović (2020) notes that higher capital requirements increase the overall loss-absorbing capability of banks. At the same time, they promote the risk-taking of banks that might invest in potentially more profitable but riskier assets. On the other hand, the ECB seems confident that macroprudential tools are sufficient (Constâncio 2018).

3 An example is given by the euro area, where the financing structure of non-financial firms has changed significantly since the outbreak of the financial crisis (Deutsche Bundesbank 2018). In the four largest economies (Italy, France, Spain and Germany), internal financing has increased sharply and been subject to only minor fluctuations. In comparison, external corporate financing declined and showed strong cyclical fluctuations. Within external corporate financing, bank loans lost importance compared to the issuance of securities, both in the form of bonds and shares. Small and medium-sized enterprises were particularly affected by the more difficult access to bank loans because they had limited alternative forms of financing. Such changes in the financing structure affect the vulnerability of firms to financial shocks and alter the transmission channels of monetary policy to the real sector (Holm-Hadulla et al. 2022)

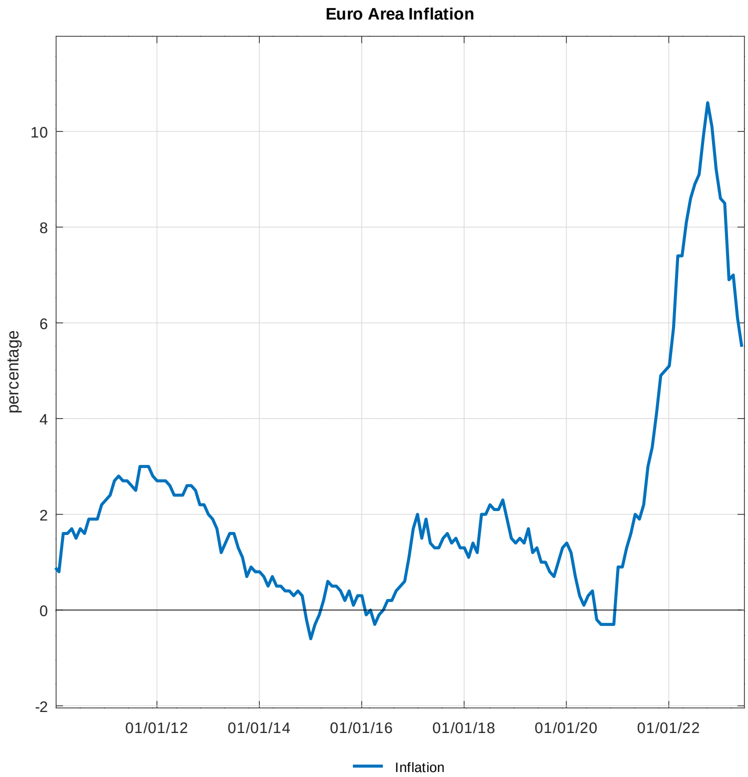


Figure 1. This figure shows the year-on-year percentage change in the monthly harmonized consumer price index (HCPI), i.e. the euro area inflation, from 2010 to 2023. source: Eurostat and own representation.

Finally, despite the expansionary monetary policy stance, the inflation record within the euro area was rather modest until 2021. Only in spring 2018 did inflation, measured by the (harmonised) consumer price index, reach 2 %. Before (from 2013 to 2018), inflation moved between 0 and 1.5% (see Figure 1). This sluggish inflation record sparked a debate about the reasons for the seemingly declining importance of monetary policy for inflation in the euro area. One explanation focuses on the interest rate set by the central bank and the overall economic credit cycle. There are two possible transmission channels. The first one refers to monetary policy decisions by the Eurosystem since the financial crisis of 2008, which have been more focused than before on avoiding financial instability and preventing the emergence of asset price bubbles. Such a "leaning against the wind" policy sets a higher interest rate than is necessary to maintain price stability.[4] The second channel refers to macroprudential tools at hand of the Eurosystem, which aim to increase financial stability and thus make “leaning against the wind” unnecessary. Thus, the ECB could maintain its primary objective and set lower key interest rates while using macroprudential policy tools to maintain financial stability (Constâncio 2018). The period from 2013 to 2018 has seen tighter macroprudential targets in response to the financial crisis and a rather loose monetary policy, and it remains unclear how both policies interact.

[4] Indeed, the ECB has announced on several occasions "that consideration should be given to ’leaning against the wind’ of asset price bubbles when taking interest rate decisions" (ECB 2010; see also ECB 2005; Issing 2009; Papademos and Stark 2010).

Against this background, this paper aims to assess the importance of macroprudential instruments for macroeconomic stability in an economy where firms have access to both financial markets and bank finance, as well as the interaction with monetary policy. We ask the following questions:

- How do different macroprudential rules affect macroeconomic stability?
- How does direct finance influence macroeconomic stability?
- What is the model-based inflation response to a simultaneous monetary and macroprudential policy shock?

We use a DSGE model of a closed economy with a financial sector that includes financial intermediaries and securities markets. Capital goods firms' access to external financing depends on their own and banks' equity. We take a maximum leverage ratio for banks as a macroprudential instrument and the short-term nominal interest rate as a monetary policy instrument. Both instruments are used by the same institution, namely the central bank, and there are no coordination problems between monetary policy and macroprudential instruments. The central bank applies a rule for each instrument, namely a variant of the *Taylor* rule for the interest rate and a simple feedback rule for maximum leverage.

Our modelling of the financial sector applies the double moral hazard problem taken from Holmström and Tirole (1997). This framework considers funding through intermediaries and funding through financial markets and allows both forms of investment finance to coexist. The model considers financial intermediaries—such as banks—as institutions that reduce the credit rationing of firms by monitoring their activities. Through monitoring, the firm has lower incentives to engage in moral hazard but pays a higher interest rate. The monitoring activities by the intermediary are not publicly observable, which requires the bank to be sufficiently remunerated to monitor. Hence, financial intermediaries are used only if monitoring is not too expensive. Otherwise, firms use direct finance through markets.

Holmström and Tirole (1997) propose two variants of their model. The first assumes a fixed investment level for all individual firms. Furthermore, they assume heterogeneous equity endowments among firms. These two assumptions imply that firms need minimum equity endowments to obtain financing from banks (indirect finance) or markets (direct finance) to fund investment for their project. However, this model variant only allows for a constant investment level.

The second variant allows firms to choose their optimal investment level. Each firm chooses an investment level that uses all its equity, and intermediaries finance the remaining funds. Consequently, equity endowments of firms are irrelevant since banks finance every investment exclusively. Thus, it is unnecessary to distinguish between equity-rich and equity-poor firms in the second model variant.

In order to allow for a coexistence of indirect and direct financing with variable investment, we make use of an investment externality. We assume that owners of capital goods firms (entrepreneurs) have heterogeneous equity endowments and that a firm's return on investment depends on average investment at the firm level. The economic rationale behind this assumption is that investment by one entrepreneur increases not only his return but also the return on investment of other entrepreneurs, which resembles a positive externality. Therefore, an individual entrepreneur cannot choose investment and would imply a constant investment for all firms in every period. However, we achieve variable investment in our model by allowing households to choose investment through their savings decision.

Investment externalities offer a convenient way to justify why individual project returns increase with investment (Conley and Dupor 2003; Harrison 2003).[5] Such externalities may result from demand or agglomeration (cluster) effects, which explain why one entrepreneur's investment also affects other entrepreneur's project returns.[6] For example, when investment activity increases, demand for goods and labour increases, which positively affects the returns generated by other firms. Agglomeration effects arise from knowledge spillovers. They improve the overall quality of labour, which is particularly important for R&D-intensive firms.

We integrate the Holmström and Tirole (1997) framework into a medium-sized DSGE model, a lá Smets and Wouters (2003) and calibrate the model using numerical results from previous studies for the euro area. We consider two types of external shocks: an expansionary monetary policy shock and an adverse macroprudential policy shock. We compare two types of macroprudential policy regimes: a counter-cyclical and a time-invariant macroprudential policy. We find that the type of macroprudential policy regime only modestly affects macroeconomic stability but affects external funding quantitatively in the case of monetary policy and macroprudential shocks. The reason is that time-invariant macroprudential policies force banks to maintain a fixed leverage ratio while counter-cyclical policies are more flexible, which affects bank lending, investment, and financial market funding.

Furthermore, an economy with a larger share of direct finance is less capital intensive and prone to larger volatility in the financial sector and output in case of a monetary policy shock. However, inflation is less volatile. Furthermore, a larger share of direct finance increases the impact of tighter leverage ratios (macroprudential policy shock) in a counter-cyclical macroprudential policy regime since bank equity is more volatile, which causes a stronger regulatory response and reduces the ability to fund investment.

Finally, an economy prone to a simultaneous monetary policy and macroprudential policy shock responds almost equally to an economy prone to a single monetary policy shock. Hence, the monetary policy shock dominates the response of the economy. In particular, such a simultaneous shock does not alter the response of inflation. However, it causes (small) permanent losses in output, investment and external finance compared to a separate monetary policy shock.

---

[5] Evidence shows that lending cuts by banks not only affect the firms borrowing from them, but also influence economic activity in the regions in which the firms operate (Berg et al. 2021; Huber 2018). Likewise the returns that firms make on borrowed capital increase if other firms are able to obtain financing too (Jorge and Rocha 2020).

[6] Note that investment externalities not only imply that the returns of entrepreneurs depend on other entrepreneurs' investments but also increase banks' failure risk since they provide too much insurance against liquidity risks. (Dietrich and Vollmer 2023).

Several other papers also examine the financial sector's role in the transmission of real and financial shocks. We differ from them in two aspects. First, all papers assume that firms finance themselves either by issuing securities (Bailliu et al. 2015; Iacoviello 2005) or by taking bank loans (Angelini et al. 2014; Cozzi et al. 2020; Kannan et al. 2012; Meh and Moran 2010), but do not consider a coexistence of direct and indirect corporate finance. The only exception is Coenen et al. (2018), who investigates the role of unconventional monetary policies but do not consider macroprudential regulation.[7] Second, models with a banking sector often refrain from endogenising either the existence of the bank or macroprudential regulation. Some papers justify the existence of a bank as a consequence of incentive problems between capital providers and capital takers due to information asymmetries (Christensen et al. 2011; Silvo 2019) or incomplete financial contracts (Angeloni and Faia 2013). They introduce macroprudential tools into the analysis but without further justifying their existence. Other papers justify why banks are subject to macroprudential regulation but assume the existence of a bank. Such regulations prevent strategic default in interbank markets (Dib 2010). In this paper, we explain the bank's existence by incentive problems due to information asymmetries between entrepreneurs and households and justify the existence of macroprudential regulations utilising investment externalities that lead to over-investment.

The paper is structured as follows: Section 2 presents the model setup. Section 3 gives the calibration, and section 4 presents the simulation results. Section 5 discusses how a different degree of direct and indirect finance affects the transmission of shocks. Furthermore, Section 5 discusses how correlated policy shocks affect macroeconomic stability. Section 6 summarises and concludes.

2 Model Set-up

We follow Chen (2001), Christensen et al. (2011), and Meh and Moran (2010) and consider a model with two types of risk-neutral agents: entrepreneurs (e) and bankers (b), with masses η^h, η^e, and a risk-avers households (h) with mass $\eta^b = (1 - \eta^e - \eta^h)$. In addition, one type of firm produces intermediate goods, a second type produces a final good, and a third type produces a capital good. Households own the intermediate goods and final goods firms. Time t is discrete. Intermediate goods (indexed j) are produced by firms facing nominal rigidities under monopolistic competition using capital goods and labour as inputs. Furthermore, the single final (consumer) good is assembled under perfect competition with only intermediate goods as inputs. Finally, capital goods firms assemble a (single) capital good using a technology with the final good as input. Entrepreneurs own the capital goods firms. The consumer good serves as the numeraire, and the price of the capital good in units of the consumer good is q_t.

Households supply labour, consume, save, and make a portfolio choice. They supply financial funds to entrepreneurs either directly by buying bonds or indirectly through banks in the form of deposits. Bankers and entrepreneurs inelastically supply one unit of labour each.

[7] Hence, the central bank buys corporate bonds. However, there is no other agent financing investment directly.

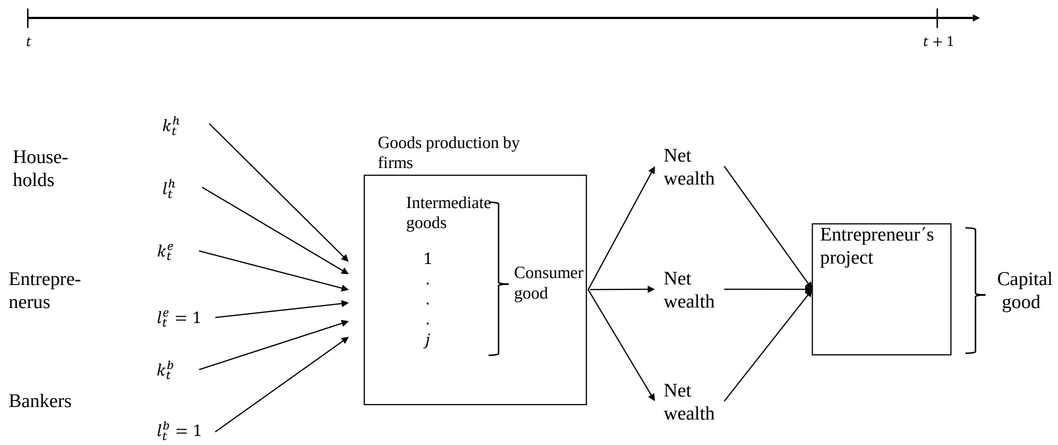


Figure 2. shows the flow of funds in the model in period t. Households, entrepreneurs, and bankers each start with an initial supply (k_t) of capital goods, which they lend to intermediate goods producers together with their labour supply (l_t). Final good producers assemble intermediate products into the final good. Agents receive a capital income and a labour income which increases their net wealth. Households and bankers provide this net wealth to entrepreneurs who use it with their equity to produce homogenous capital goods. New capital goods form agents' initial endowment of capital goods in the following period $t + 1$

Bankers raise funds from households, lend to entrepreneurs and monitor firms. Entrepreneurs need financing from households or banks to produce a capital good. Figure 2 illustrates the flow of funds during one single period t.[8]

2.1 Financial Sector

2.1.1 Moral Hazard

Entrepreneurs have access to the same production technology (project idea) but differ in equity endowment $n_t \in (0, n^{\max})$ to allow for a coexistence of indirect and direct financing. The distribution of n_t across entrepreneurs is given by a cumulative density function $G(n_t)$ with $n_t \sim U(0, n^{max})$. Each project requires an identical average investment $I_t \equiv \frac{i_t}{\eta^h+\eta^b+\eta^e} = i_t > n_t$ at t with the individual investment level i_t. Hence, an individual entrepreneur cannot choose investment. Furthermore, firm's return on investment depends on average investment I_t. at the firm level. The project generates a verifiable and publicly observable return of $\mathcal{R}(I_t) = RI_t$ $(R > 0)$ in $t+1$ if the project is successful—with probability $p \in \left\{p^H; p^L\right\}$—and zero otherwise. Variables n_t and I_t are measured in units of the consumer good; $\mathcal{R}(I_t)$ is measured in units of the capital good. Each entrepreneur can choose between three versions of the project:

- A project with "no-private benefit" with a probability of success $p^H > p^L$.
- Two versions of the project with identical success probability $p^L := p^H - \Delta p$, $(\Delta p > 0)$ but with two different levels of a private benefit $\widetilde{b}(I_t) = bI_t$ with $b \in \left\{\underline{B}; \bar{B}\right\}$ and

[8] Every period t is subdivided into sub-periods $\tau = 0, 1, ...$

$\bar{B} > \underline{B} > 0$.

Without the bank, the entrepreneur will always prefer the version with private-benefit $b = \overline{B}$ over the version with private-benefit $b = \underline{B}$ since they all produce the same low probability p^L. Furthermore, the private benefit is scaled up by the average level of investment because otherwise, moral hazard becomes more irrelevant the larger the average level of investment. A reasoning could be that the outside option increases with the availability of capital goods, which increases with the average level of investment. For example, the more (capital) goods are produced, the larger the alternatives for consumption, increasing the private benefit of the entrepreneur.

Variables n_t, p, b, I_t, R, q, p^H, and p^L are common knowledge, but only the entrepreneur knows which version of the project he will undertake. It is assumed that the project is economically viable only if the entrepreneur chooses the no-private benefit project, i.e., if

$$q_t p^H R I_t - (1 + r_t^d) I_t > 0 > q_t (p^H - \Delta p) R I_t - (1 + r_t^d) I_t + q_t \bar{B} I_t \,,$$

holds, where $1 + r_t^d$ is the (gross) market interest rate.[9] Finally, we assume that returns of the project funded by each bank are perfectly correlated.[10]

Note that thus far, our modelling would imply a constant investment for all firms in every period. However, we achieve variable investment in our model by allowing households to choose investment through their savings decision.

2.1.2 Financial Contract Under Direct Finance

Under direct finance, entrepreneurs borrow directly from households by issuing bonds. At subperiod $\tau = 0$, the entrepreneur invests his capital endowment n_t (equity) fully into the project, while the rest ($I_t - n_t = \mathfrak{b}_t$) is paid in by households as ("uninformed") investors. We denote $\mathfrak{b}_t$ as uninformed capital.[11] Also at $\tau = 0$, the contract is agreed upon and determines how project returns are shared between contractual parties. If the project succeeds, the entrepreneur receives $R_t^{e,dr}$, while households receive $R_t^{h,dr}$, with $R_t^{e,dr} + R_t^{h,dr} = R I_t$. If the project fails, however, neither party gets anything. At $\tau = 1$, all payments are made.

Under this contract, entrepreneurs choose no-private benefit if

$$\begin{aligned} & p^H q_t R_t^{e,dr} \geq (p^H - \Delta p) q_t R_t^{e,dr} + q_t \bar{B} I_t, \\ \Leftrightarrow \qquad & R_t^{e,dr} \geq \frac{\bar{B} I_t}{\Delta p}. \end{aligned} \tag{IC_{E1}}$$

Entrepreneurs can obtain the highest amount of external funding if they restrict their contracted income to $\frac{\bar{B} I_t}{\Delta p}$ because then they can pledge $\left(R - \frac{\bar{B}}{\Delta p}\right) I_t$ of income to the households in case of success. Households' expected income cannot be less than $(1+r_t^d)(I_t - n_t)$,

9 A sufficient condition for this to hold is $\bar{B} < \Delta p R$.

10 Otherwise, banks could diversify between projects and reduce the probability of failure approximately to zero.

11 We assume perfect competition between households.

where r_t^d is the interest rate households require to fund a project. Hence:

$$p^H q_t \left(R - \frac{\bar{B}}{\Delta p}\right) I_t \geq (1 + r_t^d)(\underbrace{I_t - n_t}_{\mathfrak{b}_t}) = \ (1 + r_t^d)\mathfrak{b}_t \,, \qquad (PC_{H1})$$

holds and the second equality uses the definition of uninformed capital in the participation constraint (PC_{H1}). Note that given the distribution of equity $G(n_t)$ there is an equity limit $\bar{n}_t$ which just about fulfils (PC_{H1}). This equity limit $\bar{n}_t$ results from the assumption that entrepreneurs cannot choose the size of the investment at the firm level but rather take an average investment level I_t as given. For the case of a fulfilled (PC_{H1}), define

$$\begin{aligned} \bar{n}_t &\equiv I_t - \frac{p^H q_t}{1 + r_t^d} \left(R - \frac{\bar{B}}{\Delta p}\right) I_t \,, \\ &= I_t - \mathfrak{b}_{\bar{n},t} \,, \end{aligned}$$

where $\mathfrak{b}_{\bar{n},t}$ denotes demand for uninformed capital when (PC_{H1}) holds with equality. Only entrepreneurs with equity $n_t \geq \bar{n}_t$ ("well-capitalised firms") can invest using direct finance.[12] Less "capital-rich firms" with $n_t < \bar{n}_t$ will be unable to invest by using direct finance because they cannot fulfil incentive compatibility (IC_{E1}) and the participation constraint (PC_{H1}) at the same time. Furthermore, we assume that firms with $n_t > \bar{n}_t$ invest the surplus $(n_t - \bar{n}_t)$ in the project.

2.1.3 Financial Contract Under Indirect Finance

Under indirect finance, entrepreneurs borrow from banks which use their "informed" capital a_t (bank equity) and raise uniformed capital through deposits d_t from households to fund the project. Each entrepreneur holds equity n_t, external finance covers the difference, giving the balance sheet identity of a bank

$$a_t + d_t = I_t - n_t.$$

Banks monitor entrepreneurs' behaviour with (private) costs $\widetilde{M}(I_t) = \mu I_t$ and $\mu > 0$. By monitoring, banks restrict private benefits to $b = \underline{B}$. Monitoring activity is private information of the bank and imperfect, i.e. it cannot exclude a "private benefit" completely. Entrepreneurs do not monitor other entrepreneurs. Thus, they invest excess capital in the open market, earning the uninformed rate of return r_t^d.

The financial contract concluded at $\tau = 0$ determines: *i.*) the agreed-upon payments $\left\{R_t^{e,ind}; R_t^b; R_t^{h,ind}\right\}$ to the entrepreneurs, banks and households in case the project succeeds; and *ii.*) the project financing $\{a_t; d_t; n_t\}$. We assume perfect competition between banks and households respectively and consider only contracts where the zero profit condition for banks and households holds.[13] Limited liability ensures that no agent earns a negative

12 In order to exclude $\bar{n} < 0$, it is assumed that $p_H R - (1 + r_t^d) < -p_H \frac{\bar{B}}{\Delta p}$ holds. This states that the total surplus from a project is less than the minimum share an entrepreneur must be paid to choose the no-private benefit project. See Holmström and Tirole (1997).

13 This implies that only entrepreneurs receive profits from the project and decide how to finance

return. As in the case of direct finance, the overall return is shared between the parties of the contract, i.e.

$$RI_t = R_t^{e,ind} + R_t^b + R_t^{h,ind}. \tag{2.1}$$

Intermediaries' participation reduces entrepreneurs' private benefit (private return) to $\underline{B}I_t$ but cannot be lower. Otherwise, entrepreneurs have an incentive to choose a project with private benefits. Likewise, each intermediary has (private) costs μI_t in capital goods for which he wishes to be compensated. The respective incentive constraints for entrepreneurs and intermediaries are

$$p^H q_t R_t^{e,ind} \geq (p^H - \Delta p) q_t R_t^{e,ind} + q_t \underline{B} I_t, \tag{IC_{E2}}$$

$$p^H q_t R_t^b - q_t \mu I_t \geq (p^H - \Delta p) q_t R_t^b. \tag{IC_F}$$

Participation of external investors requires that the expected returns from the project must equal the amount invested by banks and households, respectively, i.e.,

$$p^H q_t R_t^b = (1 + r_t^a) a_t, \tag{PC_F}$$

$$p^H q_t R_t^{h,ind} = (1 + r_t^d) d_t. \tag{PC_{H2}}$$

Given bank's (zero-profit) participation (PC_F) and incentive constraint (IC_F), the return of the bank R_t^b determines the return on bank equity r_t^a.

The minimum return that is necessary to induce bankers to monitor is given by

$$R_t^b = \frac{\mu I_t}{\Delta p}, \tag{2.2}$$

and the minimum return that is necessary to induce entrepreneurs to choose the project variant without a private benefit is given by

$$R_t^{e,ind} = \frac{bI_t}{\Delta p} = \frac{\underline{B} I_t}{\Delta p}. \tag{2.3}$$

Both returns result in the maximum pledgeable income of entrepreneurs to households since the remaining share of the project return for the household declines in R_t^b and $R_t^{e,ind}$ (see equation (2.1)). The maximum pledgeable income equals the return of households from investing in the project and is given by

$$R_t^{h,ind} = \left(R - \frac{\underline{B} + \mu}{\Delta p} \right) I_t, \tag{2.4}$$

using equations (2.1) to (2.3). All three parties conclude the contract provided that the contractually agreed payments (per project) to the entrepreneur, to the bank, and to the household are in line with (2.1) to (2.4). The contract implies that the entrepreneur conducts the project without a private benefit and the bank monitors.

their project.

Finally, we require that banks are not too leveraged and, in particular, that lending by bankers does not exceed a regulatory threshold lev_t of their bank equity a_t, i.e.

$$lev_t a_t \geq I_t - n_t\,.$$

Note that this is the restriction for an individual bank.

Introducing (2.4) into (PC_{H2}) yields:

$$d_t = \frac{q_t p^H}{1+r_t^d}\left(R - \frac{\underline{B}+\mu}{\Delta p}\right) I_t.$$

The previous equation establishes a relationship between the return to households $R_t^{h,ind}$ and the amount of deposits (or “uninformed capital”) households provide. This relationship depends, inter alia, on two macroeconomic variables: the interest rate on deposit r_t^d and the price q_t for the (physical) capital good. The higher r_t^d, the fewer deposits households will supply to the bank. In contrast, the higher q_t, the more uninformed capital households provide. Furthermore, an increase in the monitoring cost μ reduces the required payment to the household because less would violate the incentives to monitor.[14] As a consequence, the contribution of uniformed capital by households declines.

Finally, from (2.2) and (PC_F) we get:

$$a_t = \frac{q_t p^H \mu I_t}{(1+r_t^a)\Delta p},$$

which gives the minimum amount of informed capital to be invested by the bank into the project. The equation shows a positive correlation between the monitoring cost of the bank and bank equity as well as a negative one between the interest rate r_t^a for informed capital and bank equity.

2.1.4 Direct vs. Indirect Finance

As in the case for direct finance there is a threshold for the equity of entrepreneurs $\hat{n}_t$ given an investment level due to the distribution of equity $G(n_t)$ which is defined as

$$\begin{aligned}\hat{n}_t(\overset{(+)}{r_t^d};\overset{(+)}{r_t^a}) &\equiv I_t - \frac{q_t p^H \mu}{(1+r_t^a)\Delta p} I_t - \frac{q_t p^H}{1+r_t^d}\left(R - \frac{\underline{B}+\mu}{\Delta p}\right) I_t\,,\\ &= I_t - a_{\hat{n},t} - d_{\hat{n},t}\,,\end{aligned}$$

where $a_{\hat{n},t}$ and $d_{\hat{n},t}$ denote the informed capital demand and the deposit demand that just fulfils all participation and incentive constraint for indirect finance. Hence, only entrepreneurs with equity $n_t > \hat{n}_t$ have access to indirect finance. Entrepreneurs with equity $n_t < \hat{n}_t$ ("poorly-capitalised firms") do not receive indirect (intermediated) finance because they either cannot pay $(1 + r_t^a)$ or $(1 + r_t^d)$ to the bank or outside investors (households) or they cannot signal to choose "no-private-benefit". These unfunded entrepreneurs make their

[14] The same argument implies for increases in the private-benefit $\underline{B}$.

unused capital available to other entrepreneurs as uninformed capital. Note again that $\hat{n}_t(r_t^d; r_t^a)$ is an equilibrium outcome determined in the steady state. Furthermore, we require $\hat{n}_t < \bar{n}_t$, i.e. firms can raise external funds, either directly or indirectly, which holds if

$$\mu < \frac{\bar{B} - \underline{B}}{1 - \frac{1+r_t^d}{1+r_t^a}}.$$

2.2 Goods Production Sectors

The modelling of the final and intermediate goods sectors follows Smets and Wouters (2003) and Christiano et al. (2005). Final good producers compete with each other and use only intermediate goods as inputs. Intermediate-goods producers operate under monopolistic competition. Furthermore, they are subject to nominal rigidities and use labour and capital as inputs. Households provide labour and capital on competitive factor markets.

The demand by final goods producers for intermediate goods y_{jt} is given by

$$y_{jt} = \left(\frac{P_{jt}}{P_t}\right)^{\xi_P} Y_t,$$

with final goods output Y_t, intermediate-goods price P_{jt}, and the aggregate price index P_t, which is equal to:

$$P_t = \left(\int_0^1 P_{jt}^{1-\xi_p} dj\right)^{\frac{1}{1-\xi_p}},$$ [15]

and let $\pi_t = \frac{P_t}{P_{t-1}}$ denote the (gross) inflation rate.

Firms produce intermediate goods under monopolistic competition and nominal rigidities, as introduced by Calvo (1983). In particular, intermediate goods producing firms can only adjust their prices with probability $1 - \phi_P$. If they cannot adjust their prices to the optimal price (with probability ϕ_P), they index prices with the inflation rate and set $P_{j,t+k} = \Pi_{s=0}^{k-1} \pi_{t+s} P_{j,t}$. The firm producing good j operates the following technology:

$$y_{jt} = \begin{cases} k_{jt}^{\theta_k}(h_{jt}^h)^{\theta_h}(h_{jt}^e)^{\theta_e}(h_{jt}^b)^{\theta_b} - \Theta & \text{, if } k_{jt}^{\theta_k}(h_{jt}^h)^{\theta_h}(h_{jt}^e)^{\theta_e}(h_{jt}^b)^{\theta_b} \geq \Theta \\ 0 & \text{otherwise.} \end{cases}$$

Here, k_{jt}, h_{jt}, h_{jt}^e, and h_{jt}^b are total capital and labour services from workers, entrepreneurs, and banks used by firm j in t. Parameter $\Theta > 0$ represents fixed costs (Meh and Moran 2010).

The intermediate goods firm's minimise producer costs on factor markets taking the prices of production factors as given: The First-order conditions for capital and

[15] See Appendix A.1 for derivation of intermediate goods demand.

labour (for entrepreneurs, bankers and households) are as follows:[16]

- $r_t = s_t \theta_k k_{jt}^{\theta_k - 1} (h_{jt}^h)^{\theta_h} (h_{jt}^e)^{\theta_e} (h_{jt}^b)^{\theta_b}$,
- $w_t = s_t \theta_h k_{jt}^{\theta_k} (h_{jt}^h)^{\theta_h - 1} (h_{jt}^e)^{\theta_e} (h_{jt}^b)^{\theta_b}$,
- $w_t^e = s_t \theta_e k_{jt}^{\theta_k} (h_{jt}^h)^{\theta_h} (h_{jt}^e)^{\theta_e - 1} (h_{jt}^b)^{\theta_b}$,
- $w_t^b = s_t \theta_b k_{jt}^{\theta_k} (h_{jt}^h)^{\theta_h} (h_{jt}^e)^{\theta_e} (h_{jt}^b)^{\theta_b - 1}$.

Variable s_t is the Lagrangian multiplier and equals marginal costs. Total variable costs are $s_t y_{jt}$. Furthermore, r_t is the user cost of capital; w_t, w_t^e, and w_t^b are real wages paid to households, entrepreneurs, and bankers, respectively. The optimal price-setting rule for intermediate goods is standard.[17]

2.3 Households, Entrepreneurs and Bankers

Households live infinitely, but a share τ^e of entrepreneurs and a share τ^b of bankers obtains a signal to leave the economy at the end of each period.[18]

2.3.1 Households

Expected lifetime utility of a representative household h in t is given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^h - \gamma c_{t-1}^h, l_t) = E_0 \sum_{t=0}^{\infty} \beta^t \left(\left(\ln(c_t^h - \gamma c_{t-1}^h \right) - \psi \frac{l_t^{1+\eta}}{1+\eta} \right) ,$$

where c_t^h is household consumption in t, l_t is hours worked; γ measures the importance of (internal) habit formation, β is the discount factor, ψ denotes the weight on labour, and η denotes the inverse *Frisch* elasticity.

The representative household h starts period t with an endowment of capital goods k_t^h. The household generates labour income $\frac{W_t}{P_t} l_t$ (with nominal wage rate W_t), receives dividend income Π_t from the firms that produce intermediate goods, and receives rental income from lending capital stock to capital-good producers. Furthermore, a household receives interest payments on deposits and bond holdings. Income received is spent for consumption c_t^h , investment i_t^h into entrepreneurs project, investment in bank deposits D_t and bonds $\mathcal{B}_t$. This yields the following budget constraint in real terms:

$$[r_t + (1-\delta) q_t] \, k_t^h + \frac{W_t}{P_t} l_t + \Pi_t + (1+r_t^d) \frac{D_t}{P_t} + (1+r_t^d) \frac{\mathcal{B}_t}{P_t} = c_t^h + q_t k_{t+1}^h + \frac{D_{t+1}}{P_t} + \frac{\mathcal{B}_{t+1}}{P_t} , \quad (2.5)$$

where δ is the rate of depreciation of the capital stock.[19] The household chooses c_t^h, l_t,

[16] For a derivation, see Appendix A.2.

[17] See Appendix A.3 for the price setting rule and its derivation.

[18] This assumption prevents entrepreneurs and bankers from delaying consumption and accumulating net worth until they no longer need financial markets. It ensures that a steady state with feasible financing constraints exists. See Meh and Moran (2010).

[19] Note that the law of motion of capital of households $k_{t+1}^h = (1-\delta) k_t^h + i_t^h$ has already been substituted in equation (2.5).

k^h_{t+1}, D_{t+1}, and $\mathcal{B}_{t+1}$. The first-order conditions yield an intertemporal consumption *Euler* equation, a labour supply equation, and a capital pricing equation.[20]

2.3.2 Entrepreneurs and Bankers

Entrepreneurs and bankers enter period t with holdings n_t and a_t of equity in final goods, respectively. Both have similar choices depending on whether a signal for leaving the economy arrives at the end of the period. In any case, the entrepreneur leases his initial stock of capital goods k^e_t at the interest rate r_t to intermediate-good producers and receives (real) wage w^e_t for his inelastic labour supply of one. After production, he receives the depreciated capital stock, which adds to his equity. Thus, the entrepreneurs' equity in t is given by:

$$n_t = [r_t + q_t(1-\delta)]\, k^e_t + w^e_t. \tag{2.6}$$

The entrepreneur invests the entire amount n_t into the project, and if it is successful, he will receive a payment of $R^{e,dr}_t$ (or $R^{e,ind}_t$) and zero otherwise. Entrepreneurs who leave the economy completely consume their income; the other entrepreneurs save the income in total so that their capital stock in $t+1$ is equal to:

$$k^e_{t+1} = \begin{cases} R^{e,dr}_t & \text{if bond financed, surviving and successful} \\ R^{e,ind}_t & \text{if bank financed, surviving and successful} \\ 0 & \text{otherwise.} \end{cases}$$

Similarly, a banker can lend the newly produced capital goods to intermediate goods producers, from which he earns an interest income that supplements his labour income. After production, he receives the depreciated capital stock, which adds to his equity. Accordingly, for the equity of the banker, we have:

$$a_t = [r_t + q_t(1-\delta)]\, k^b_t + w^b_t\,. \tag{2.7}$$

Bankers who are not leaving the economy save their entire income and obtain capital in $t+1$ given by:

$$k^b_{t+1} = \begin{cases} R^b_t & \text{, if surviving and successful} \\ 0 & \text{, otherwise,} \end{cases}$$

Bankers who leave the economy consume.

[20] See Appendix A.4 for the first-order conditions.

2.4 Monetary Policy and Macroprudential Policy

The central bank chooses both the monetary policy instrument and macroprudential instruments rule-based. The deposit rate r_t^d serves as the monetary policy instrument. The macroprudential instrument is the maximum leverage ratio, where the leverage ratio (at the firm level) is defined as $lev_t = \frac{I_t - n_t}{a_t}$. Hence, maximum leverage is the inverse of a minimum capital requirement, where equity must equal a certain percentage of all assets; hereafter, we refrain from risk-weighting the assets. We assume the following policy rules:

- The central bank sets the deposit interest rate r_t^d according to the (linearised) *Taylor* rule (Christiano et al. 2010):

$$\widehat{r}_t^d = \rho_r \widehat{r}_{t-1}^d + (1-\rho_r)\left[\rho_\pi(\widehat{\pi}_{t+1} - 0) + \rho_{dy}(\hat{y}_t - \hat{y}_{t-1}) + \rho_{d\pi}(\widehat{\pi}_t - \widehat{\pi}_{t-1})\right] + \widehat{MP}_t\,,$$

  where $\widehat{\pi}_t$ is the deviation from steady state inflation, $\hat{y}_t$ represents output deviations from steady state, and with ϵ_t^{mp} as an i.i.d. monetary policy shock with standard deviation σ^{mp}. ρ_r is the interest rate smoothing or persistence parameter (with $0 < \rho_r < 1$), ρ_π, $\rho_{d\pi}$ and ρ_{dy} are the weights of the respective policy target values. Accordingly, the central bank reacts with its monetary policy rate to differences from expected inflation to target inflation (set to zero), changes in output, and changes in inflation.

- The central bank, as the macroprudential policy authority, sets the leverage ratio for banks according to the feedback rule:

$$lev_t = \upsilon_t lev_{SS} + \varpi(x_t - x_{SS}), \tag{2.8}$$

  where lev_{SS} is the steady-state leverage ratio, and x_t represents an economic variable that regulation might respond to (with ϖ measuring the strength of this response). In what follows, x_t is equal to the credit-to-GDP ratio, following Christensen et al. (2011). Hence, this rule allows fluctuations in bank capital-to-asset ratios that capture euro area regulation. Finally, υ_t captures changes in regulatory minimum capital requirements and follows the (linearised) AR(1) process $\hat{\upsilon}_t = \rho_\upsilon \hat{\upsilon}_{t-1} - \epsilon_t^\upsilon$.

2.5 Sequence of Events and Competitive Equilibrium

2.5.1 Sequence of Events

On each period t, the sequence of events is as follows:

1. Monetary policy shock (ϵ_t^{mp}) and leverage shock (ϵ_t^υ) are realized.
2. Households, bankers, and entrepreneurs rent their capital holdings k_t^h, k_t^b, and

k_t^e to intermediate-goods producers. Households, bankers, and entrepreneurs supply labour to goods producers; intermediate and final goods are produced.

3. Households buy bonds from entrepreneurs and deposit savings in banks; entrepreneurs finance projects.
4. Entrepreneurs choose the project version; banks choose to monitor.
5. Successful projects return RI_t units of new capital which agents share.
6. Exiting agents sell their capital for consumption goods to households. Surviving agents buy this capital.
7. All markets close.

2.5.2 Competitive Equilibrium and Resource Constraints

The competitive equilibrium consists of the following eight sets of conditions where uppercase letters denote the respective aggregate variable:[21]

1. Decision rules for $c_t^h, i_t^h, W_{it}, k_{t+1}^h, d_t, \mathfrak{b}_t$ that solve the maximization problem of households.
2. Decision rules for $\tilde{p}_{jt}, k_{jt}, h_{jt}$ that solve the maximization problem of firms producing intermediate goods.
3. Decision rules for $R_t^e, R_t^b, R_t^h, a_t, d_t$ that fulfil the financial contract.
4. Savings and consumption decision rules for entrepreneurs and banks.
5. Market clearing conditions:
   - Total capital stock holdings:

$$K_t = K_t^h + K_t^e + K_t^b$$

   - Total capital services:

$$K_t^h + K_t^e + K_t^b = \int_0^1 k_{jt} \mathrm{d}j$$

   - Labour market equilibria:

$$\begin{aligned} \int_0^{\eta^h} l_t \mathrm{d}h = L_t &= \int_0^1 h_{jt}^h \mathrm{d}j\,, \\ \eta^b &= \int_0^1 h_{jt}^b \mathrm{d}j\,, \\ \eta^e &= \int_0^1 h_{jt}^e \mathrm{d}j \end{aligned}$$

21 Appendix B provides the aggregation for the model.

- Final goods market equilibrium:

$$Y_t = C_t^e + C_t^b + C_t^h + \mathfrak{I}_t$$

- Market for bank deposits equilibrium:

$$\eta^b d_t = \eta^h \frac{D_t}{P_t}$$

- Bond market equilibrium:

$$\eta^e \mathfrak{b}_t = \eta^h \frac{\mathcal{B}_t}{P_t}$$

6. Law of motion for aggregate capital with aggregate (externally funded) investment $\mathfrak{I}_t$:

$$K_{t+1} = (1-\delta)K_t + p^H R \mathfrak{I}_t$$

7. Regulatory leverage:

$$lev_t = \upsilon_t lev_{SS} + \varpi(x_t - x_{SS}), \tag{2.9}$$

with x_t

$$x_t = \frac{\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t) - \frac{1}{n^{\max}}(\bar{n}_t - \widehat{n}_t)([r_t + q_t(1-\delta)]\, K_t^e + \eta^e w_t^e) + (1-\Gamma_t)\mathfrak{Res}_t}{Y_t},$$

8. Resource constraints:

- The household budget constraint:

$$C_t^h + q_t K_{t+1}^h + \eta^b d_t + \eta^e \mathfrak{b}_t = (r_t + q_t(1-\delta))K_t^h + \Pi_t + w_t L_t + (1 + r_t^d)(\eta^b d_t + \eta^e \mathfrak{b}_t)$$

- the financial resource constraint:

$$A_t + \eta^b d_t + \eta^e \mathfrak{b}_t + N_t^e = \frac{1}{n^{max}}(\bar{n}_t - \hat{n}_t)\,[I_t - [r_t + q_t(1-\delta)]K_t^e + \eta^e w_t^e] + \frac{1}{n^{max}}(n^{max} - \bar{n}_t)\,(I_t - [r_t + q_t(1-\delta)]K_t^e + \eta^e w_t^e) + \Gamma_t \mathfrak{Res}_t$$

Remark: The financial resource constraint ensures that all sources of external finance are met by credit, bonds, or bank reserves $\mathfrak{Res}_t$. Without reserves, the calibrated model implies a violated balance sheet identity, i.e. assets would not equal liabilities. The reason is that the aggregate regulatory leverage restriction would not bind.[22] In particular, regulatory authorities would allow for a higher leverage $lev_t A_t$ than the aggregate credit supply chosen by banks $\frac{1}{n^{max}}(\bar{n}_t - \hat{n}_t)(I_t - N_t)$ in equilibrium. Consequently, some of the (external) funds of banks—bank equity plus households' deposits—remain unused since deposits and bank equity exceed the supply of credit in a steady state. Thus, banks hold reserves $\mathfrak{Res}_t$ of which Γ_t are held in final goods (liquid reserves). Furthermore, the demand for bonds $(\eta^e \mathfrak{b}_t + N_t^e)$ can exceed the supply for bonds in equilibrium. If this is the case, holdings in liquid reserves are reduced (Γ_t declines) and banks invest in bonds and vice versa. In addition, solving the model without reserves would require solution methods other than linearizing because of the non-binding leverage restriction. Thus, we include reserves to obtain a steady state with binding constraints and allow banks to adjust to new leverage regulations. We solve the model by standard methods, i.e., linearising around a steady state and using Dynare to solve a first-order approximation. Dynare uses a generalized Schur decomposition to find policy functions for the first-order approximation described in Villemot (2011).[23]

3 Calibration

Table IV.1 shows the parameter values used for calibration. The values for the real economy are mostly taken from the literature. This applies to the discount factor ($\beta = 0.998$), the habit parameter ($\gamma = 0.62$), the percentage of optimising firms ($\phi_P = 0.58$), and the elasticity of substitution between goods ($\xi_P = 5.5$).[24] The masses of households, entrepreneurs, and bankers are equal to $\eta^h = 0.9$, $\eta^e = 0.07$ and $\eta^b = 0.03$. The share of capital in production is set to $\theta_k = 0.36$, which implies a share for labour of $1 - \theta_k = 0.64$. This labour share is split between households, entrepreneurs and bankers such that entrepreneurs and bankers contribute only a small fraction to production, i.e. $\theta_h = 0.6399$ and $\theta_e = \theta_b = 0.0005$ (Meh and Moran 2010). The inverse elasticity of labour and the weight on labour are set to $\eta = 0.2$ and $\Psi = 1.3$, respectively. Furthermore, the parameters governing the survival of entrepreneurs and bankers are set such that the return on bank equity (ROE) r_t^a matches empirical

22 Formally, the balance sheet identity is given by B.8 and the aggregate leverage restriction is given by B.6, both in Appendix B.

23 The system of equations used to calculate the steady states can be found in Appendix C. The system of linearised equations can be found in appendix D.

24 The *Calvo* parameter value of 0.58 is for export prices in Coenen et al. (2018) which we use because for larger values the fixed costs turn negative in steady state. Furthermore, Coenen et al. (2018) suggest a mark-up of 1.35 which would correspond to a value for the elasticity of substitution of $\xi_P = 3.85714$ which again would result in negative fixed cost. Our calibration results in a mark-up of 1.222.

evidence of an average annualised return of 11.8% in Berger (2003).[25] The respective values are $\tau^e = 0.90$ and $\tau^b = 0.965$. The fixed costs follow endogenously from our model, allowing us to match a steady state with empirically plausible capital and investment-to-output ratios.[26] The steady state fix costs are $\Theta = 0.17276$. Finally, the depreciation rate is set to $\delta = 0.025$, as in Coenen et al. (2018).

The financial contract's parameters (R, p^H, p^L, n^{max}, b, $\bar{B}$, and μ) determine the production of capital goods and investment. They are calibrated to match the steady state investment-to-output ratio and the capital stock-to-output ratio of $I/Y = 0.2098$ and $K/Y = 12.52$, respectively. These numbers are relatively close to the values (0.21 and 12.5) estimated by Christiano et al. (2010) and Coenen et al. (2018). Since many of the remaining parameters do not have empirical counterparts, the values are set to support the two steady-state ratios mentioned above. In particular, we have chosen $R = 1.507$, $p^H = 0.99$, $p^L = 0.83$, $n^{\max} = 1$, $b = 0.08$, $\bar{B} = 0.22$ and $\mu = 0.024$.[27] Having fixed all parameters, the steady states are computed by a standard solver for non-linear equation systems using Octave. Note that it is necessary to allow banks to hold reserves to obtain a steady-state value. Reserve holdings ensure that the financial constraints are binding, and the model can be linearised around a steady state and solved by standard methods. Furthermore, intermediate goods producers make profits, ensuring all markets are closed.

The calibration of the policy parameters follows a mixed procedure. The parameters of the *Taylor* rule are taken from Coenen et al. (2018) and are set to $\rho_r = 0.93$, $\rho_\pi = 2.74$, $\rho_{d\pi} = 0.04$, and $\rho_{dy} = 0.1$ respectively. The steady-state value for the leverage ratio follows endogenously from the model and is given by $lev_{SS} = 1.1271$. The coefficient measuring the strength of the reaction in the macroprudential feedback rule is set to $\omega = -400$ to ensure that leverage fluctuates sufficiently by at least 2.1%.[28] This ensures that the capital buffers can be depleted sufficiently to show the mechanics of the model.[29]

[25] Berger (2003) investigates the influence of technological change on the U. S. banking industry and find a ROE of 11.65%. They report performance indicators among which the return on equity is calculated for the period from 1984 to 2001. Using the entrepreneurs' and bankers' survival rate to match the ROE closely follows the calibration strategy of Meh and Moran (2010).

[26] Note that households still receive profits despite using fix costs.

[27] Christensen et al. (2011) and Meh and Moran (2010) report values for these parameters but using their values results in implausible steady state ratios or in an unstable equilibrium, i.e. no steady state. For informational purpose only the respective values from Christensen et al. (2011) are given: $R = 1.05$, $p^H = 0.99$, $p^L = 0.64$, $\bar{B} = 0$ and $b = 0.1575$. Meh and Moran (2010) use $R = 1.21$, $p^H = 0.99$, $p^L = 0.75$, $b = 0.16$ and $\mu = 0.025$.

[28] 2.1% is the maximum value for fluctuations of regulatory leverage in our model. 62.5% would be allowed according to Capital Requirement Regulation II and Capital Requirement Directive IV which codifies the regulation for European banks. In particular, taking a total capital ratio of 8% as the lower bound and assume that the capital conservation buffer as well as the counter-cyclical capital buffer (in sum a total of 5% of Tier 1 capital) are depleted completely at once. Hence, the upper bound of the capital ratio is 13% which translates to a maximum fluctuation of 62.5%.

[29] Nevertheless, 2.1% is an arbitrary number which is not tied to an empirical value. Our counter-cyclical macroprudential policy regime equation (2.9 in Appendix B) reacts instantaneous to

The standard deviation of the monetary policy shock is set to $\sigma_{MP} = 0.11$, which is an estimation of Coenen et al. (2018). Furthermore, the standard deviation for the adverse macroprudential policy shock is set to $\sigma_{\upsilon} = 6$. We set the persistence parameter of $\rho_{\upsilon} = 0.99$ to achieve an almost permanent change in macro-variables for the macroprudential policy regime.

Description	*Parameter*	*Value*	*Source*
Policy Parameters			
Output weight	ρ_{dy}	0.1	Coenen et al. (2018)
Inflation weight	ρ_{π}	2.74	Coenen et al. (2018)
Weight on changes in inflation	$\rho_{d\pi}$	0.04	Coenen et al. (2018)
Interest rate persistence	ρ_r	0.93	Coenen et al. (2018)
Leverage	lev_{SS}	1.1271	own calibration
Macroprudential response	ϖ	-400/0	own calibration
Shocks: standard deviations and persistence parameters			
Standard deviation Monetary policy shock	σ_{MP}	0.11	Coenen et al. (2018)
Leverage shock persistence	ρ_{υ}	0.99	Cozzi et al. (2020)
Standard deviation leverage shock	σ_{υ}	6	own calibration
Steady State Ratios and Values			
Investment-to-output ratio	$\frac{I}{Y}$	0.2098	Target ratio of 0.21 (Coenen et al. 2018)
Capital-to-output ratio	$\frac{K}{Y}$	12.52	Target ratio of 12.5 (Christiano et al. 2010)
Return on bank equity	r^a	0.11789	Target value of 0.1165 (Berger 2003)
Fixed costs	Θ	0.17276	No target value
Households			
Weight on leisure	ψ	1.3	own calibration
Inverse elasticity of labour	η	0.2	own calibration
Habit parameter	γ	0.62	Coenen et al. (2018)
Fraction of households	η^h	0.9	Meh and Moran (2010)
Discount factor	β	0.998	Coenen et al. (2018)

changes in the credit-to-GDP ratio. This policy rule seems to be more responsive than European regulators are reacting to their target rate (deviations from the long-term growth rate of the credit-to-GDP ratio) in the past. Since their full implementation in 2019, counter-cyclical capital buffers have been adjusted only once during the Corona pandemic. However, our rule would imply more frequent adjustments given a long-term growth rate of 1.6 percent per year of the (nominal) credit-to-GDP ratio year for the euro area and an increase in the growth rate by 18 percent in the second quarter of 2020 and a decline by 11 percent in the second quarter of 2021 (see figure 8 in Appendix E).

Description	*Parameter*	*Value*	*Source*
Entrepreneurs			
Probability of success	p^H	0.99	Meh and Moran (2010)
Probability of success in a private benefit project	p^L	0.83	own calibration
Project return	R	1.507	own calibration
Entrepreneur‘s maximum capital endowment	$n^{\max}$	1	own calibration
Low private benefit	$\underline{B}$	0.08	own calibration
High private benefit	$\bar{B}$	0.22 0.151	own calibration
Surviving probability entrepreneur	τ^e	0.90	own calibration
Fraction of entrepreneurs	η^e	0.07	Meh and Moran (2010)
Bankers			
Monitoring cost	μ	0.024	own calibration
Surviving probability banker	τ^b	0.965	own calibration
Fraction of bankers	η^b	0.03	Meh and Moran (2010)
Intermediate Goods Producer			
Elasticity of substitution between goods	ξ_P	5.5	own calibration
Percentage of reoptimizing Firms	ϕ_P	0.58	Coenen et al. (2018) for import prices
Capital share of production	θ_k	0.36	Meh and Moran (2010), Coenen et al. (2018)
Entrepreneur labor share of production	θ_e	0.00005	Meh and Moran (2010)
Banker labor share of production	θ_b	0.00005	Meh and Moran (2010)
Household labor share of production	θ_h	0.6399	Meh and Moran (2010)
Depreciation rate	δ	0.025	Coenen et al. (2018)

Table 1. Parameter Calibration

4 Impulse Response Functions (IRFs)

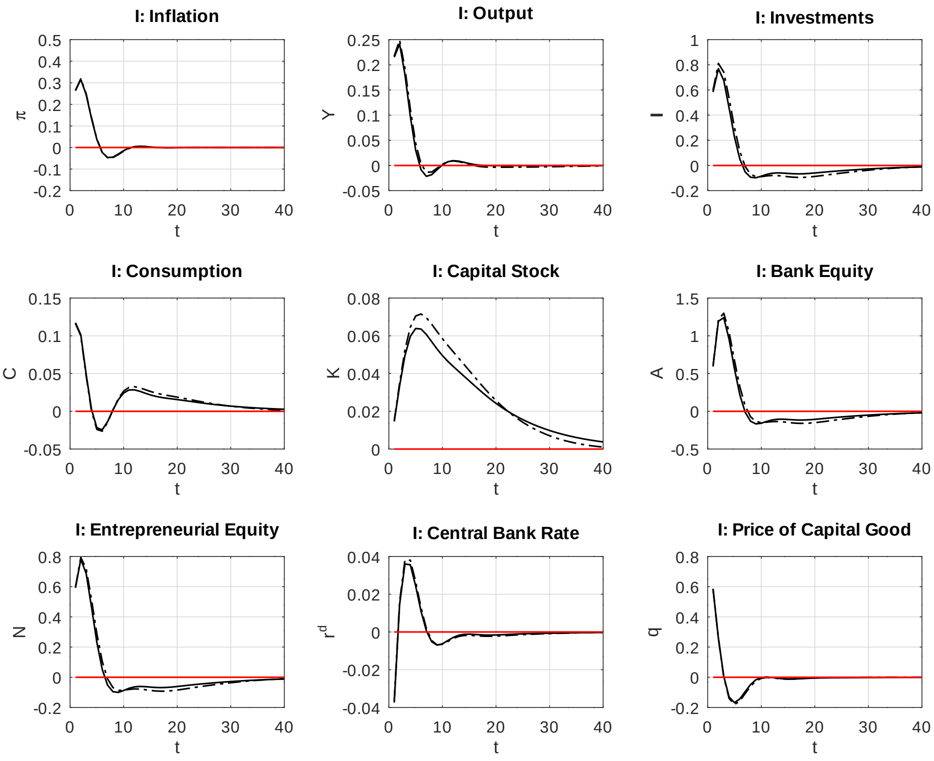
The economy is subject to two different shocks: 1) an expansionary monetary policy shock; and 2) a negative leverage shock accounting for changes in macroprudential policies. Both are policy shocks and we show the IRFs for two model economies. The first economy is subject to a counter-cyclical macroprudential policy regime (solid lines), and the second to a time-invariant macroprudential policy (dashed lines) regime. Note that the deviation from the steady state of the leverage ratio is always zero in the latter case.

4.1 Monetary Policy Shock

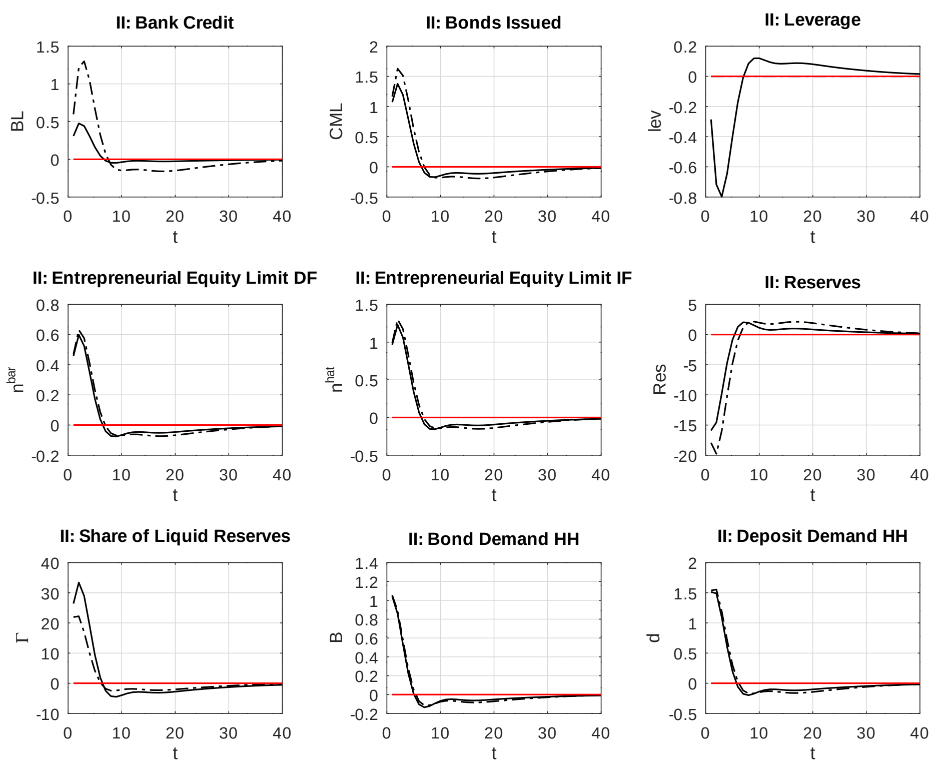
Figures 3a and 3b show the impulse responses to an expansionary monetary policy shock (r^d is lowered). Figure 3a presents real sector variables (including inflation), and figure 3b variables governing external finance. The interest rate shock implies that output, consumption, and inflation increase. Consumption increases because a lower policy rate induces households to consume more today and less in the future. Furthermore, the capital good price q increases on impact, increasing banks' and entrepreneurs' equity. Thus, entrepreneurs' access to external financing improves because they gain wealth and the increase of the critical equity limits $\bar{n}$ and $\hat{n}$ is small enough. Thus, bank lending BL and direct funding (financial market funding) CML increase while bank reserve holdings decline. These IRFs are standard and qualitatively in line with previous research (e.g. Christiano et al. (2010), Coenen et al. (2018), Gertler and Karadi (2011), Meh and Moran (2010), and Smets and Wouters (2003)).

Comparing the IRFs for counter-cyclical macroprudential policies with those of time-invariant policies reveals that major differences are only visible for the stock of capital and external finance variables (bank credit, direct funding, reserves and liquid reserves). However, only the quantitative magnitudes differ. Under a counter-cyclical policy regime, the regulatory authority tightens macroprudential policies (i.e. reducing the maximum leverage ratio) since the credit-to-GDP ratio increases. Consequently, bank credit expands less than in a time-invariant regime. Furthermore, banks hold a larger fraction of their reserves in "cash" (Γ increases and $\mathfrak{Res}$ decreases). Hence, financial market funding by banks declines, contributing to a smaller increase in BL. Furthermore, direct funding increases on impact of the monetary policy shock, but this increase is smaller than in a time-invariant macroprudential regime due to a lower demand for external funding. Consequently, investment increases less in the case of counter-cyclical macroprudential policies since banks also have to obey stricter leverage restrictions.[30] Thus, stricter bank regulation is felt in financial and credit markets since banks must obey new rules, affecting their ability to lend in both markets.

[30] This especially is visible for periods 10 to 30 in figure 3a.



(a) Real variables



(b) Financial variables

Figure 3. shows IRFs for an expansionary monetary policy shock. Source: own calculation.

Nevertheless, the effect on output is negligible since well-capitalised entrepreneurs can rely on internal finance, which reduces demand for bonds because their equity increases sufficiently.

4.2 Leverage Shock

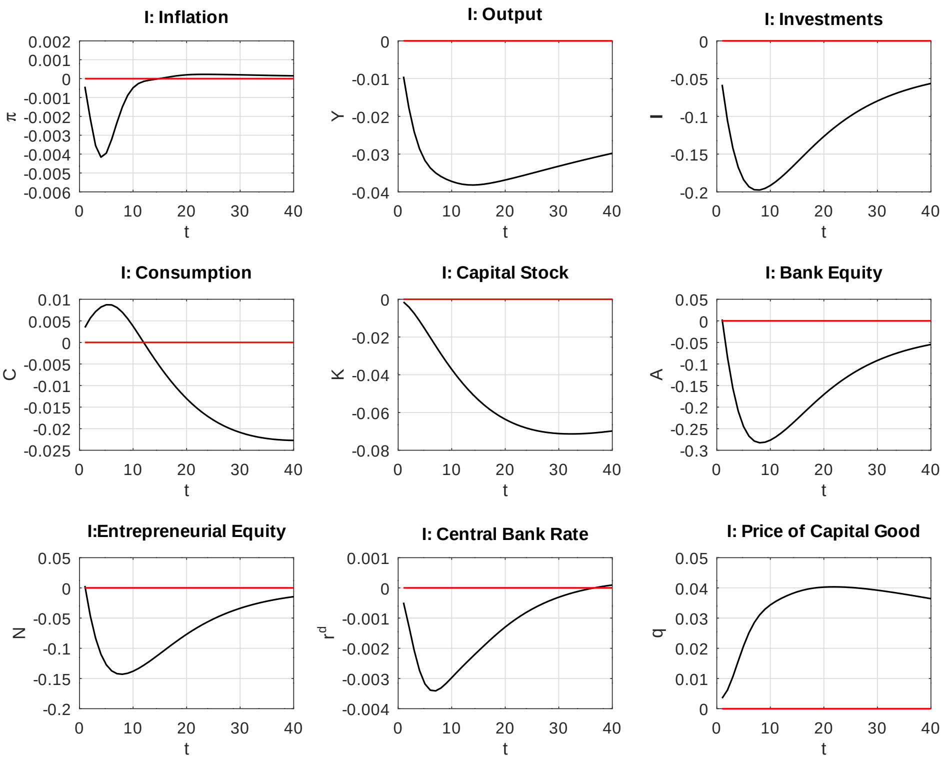
Figures 4a and 4b show the IRFs to a negative leverage shock, i.e. permanently lower leverage ratio for the real and financial variables, respectively. We only consider a counter-cyclical macroprudential policy regime since the IRFs are qualitatively the same in both policy regimes.[31]

The central bank reduces maximum leverage by one percent, and banks must deleverage. Banks achieve this by cutting credit supply, which lowers investment $\mathfrak{I}$ of entrepreneurs, bankers, and households and reduces household savings $\mathfrak{b}$ and d. Note that banks increase their holding in liquid reserves as alternatives for investments are missing (both Γ and $\mathfrak{Res}$ increase). Declining investment results in declining capital formation, bank equity, and entrepreneurial equity, which results in lower output and consumption (in the long-run).

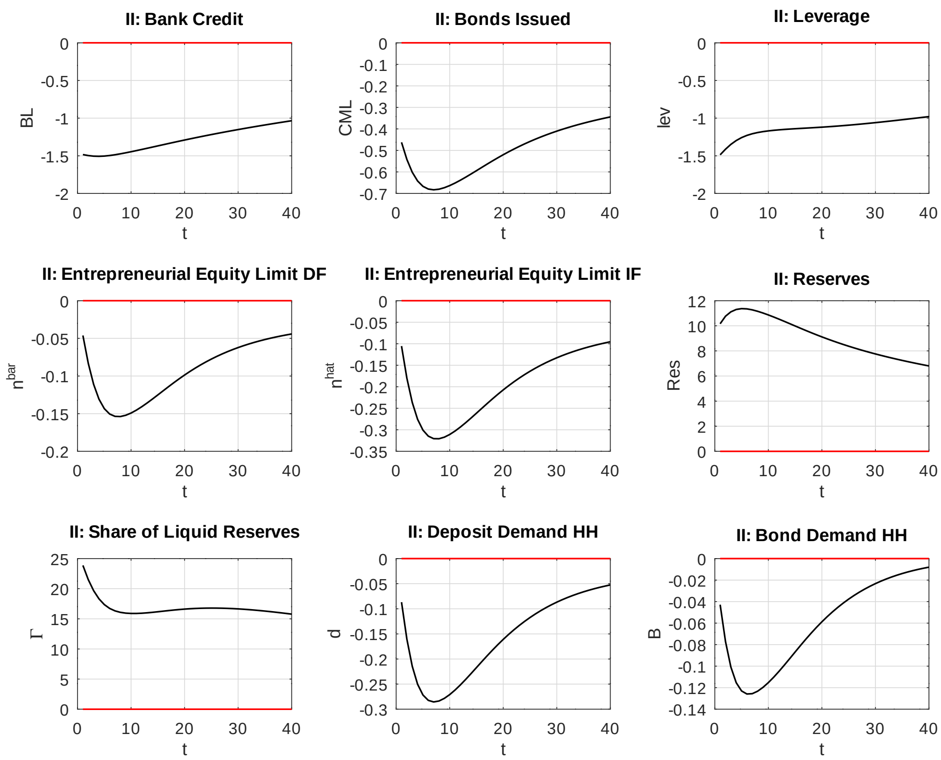
Furthermore, a lower leverage ratio causes deflationary pressure for two reasons. First, declining output implies declining wages. Second, output declines faster than capital initially. However, over the transmission period, capital declines more than output, which implies first a decline and later an increase in the rental rate of capital. Hence, marginal costs first decline, which results in lower inflation. However, as the rental rate of capital returns to and above its steady state value, inflation returns to its steady state.

Finally, financial market funding can only partially substitute bank funding if the leverage ratio declines. Low demand for investments spills over to financial markets, i.e. the demand for financial market funding declines similarly to bank funding. Furthermore, as banks hold more "cash", they also reduce their bond investment. Still, financial market funding declines less than bank funding.

[31] However, note that the central bank undermines its own policy goal if it reduces maximum leverage and at the same time reacts dynamically to changes in the credit-to-GDP ratio as modelled in equation (2.8). Hence, we assume that the policy maker anticipates its own behaviour. This requires that the size of the shock is increased such that a reduction by one percent in leverage is accomplished which requires a standard deviation of $\sigma_\nu = 2.9$. To achieve a permanent reduction of maximum leverage in the counter-cyclical regime, we set the persistence parameter ρ_ν to 0.99, which results in a prolonged transition to the steady state (Cozzi et al. 2020). In particular, it takes output over 90 years to return back to its steady state value.



(a) Real variables



(b) Financial variables

Figure 4. shows IRFs for a negative leverage shock. Source: own calculation.

5 Discussion

This section investigates the influence of the investment externality, the influence of direct finance in the first and second subsection and the response of our model to simultaneous policy shocks in the third subsection. The latter experiment is motivated by the recent period of central bank history where, e.g. the ECB and its constituents extended their set of instruments by macroprudential policies to ensure financial stability while maintaining their primary target of price stability. In particular, the ECB kept the main refinancing rate close to or at zero while macroprudential policy pursued tighter capital requirements.

5.1 Investment Externality

The investment externality allows us to model a firm (capital goods producer) that can use indirect or direct finance and has varying investment levels. We achieve this by assuming that firms do not choose an individual investment level i_t but rather take an average investment I_t as given. If firms could choose i_t, only indirect finance would be used since firms adjust their project size i_t to match their net worth n_t.

As a result, the investment externality increases (aggregate) investment beyond the level which would have been implied by an economy where each entrepreneur chooses investment at the firm level individually. The main reason is that indirect finance is more expensive ($r_t^a > r_t^d$) than direct finance. Hence, more firms which would otherwise use direct finance are using indirect finance in an economy without the externality since they adjust their project size downward to fit their net worth. While this implies that more firms are obtaining funding, the aggregate effect is that overall investment demand declines. Investment demand declines since the price of capital increases due to more expensive bank finance. As a result the economy without the externality is also less capital intensive and produces less output.

Note that the uniform distribution of firm net worth may drive this result. This distribution implies a large fraction of well-capitalised firms in the total set of firms. Hence, a relatively large number of firms could use a more favourable type of funding. If the distribution were more skewed towards less capitalised firms, the advantage of more firms obtaining funding could outweigh the higher cost.

The model dynamics do not severely change if the externality is not included in the case of both policy shocks. Generally, the counter-cyclical macroprudential policy regime becomes less volatile, whereas the time-invariant macroprudential policy regime becomes more volatile as compared to the model with the investment externality.

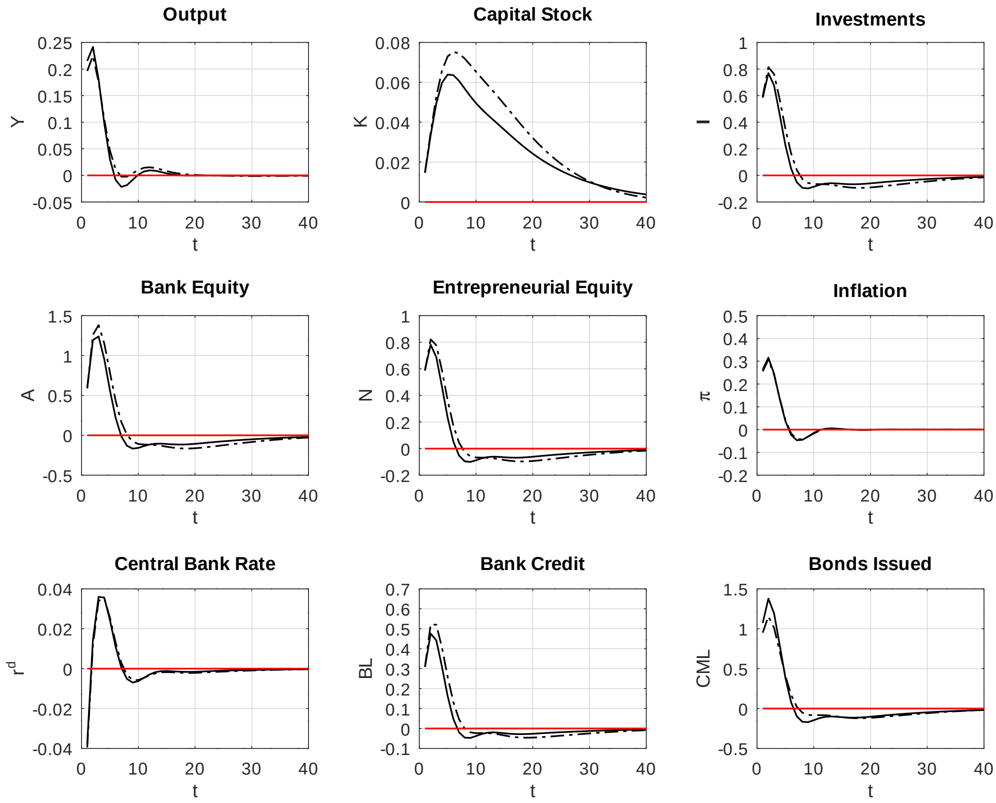


Figure 5. Expansionary monetary policy shock for baseline economy (solid lines) and low-moral hazard economy (dashed line). Source: own calculation.

5.2 The Influence of Direct Finance

In order to better assess the implications of direct finance for macroeconomic stability, we alter the degree of moral hazard in the economy and reduce the private benefit to $\overline{B} = 0.151$ (from 0.22). This has two opposing effects. First, a lower private benefit implies a lower return for entrepreneurs who fund their projects through capital markets. As a result, steady-state values for investments, capital stock and output are lower than in the baseline model because the return on investment declines and entrepreneurs are less induced to invest at a large scale on an aggregate level. The lower incentive to invest also shows in a lower investment-to-output ratio (now $I/Y = 0.17344$) and a lower capital intensity ($K/Y = 10.35$).[32] Hence, the low-moral-hazard economy is relatively poor on capital and lacks investments compared to the baseline economy. Second, more investments are funded through financial markets (direct funding) since information asymmetry is less pronounced, and households are more willing to supply capital directly.

Note that the figures of this subsection only show the transmissions for counter-cyclical macroprudential policies if the results are not affected by the type of macro-prudential policy. The solid lines now show the IRFs for the baseline model, and the

[32] In the baseline model the respective ratios were $I/Y = 0.2098$ and $K/Y = 12.52$.

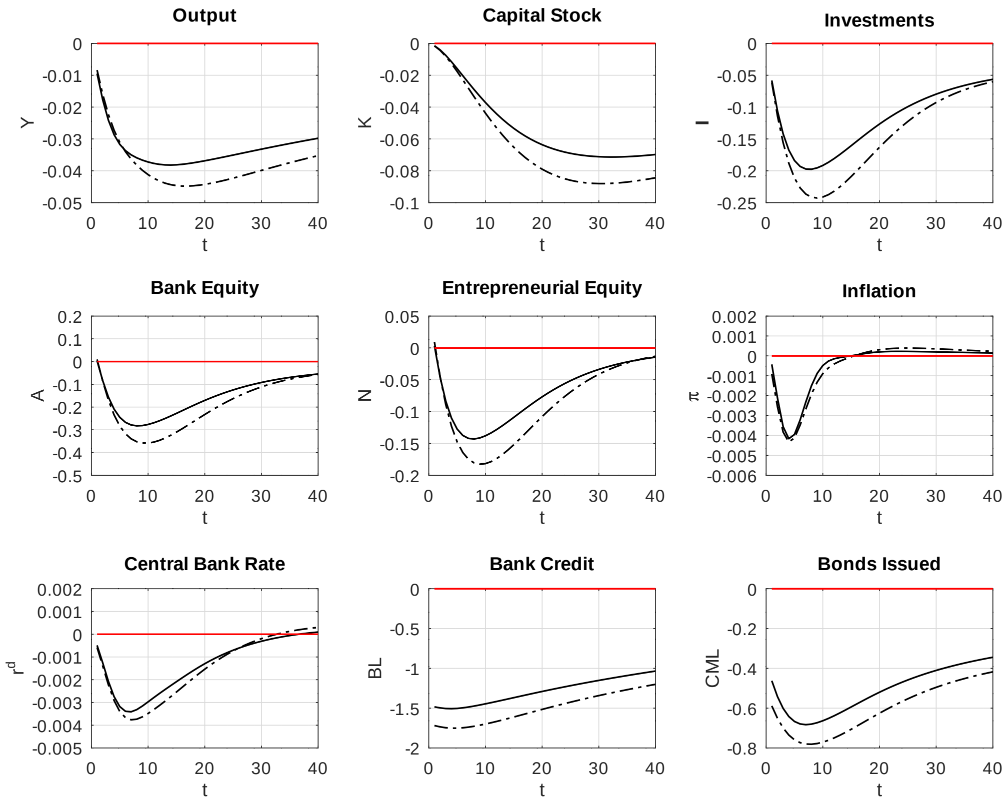


Figure 6. Negative leverage shock (counter-cyclical regulation) for baseline economy (solid lines) and low-moral hazard economy (dashed line). Source: own calculation.

dashed lines show the IRFs for the model economy with lower moral hazard (more direct funding).

In the case of an expansionary monetary policy shock, less moral hazard causes lower fluctuations in direct funding (CML) but larger in investment and bank lending (BL) (see Figure 5). Larger investment results from a stronger increase in banks' and entrepreneurs' equity as a consequence of a higher price of capital, resulting in a larger increase in the capital stock. The lower volatility in direct funding results from a stronger increase in lending standards for direct funding($\bar{n}$, not shown) when firms rely more on direct finance. Bank lending is more volatile since banks fund a smaller share of external finance, which reacts more sensitively to changes in investment. Finally, inflation responds almost the same since more direct funding does not affect marginal costs.

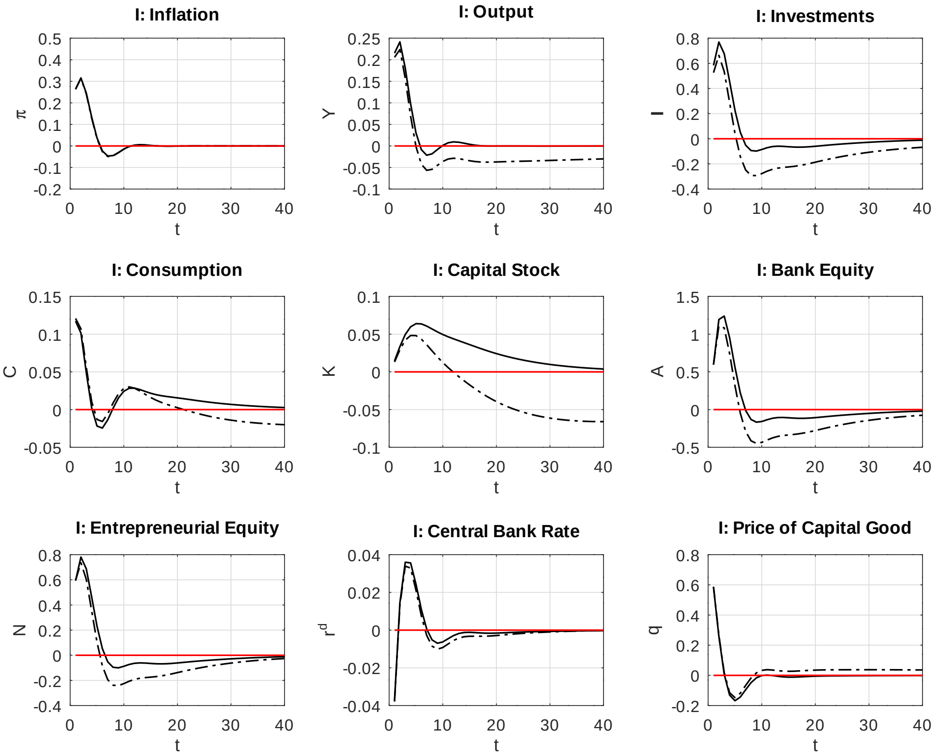
A tightening of leverage restrictions is causing a more pronounced response in every variable in the economy with less moral hazard (see Figure 6). As expected, bank lending declines under the new regulation. Since banks fund less indirectly, their equity is smaller and reacts more volatile to changes in investment, causing a stronger decline in BL. This decline in BL is amplified by the response of the regulatory authority, which reduces the maximum leverage (not shown) more in a low-moral hazard economy due to the higher volatility of bank equity. Furthermore, a higher dependency on financial market finance makes banks hold more bonds in a steady state.[33] Since bond investments also fall under regulation, these also have to be reduced permanently under the new regulatory target, which further reduces BL. Financial market funding CML declines more due to a lower demand for external funding. Hence, a reduction in bank lending and financial market funding from banks causes a stronger decline in investment. Thus, capital accumulation is more affected, and the capital stock declines more strongly. Note that this makes capital more scarce and causes higher persistency in the price of capital q (not shown), which results in more persistent inflation.

5.3 Interdependencies between Macroprudential and Monetary Policy

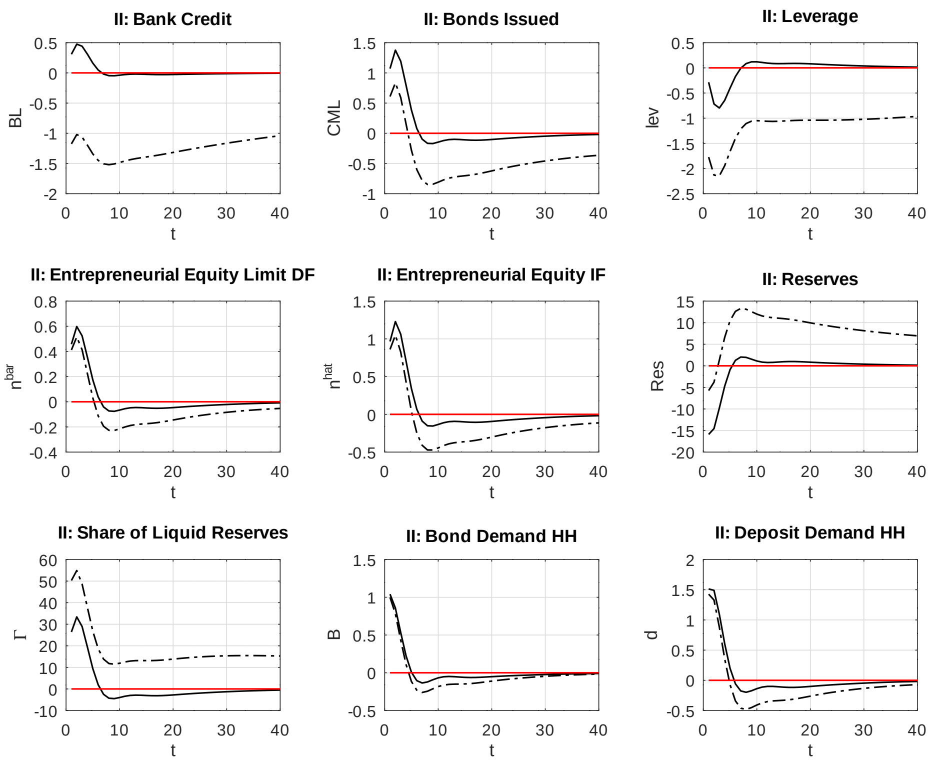
The following subsection assumes a perfect correlation ($\rho_{Corr} = 1$) between a monetary policy and macroprudential shock. Consequently, whenever policymakers change the target rate unanticipatedly, they also change the maximum leverage. Hence, we investigate the consequences of an expansionary monetary policy shock accompanied by increased capital requirements (reduction in maximum leverage). Figure 8 shows the IRFs for our experiment only in the case of a counter-cyclical macroprudential policy regime and reveals no conflicts between the monetary policy target and the conduct of macroprudential policies. In particular, inflation responds as in the case of an uncorrelated monetary policy shock while output, consumption, investments and the capital stock indicate permanent losses (the dashed lines indicate IRFs for correlated shocks). One reason for this response of inflation is the almost identical reaction of marginal costs in the experiments with and without correlated shocks. The second reason is that monetary policymakers keep the interest rate slightly lower if they simultaneously conduct macroprudential policies as output permanently is below its steady-state value. The lower interest rate stabilises inflation and keeps inflation closer to its target.

The adverse effect on financial variables (CML, BL, A and N) is more pronounced than on real variables (Y and C), manifesting in slightly less capital accumulation and investment. Hence, despite accommodative interest rate policies, bank and financial market finance is lower in the economy with correlated shocks. As expected, banks cut on lending by granting less credit, which contributes to less investments. Furthermore, higher capital requirements also affect bond investment by banks, which becomes apparent by banks' higher share of "cash" holdings (Figure 7b). Financial market funding (CML) declines mainly due to spill-overs of lower investment activity by firms.

33 In particular, $\tilde{A}_{\bar{B}=0.151} = 0.011\,769$ vs. $\tilde{A}_{\bar{B}=0.22} = 0.017\,61$ and $(1 - \widetilde{\Gamma}_{\bar{B}=0.151})\widetilde{\mathfrak{Res}}_{\bar{B}=0.151} = 0.004\,542\,1$ vs. $(1 - \widetilde{\Gamma}_{\bar{B}=0.22})\widetilde{\mathfrak{Res}}_{\bar{B}=0.22} = 0.000\,103\,743$.



(a) Real variables



(b) Financial variables

Figure 7. shows IRFs for a correlated monetary policy shock and leverage shock (dashed line) and IRFs for a monetary policy shock only (solid line). Source: own calculation.

6 Conclusions

This paper investigates the transmission of policy shocks in an economy with direct and indirect finance as well as a macroprudential policy regime. Therefore, we use two different macroprudential policy regimes: a time-invariant and a counter-cyclical. Finally, we investigate how the simultaneous conduct of monetary and macroprudential policies affects the model economy.

We find that neither macroprudential policy regime significantly affects the conduct of monetary policy; i.e. the transmission of a monetary policy shock delivers usual responses in output and inflation. Hence, an expansionary monetary policy shock raises output and inflation. Furthermore, both types of external funding respond qualitatively similarly to a monetary policy shock irrespective of the macroprudential policy regime.

Tightening capital requirements causes permanent declines in output, investment and capital stock but only a transitory decline in inflation. Thus, our model confirms intuition over higher capital buffers for banks, i.e. banks reduce lending if forced to hold more capital, which causes lower economic activity. However, given the small effects of higher capital buffers on economic activity and no permanent effect on inflation, the concerns over higher capital buffers should not be overstated according to our model.

Finally, the simultaneous conduct of monetary and macroprudential policy causes an insignificant permanent loss in output, investment and capital stock in the long run and only temporarily lowers inflation. In the short run, macroeconomic variables are driven by the monetary policy shock, i.e. output, investment and inflation increase after a decrease in the interest rate. Hence, the simultaneous conduct of monetary and counter-cyclical macroprudential policy poses no threat to central banks' traditional aim of guaranteeing price stability (and sometimes stable economic performance).

References

Angelini, Paolo, Stefano Neri, and Fabio Panetta (2014). "The Interaction between Capital Requirements and Monetary Policy". In: *Journal of Money, Credit and Banking* 46.6, pp. 1073–1112. DOI: 10.1111/jmcb.12134.

Angeloni, Ignazio and Ester Faia (2013). "Capital regulation and monetary policy with fragile banks". In: *Journal of Monetary Economics* 60.3, pp. 311–324. DOI: 10.1016/j.jmoneco.2013.01.003. URL: http://www.sciencedirect.com/science/article/pii/S0304393213000044.

Bailliu, Jeannine, Cesaire Meh, and Yahong Zhang (2015). "Macroprudential rules and monetary policy when financial frictions matter". In: *Economic Modelling* 50, pp. 148–161. DOI: 10.1016/j.econmod.2015.06.012. URL: https://www.sciencedirect.com/science/article/pii/S0264999315001595.

Berg, Tobias, Markus Reisinger, and Daniel Streitz (2021). "Spillover effects in empirical corporate finance". In: *Journal of Financial Economics* 142.3, pp. 1109–1127. DOI: 10.1016/j.jfineco.2021.04.039. URL: https://www.sciencedirect.com/science/article/pii/S0304405X21001690.

Berger, Allen N. (2003). "The Economic Effects of Technological Progress: Evidence from the Banking Industry". In: *Journal of Money, Credit and Banking* 35.2, pp. 141–176. URL: http://www.jstor.org/stable/3649852.

Calvo, Guillermo A. (1983). "Staggered prices in a utility-maximizing framework". In: *Journal of Monetary Economics* 12.3, pp. 383–398. DOI: 10.1016/0304-3932(83)90060-0. URL: https://www.sciencedirect.com/science/article/pii/0304393283900600.

Chen, Nan-Kuang (2001). "Bank net worth, asset prices and economic activity". In: *Journal of Monetary Economics* 48.2, pp. 415–436. DOI: 10.1016/S0304-3932(01)00076-9.

Christensen, Ian, Césaire Meh, and Kevin Moran (2011). "Bank Leverage Regulation and Macroeconomic Dynamic". In: *CIRANO Scientific Publications* 2011s-76, pp. 1–40. DOI: 10.2139/ssrn.1999002.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans (2005). "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy". In: *Journal of Political Economy* 113.1, pp. 1–45. DOI: 10.1086/426038.

Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno (2010). "Financial Factors in Economic Fluctuation". In: *ECB Working Paper Series* 1192, pp. 1–131. DOI: 10.2139/ssrn.1600166.

Coenen, Günter, Peter Karadi, Sebastian Schmidt, and Anders Warne (2018). "The New Area-Wide Model II: An Extended Version of the ECB's Micro-Founded Model for Forecasting and Policy Analysis with a Financial Sector". In: *ECB Working Paper Series* 2200, pp. 1–134. DOI: 10.2139/ssrn.3287647.

Conley, Timothy G. and Bill Dupor (2003). “A Spatial Analysis of Sectoral Complementarity”. In: *Journal of Political Economy* 111.2, pp. 311–352. DOI: 10.1086/367681.

Constâncio, Vitor (2018). *Financial stability risks and macroprudential policy in the euro area: Speech at the ECB and Its Watchers XIX Conference*. URL: https://scholar.google.de/citations?user=pwywfdmaaaaj&hl=de&oi=sra.

Cozzi, Guido et al. (2020). “Macroprudential Policy Measures: Macroeconomic Impact and Interaction with Monetary Policy”. In: *ECB Working Paper Series* 2376, pp. 1–63. DOI: 10.2139/ssrn.3541732.

Dautović, Ernest (2020). “Has Regulatory Capital Made Banks Safer? Skin in the Game vs Moral Hazard”. In: *Working Paper Series* 91. DOI: 10.2139/ssrn.3659873.

Deutsche Bundesbank (2018). *Rezession*. URL: www.bundesbank.de/Redaktion/DE/Glossareintraege/R/rezession.html (visited on 03/23/2018).

Dib, Ali (2010). “Banks, credit market frictions, and business cycles”. In: URL: https://www.econstor.eu/handle/10419/53873.

Dietrich, Diemo and Uwe Vollmer (2023). “Investment externalities, bank liquidity creation, and bank failures”. In: *Journal of Economics* 103.417, pp. 318–344. DOI: 10.1007/s00712-023-00846-7.

Dybowski, Philipp T. and Bernd Kempa (2019). “The ECB’s monetary pillar after the financial crisis”. In: *CQE Working Papers* 8519.

ECB, European Central Bank (2005). “Asset Price Bubbles and Monetary Policy”. In: *Monthly Bulletin* April, pp. 47–60.

ECB, European Central Bank (2010). “Asset Price Bubbles and Monetary Policy Revisited”. In: *Monthly Bulletin* November, pp. 71–83.

ECB, European Central Bank (2016). *Chapter 1 – Topical issue: The ECB’s macroprudential policy framework*. Ed. by European Central Bank.

European Parliament and of the Council (2013a). *Directive 2013/36/EU (from the 26.06.2013): CRD IV*.

European Parliament and of the Council (2013b). *Regulation (EU) Nr. 575/2013: CRR II*.

Galí, Jordi (2014). “Monetary Policy and Rational Asset Price Bubbles”. In: *American Economic Review* 104.3, pp. 721–752. DOI: 10.1257/aer.104.3.721.

Gertler, Mark and Peter Karadi (2011). “A model of unconventional monetary policy”. In: *Journal of Monetary Economics* 58.1, pp. 17–34. DOI: 10.1016/j.jmoneco.2010.10.004.

Harrison, Sharon G. (2003). “Returns to scale and externalities in the consumption and investment sectors”. In: *Review of Economic Dynamics* 6.4, pp. 963–976. DOI: 10.1016/S1094-2025(03)00034-6. URL: https://www.sciencedirect.com/science/article/pii/S1094202503000346.

Holm-Hadulla, Fédéric, Alberto Musso, Giulio Nicoletti, and Mika Tujula (2022). “Firm debt financing structures and the transmission of shocks in the euro area”.

In: *Economic Bulletin Articles* 4, pp. 116–135. URL: https://ideas.repec.org/a/ecb/ecbart/202200042.html.

Holmström, Bengt and Jean Tirole (1997). "Financial Intermediation, Loanable Funds, and The Real Sector". In: *The Quarterly Journal of Economics* 112.3, pp. 663–691. DOI: 10.1162/003355397555316. URL: https://dx.doi.org/10.1162/003355397555316.

Huber, Kilian (2018). "Disentangling the Effects of a Banking Crisis: Evidence from German Firms and Counties". In: *American Economic Review* 108.3, pp. 868–898. DOI: 10.1257/aer.20161534.

Iacoviello, Matteo (2005). "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle". In: *American Economic Review* 95.3, pp. 739–764. DOI: 10.1257/0002828054201477.

Issing, Ottmar (2009). "Asset process and monetary policy". In: *Cato Journal* 29.1, pp. 45–51. URL: https://heinonline.org/HOL/Page?handle=hein.journals/catoj29&div=8&g_sent=1&casa_token=&collection=journals.

Jorge, José and Joana Rocha (2020). "Agglomeration and Industry Spillover Effects in the Aftermath of a Credit Shock". In: *62nd issue (June 2020) of the International Journal of Central Banking*, pp. 1–50. URL: https://www.ijcb.org/journal/ijcb20q2a1.htm.

Kannan, Prakash, Pau Rabanal, and Alasdair M. Scott (2012). "Monetary and Macroprudential Policy Rules in a Model with House Price Booms". In: *The B.E. Journal of Macroeconomics* 12.1, pp. 1–42. DOI: 10.1515/1935-1690.2268.

Meh, Césaire A. and Kevin Moran (2010). "The role of bank capital in the propagation of shocks". In: *Journal of Economic Dynamics and Control* 34.3, pp. 555–576. DOI: 10.1016/j.jedc.2009.10.009.

Papademos, Lucas D. and Jürgen Stark (2010). *Enhancing monetary analysis*. Frankfurt (Main). URL: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=21522eeaca04c75c1f706676c4f1f8a3a56afcf8.

Silvo, Aino (2019). "The Interaction of Monetary and Macroprudential Policies". In: *Journal of Money, Credit and Banking* 51.4, pp. 859–894. DOI: 10.1111/jmcb.12524.

Smets, Frank and Raf Wouters (2003). "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area". In: *Journal of the European Economic Association* 1.5, pp. 1123–1175. DOI: 10.1162/154247603770383415.

Villemot, Sébastien (2011). "Solving rational expectations models at first order: what Dynare does". In: URL: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=7f32a7f79d0385c835fd7f39a90b0384a77e5cb3.

A Program Solutions

A.1 Derivation of Intermediate-Goods Demand and the Price Index for the Final Good

The final good is produced under perfect competition by firms which only use intermediate products indexed by $j \in (0,1)$ .A continuum of final goods producers use intermediate goods as input and produce final goods according to the *Dixit-Stiglitz* aggregation function :

$$Y_t = \left(\int_0^1 y_{jt}^{\frac{\xi_p - 1}{\xi_p}} dj \right)^{\frac{\xi_p}{\xi_p - 1}} .$$

Each final good producer tries to minimize the costs which implies the demand for input good j by a final good producer:

$$y_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\xi_P} Y_t. \tag{A.1}$$

A.2 Intermediate Goods Producers - Optimal Factor Price Setting

Firms producing intermediate products take factor prices as given and minimize production costs, given the production technology:

$$y_{jt} = \begin{cases} k_{jt}^{\theta_k} h_{jt}^{\theta_h} h_{jt}^{e^{\theta_e}} h_{jt}^{b^{\theta_b}} - \Theta & \text{if } z_t k_{jt}^{\theta_k} h_{jt}^{\theta_h} h_{jt}^{e^{\theta_e}} h_{jt}^{b^{\theta_b}} \geq \Theta \\ 0 & \text{otherwise} \end{cases}$$

Cost minimization implies the program:

$$\min_{k_{jt}, h_{jt}^h, h_{jt}^e, h_{jt}^b} - \left(r_t k_{jt} + w_t h_{jt}^h + w_t^e h_{jt}^e + w_t^b h_{jt}^b \right)$$

s.t.:

$$k_{jt}^{\theta_k} \left(h_{jt}^h \right)^{\theta_h} \left(h_{jt}^e \right)_h^{\theta_e} \left(h_{jt}^b \right)^{\theta_b} - \Theta - y_{jt}.$$

This implies first-order conditions are as follows:

- for capital:

$$r_t = \theta_k s_t \frac{y_{jt} + \Theta}{k_{jt}}, \tag{A.2}$$

- for household labour:

$$w_t = \theta_h s_t \frac{y_{jt} + \Theta}{h^h_{jt}}\,, \tag{A.3}$$

- for entrepreneurial labour:

$$w^e_t = \theta_e s_t \frac{y_{jt} + \Theta}{h^e_{jt}}\,, \tag{A.4}$$

- for banker labor:

$$w^b_t = \theta_b s_t \frac{y_{jt} + \Theta}{h^b_{jt}}\,. \tag{A.5}$$

The term s_t denotes the marginal costs of an intermediate goods producing firm and is given by

$$s_t = \theta_k^{-\theta_k}\theta_h^{-\theta_h}\theta_e^{-\theta_e}\theta_b^{-\theta_b}(r_t)^{\theta_k}(w_t)^{\theta_h}(w^e_t)^{\theta_e}(w^b_t)^{\theta_b}.$$

A.3 Intermediate Goods Producers: Optimal Price Setting

Profits for a representative intermediate firm are given by:

$$\Pi_{jt} = E_t \sum_{k=0}^{\infty}(\beta\phi_p)^k \lambda_{t+k}\left[\frac{P_{j,t+k}}{P_{t+k}} y_{j,t+k} - s_{t+k} y_{j,t+k}\right]\,,$$

with the marginal utility λ_{t+k} as discount factors. Given the demand for intermediate goods by final good producers

$$y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\xi_P} Y_t\,,$$

profits are given by:

$$\Pi_{jt} = E_t \sum_{k=0}^{\infty}(\beta\phi_p)^k \lambda_{t+k}\left[\left(\frac{P_{t+k-1}}{P_{t+k}P_{t-1}}\right)^{1-\xi_P}\widetilde{P}^{1-\xi_P} - s_{t+k}\left(\frac{P_{t+k-1}}{P_{t+k}P_{t-1}}\right)^{-\xi_P}\widetilde{P}^{-\xi_P}\right] Y_{t+k}\,.$$

Finally, using $P_{j,t+k} = \Pi_{s=0}^{k-1}\pi_{t+s}P_{j,t}$, the definition of (gross) inflation $\pi_{t+1} = \frac{P_{t+1}}{P_t}$, and $P_{j,t} = \widetilde{P}$ profits can be written as

$$\Pi_{jt} = E_t \sum_{k=0}^{\infty}(\beta\phi_p)^k \lambda_{t+k}\left[\pi_{t+k}^{\xi_P-1}\frac{\widetilde{P}^{1-\xi_P}}{P_{t-1}} - s_{t+k}\pi_{t+k}^{\xi_P}\widetilde{P}^{-\xi_P}\right] P_{t-1}^{\xi_P} Y_{t+k}\,.$$

The maximization problem is then given by:

$$\max_{\widetilde{P}} \; E_t \sum_{k=0}^{\infty} (\beta\phi_p)^k \lambda_{t+k} \left[\pi_{t+k}^{\xi_P - 1} \frac{\widetilde{P}^{1-\xi_P}}{P_{t-1}} - s_{t+k} \pi_{t+k}^{\xi_P} \widetilde{P}^{-\xi_P} \right] P_{t-1}^{\xi_P} Y_{t+k} \,.$$

The first-order condition is as follows:

$$0 = E_t \sum_{k=0}^{\infty} (\beta\phi_p)^k \lambda_{t+k} \left[(1-\xi_P) \pi_{t+k}^{\xi_P - 1} \frac{\widetilde{P}}{P_{t-1}} + \xi_P s_{t+k} \pi_{t+k}^{\xi_P} \right] Y_{t+k} \,. \tag{PS-10}$$

A.4 Household's First-Order Conditions

The program for a representative household is given by:

$$\max_{\{c_t^h, D_t, k_{t+1}^h, \mathcal{B}_{t+1}, l_t\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\left(\ln(c_t^h - \gamma c_{t-1}^h \right) - \psi \frac{l_{it}^{1+\eta}}{1+\eta} \right)$$

s.t.

$$(1+r_t^d)\frac{D_t}{P_t} + (r_t - q_t(1-\delta))k_t^h + \frac{W_t}{P_t} l_t + \Pi_t + (1+r_t^d)\frac{\mathcal{B}_t}{P_t} = c_t^h + q_t k_{t+1}^h + \frac{D_{t+1}}{P_t} + \frac{\mathcal{B}_{t+1}}{P_t}.$$

It results in the following first-order conditions:

- for consumption c_t^h:

$$\lambda_t = \frac{1}{c_t^h - \gamma c_{t-1}^h} - \frac{\gamma\beta}{\mathrm{E}_t \left[c_{t+1}^h \right] - \gamma c_t^h} \tag{A.6}$$

- for deposits D_t:

$$\lambda_t = \beta \mathrm{E}_t \left\{ \lambda_{t+1} (1 + r_{t+1}^d) \left(\frac{P_t}{P_{t+1}} \right) \right\} \tag{A.7}$$

- for capital k_{t+1}^h:

$$\lambda_t q_t = \beta \mathrm{E}_t \left\{ \lambda_{t+1} \left[q_{t+1}(1-\delta) + r_{t+1} \right] \right\}$$

- for bond holdings B_t:

$$\frac{\partial L_t}{\partial \mathcal{B}_{t+1}} = 0 \Leftrightarrow \lambda_t = \beta E_t \left\{ \lambda_{t+1} (1 + r_{t+1}^d) \left(\frac{P_t}{P_{t+1}} \right) \right\}$$

- Labour supply:

$$\frac{W_t}{P_t} \lambda_t = \psi l_t^{\eta}$$

- Let $\pi_t = \frac{P_t}{P_{t-1}}$ denote the (gross) inflation rate and combining the first-order condition for household consumption (A.6) as well as the first-order condition for deposit holdings (A.7) yields a typical *Euler* equation:

$$\frac{1}{c_t^h - \gamma c_{t-1}^h} - \frac{\beta\gamma}{E_t c_{t+1}^h - \gamma c_t^h} = \beta E_t (1 + r_{t+1}^d) \frac{1}{\pi_{t+1}} \left\{ \frac{1}{c_{t+1}^h - \gamma c_t^h} - \frac{\beta\gamma}{E_t c_{t+2}^h - \gamma c_{t+1}^h} \right\}.$$

B Aggregation and Laws of Motion for Capital Stock and Equity

Since banks and households are all identical, the distribution of bank equity and household net worth within both sectors is irrelevant for aggregate investment. In contrast to banks and households, entrepreneurs differ in their net worth.

Externally funded aggregate investment $\mathfrak{I}_t$ is given by:

$$\mathfrak{I}_t = \underbrace{N_t}_{\text{equity}} + \underbrace{A_t}_{\text{informed capital}} + \underbrace{\eta^b d_t + \eta^e \mathfrak{b}_t}_{\text{uninformed capital}} - \Gamma_t \mathfrak{Res}_t \,,$$

Banks hold total reserves $\mathfrak{Res}_t$ of which they invest a fraction $1 - \Gamma_t$ in bonds while the remaining fraction $0 < \Gamma_t < 1$ is held in final goods. Note that externally funded aggregate investment is also given by $\mathfrak{I}_t = 1/n^{max}(n^{max} - \hat{n}_t)I_t$. Furthermore,

$$N_t := \eta^e \int_0^{n^{\max}} n_t dG(n_t) \,,$$

is aggregate equity of entrepreneurs and let

$$N_t^e := \eta^e \int_0^{\widehat{n}_t} n_t dG(n_t) \,,$$

denote the equity of entrepreneurs who do not get any external funding. These entrepreneurs invest their excess capital as uninformed capital in the open market and lend it to other entrepreneurs (with access to finance).[34] Then, the following identity proves useful $N_t = \eta^e \int_0^{n^{\max}} n_t dG(n_t) = \frac{1}{n^{max}}(n^{max} - \hat{n}_t)N_t + N_t^e$ to distinguish between entrepreneurial equity used by externally funded entrepreneurs and unfunded

[34] Given that entrepreneurs with equity less than $\hat{n}_t$ do not obtain external finance, these entrepreneurs still fund projects through financial markets and therefore invest indirectly as well which amounts to $1/n^{max}\hat{n}_t I_t$ or the missing fraction of aggregate investment I_t. The lack in external funding is the reason why it is necessary to distinguish between I_t and $\mathfrak{I}_t$.

entrepreneurs (N_t^e). The aggregate debt of entrepreneurs is given by:

$$\mathfrak{D}_t := \frac{1}{n^{max}}(n^{max} - \hat{n}_t)(I_t - N_t) = \underbrace{A_t}_{\text{informed capital}} + \underbrace{\eta^b d_t + \eta^e \mathfrak{b}_t + N_t^e}_{\text{uninformed capital}} - \Gamma_t \mathfrak{Res}_t\,, \quad \text{(B.1)}$$

where we assume that entrepreneurs without access to external funding ($n_t < \hat{n}_t$) invest in bonds. Total bank equity and total entrepreneurial equity result from aggregating (2.6) and (2.7) over all firms and banks:

$$\begin{aligned} A_t &= [r_t + q_t(1-\delta)]\, K_t^b + \eta_t^b w_t^b\,, \\ N_t &= [r_t + q_t(1-\delta)]\, K_t^e + \eta_t^e w_t^e\,, \end{aligned}$$

where $K_t^b = \eta^b k_t^b$ and $K_t^e = \eta^e k_t^e$ are aggregate capital-good holdings by bankers and entrepreneurs.

The aggregate capital stock follows from the law of motion

$$K_{t+1} = (1-\delta)K_t + p^H R \mathfrak{I}_t\,,$$

with aggregate capital-good holdings by bankers and entrepreneurs at the beginning of period $t+1$ are determined by the project return of surviving bankers and entrepreneurs, τ^b and τ^e, respectively:

$$K_{t+1}^b = \tau^b p^H \frac{\mu}{\Delta p} \frac{I_t}{n^{\max}} (\bar{n}_t - \hat{n}_t)\,,$$

and

$$\begin{aligned} K_{t+1}^e &= \tau^e p^H \left[\int_{\hat{n}_t}^{\bar{n}_t} R_t^{e,ind} dG(n_t) + \int_{\bar{n}_t}^{n^{\max}} R_t^{e,di} dG(n_t) \right]\,, && \text{(B.2)} \\ \Leftrightarrow \quad K_{t+1}^e &= \frac{\tau^e p^H}{n^{\max}} \left[(\bar{n}_t - \hat{n}_t)\frac{B}{\Delta p} + (n^{\max} - \bar{n}_t)\frac{\bar{B}}{\Delta p} \right] I_t\,. && \text{(B.3)} \end{aligned}$$

Note that the depreciation of banker and entrepreneurial capital stock is conducted after intermediate goods production and captured in the respective net worth of bankers and entrepreneurs. Finally, aggregate consumption by bankers and entrepreneurs is given by the remaining share of exiting bankers and entrepreneurs, respectively:

$$\begin{aligned} C_t^b &= \left(1 - \tau^b\right) q_t p^H \frac{\mu}{\Delta p} \frac{I_t}{n^{\max}} (\bar{n}_t - \hat{n}_t)\,, \\ C_t^e &= \left(1 - \tau^e\right) q_t \frac{p^H}{n^{\max}} \left[(\bar{n}_t - \hat{n}_t) R^{e,ind} + (n^{\max} - \bar{n}_t) R^{e,di} \right] I_t. \end{aligned}$$

Aggregate household consumption and capital holdings are equal to:

$$C_t^h = \eta^h c_t^h \,,$$
$$K_t^h = \eta^h k_t^h \,.$$

The equity threshold for direct finance is derived from aggregating investment of directly funded entrepreneurs and aggregating uninformed capital, i.e.

$$\bar{n}_t = \int_{\bar{n}_t}^{n^{\max}} I_t \mathrm{d}G(n_t) - \eta^e \frac{p^H q_t}{1+r_t^d}\left(R - \frac{\bar{B}}{\Delta p}\right)\int_{\bar{n}_t}^{n^{\max}} I_t \mathrm{d}G(n_t)\,,$$
$$\Leftrightarrow \quad \bar{n}_t = \frac{\chi_t I_t}{1+\chi_t I_t}\,, \tag{B.4}$$

where equation (B.4) uses $n^{max} = 1$ and defines $\chi_t \equiv 1 - \eta^e \frac{q_t p_H}{1+r_t^d}\left(R - \frac{\bar{B}}{\Delta p}\right)$. The equity threshold for indirect finance is obtained in a similar manner. Thus, aggregating indirectly funded investment, deposit demand and informed capital yields

$$\hat{n}_t(\cdot) = \int_{\hat{n}_t}^{\bar{n}_t} I_t \mathrm{d}G(n_t) - \frac{q_t p^H \mu}{(1+r_t^a)\Delta p}\int_{\hat{n}_t}^{\bar{n}_t} I_t \mathrm{d}G(n_t) - \frac{q_t p^H}{1+r_t^d}\left(R - \frac{B+\mu}{\Delta p}\right)\int_{\hat{n}_t}^{\bar{n}_t} I_t \mathrm{d}G(n_t)\,,$$

$$\Leftrightarrow \quad \hat{n}_t(\cdot) = \frac{\bar{n}_t I_t \zeta_t}{1+\zeta_t I_t}, \tag{B.5}$$

where equation (B.5) again uses $n^{max} = 1$ and defines $\zeta_t \equiv 1 - \frac{q_t p_H \mu}{(1+r_t^a)\Delta p} - \frac{\eta^b q_t p_H}{1+r_t^d}\left(R - \frac{b+\mu}{\Delta p}\right)$. Aggregate return on bank equity (or on informed capital) is given by:

$$1 + r_t^a = \frac{q_t \mu p^H}{\Delta p A_t}\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t).$$

The aggregate bond demand is derived by integrating the equity of entrepreneurs given the limits for investments required by the respective type of finance. Hence:

$$\mathfrak{b}_t = \frac{q_t p^H}{1+r_t^d}\left(R - \frac{\bar{B}}{\Delta p}\right)\frac{I_t}{n^{\max}}(n^{\max} - \bar{n}_t).$$

Aggregate deposit demand is derived analogously to bond demand, which yields

$$d_t = \frac{q_t p^H}{1+r_t^d}\left(R - \frac{b+\mu}{\Delta p}\right)\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t),$$

where the right-hand side denotes the deposits used for indirect finance.

The maximum leverage restriction is given by

$$lev_t A_t = \underbrace{\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t) - \frac{1}{n^{\max}}(\bar{n}_t - \widehat{n}_t)([r_t + q_t(1-\delta)]\, K_t^e + \eta^e w_t^e) + (1-\Gamma_t)\mathfrak{Res}_t}_{\equiv BL_t}, \tag{B.6}$$

which restricts lending activities and bond purchases of the banking sector to a leverage limit lev_t of bankers' equity. Note that the restriction targets both types of external funding where only intermediate-rich firms (the second term on the right-hand side) obtain indirect funding and banks investing $(1-\Gamma_t)\mathfrak{Res}_t$ in bonds.

The market for financial market investments (bond finance) clears if

$$N_t^e + \eta^e \mathfrak{b}_t + (1-\Gamma_t)\mathfrak{Res}_t = \underbrace{\frac{I_t}{n^{\max}}(n^{\max} - \bar{n}_t) - \frac{1}{n^{\max}}(n^{\max} - \bar{n}_t)([r_t + q_t(1-\delta)]\, K_t^e + \eta^e w_t^e)}_{\equiv CML_t}, \tag{B.7}$$

holds. Note that the right side of the equation denotes bond issuance CML_t. Furthermore, using equations (B.1), (B.6) and (B.7), a bank's balance sheet identity is derived

$$\underbrace{A_t + \eta^b d_t}_{\text{Liabilities}} = \underbrace{\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t) - \frac{1}{n^{\max}}(\bar{n}_t - \widehat{n}_t)([r_t + q_t(1-\delta)]\, K_t^e + \eta^e w_t^e) + \mathfrak{Res}_t}_{\text{Assets}}. \tag{B.8}$$

Note that the right-hand side denotes bank assets which is equal to bank lending through indirect funding BL_t. The (banking) credit-to-GDP ratio as the regulatory target variable x_t is defined as

$$x_t = \frac{\frac{I_t}{n^{\max}}(\bar{n}_t - \widehat{n}_t) - \frac{1}{n^{\max}}(\bar{n}_t - \widehat{n}_t)([r_t + q_t(1-\delta)]\, K_t^e + \eta^e w_t^e) + (1-\Gamma_t)\mathfrak{Res}_t}{Y_t}.$$

Finally, aggregate output is given by

$$v_t Y_t = K_t^{\theta_k} H_t^{\theta_h} (\eta^e)^{\theta_e} (\eta^b)^{\theta_b} - \Theta\,,$$

with the price dispersion

$$v_t = \int_0^1 \left(\frac{P_{jt}}{P_t}\right)^{-\xi_P} \mathrm{d}j\,,$$

which is zero in a first-order approximation (Galí 2014, p. 59). Note that the derivation uses the intermediate-goods demand (A.1), aggregate banker labour supply—given by

$\int_0^{\eta^b} 1\mathrm{d}b = \eta^b$—and aggregate entrepreneurial—given by $\int_0^{\eta^e} 1\mathrm{d}e = \eta^e$.[35] Furthermore, note that market clearing for banker labour demand and entrepreneurial labour demand are given by$\eta^b = \int_0^1 h^b_{jt}\mathrm{d}j$ and $\eta^e = \int_0^1 h^e_{jt}\mathrm{d}j$.

C Steady State Values

We call a variable X_t to be in the steady-state, for all t, if $E_t X_{t+1} = X_t = X_{t+1} = \widetilde{X}$. In our model, we have the following steady-state values:

- Capital good producing entrepreneurs:

$$\widetilde{R}^{e,di} = \frac{\bar{B}}{\Delta p}\frac{1}{n^{\max}}\left(n^{\max} - \tilde{\bar{n}}\right)\tilde{I}\,,$$

$$\widetilde{R}^{e,ind} = \frac{B}{\Delta p}\left(\tilde{\bar{n}} - \tilde{\hat{n}}\right)\tilde{I}\,,$$

$$\widetilde{R}^{b} = \frac{\mu}{\Delta p}\left(\tilde{\bar{n}} - \tilde{\hat{n}}\right)\tilde{I}\,,$$

$$lev_{SS}\widetilde{A} + \widetilde{\Gamma}\widetilde{\mathfrak{Res}} = \widetilde{A} + \eta^b\widetilde{d}\,,$$

$$lev_{SS}\widetilde{A} = \frac{\widetilde{I}}{n^{\max}}(\tilde{\bar{n}} - \tilde{\hat{n}}) - \frac{1}{n^{\max}}(\tilde{\bar{n}} - \tilde{\hat{n}})\left(\frac{\widetilde{q}}{\beta}\widetilde{K}^e + \eta^e\widetilde{w}^e\right) + (1 - \widetilde{\Gamma})\widetilde{\mathfrak{Res}}\,,$$

$$\widetilde{N} = \frac{\widetilde{q}}{\beta}\widetilde{K}^e + \eta^e\widetilde{w}^e\,,$$

$$\widetilde{N}^e = \tilde{\bar{n}}\frac{\widetilde{q}}{\beta}\frac{\widetilde{K}^e}{n^{\max}} + \frac{\tilde{\bar{n}}}{n^{\max}}\eta^e\widetilde{w}^e\,,$$

$$\widetilde{A} = \frac{\widetilde{q}}{\beta}\widetilde{K}^b + \eta^b\widetilde{w}^b\,,$$

$$1 + \widetilde{r}^d = \frac{1}{\beta}\,,$$

$$1 + \widetilde{r}^a = \frac{\widetilde{q}p^H\mu}{\Delta p\widetilde{A}}\frac{\widetilde{I}}{n^{\max}}(\tilde{\bar{n}} - \tilde{\hat{n}})\,,$$

$$\widetilde{Y} = \widetilde{K}^{\theta_k}\widetilde{L}^{\theta_h}(\eta^e)^{\theta_e}(\eta^b)^{\theta_b} - \Theta\,,$$

$$\tilde{\bar{n}} = \frac{\widetilde{I}\left(1 - \widetilde{q}p^H\eta^e\beta(R - \frac{\bar{B}}{\Delta p})\right)}{1 + \widetilde{I}\left(1 - \widetilde{q}p^H\eta^e\beta(R - \frac{\bar{B}}{\Delta p})\right)}\,,$$

$$\tilde{\hat{n}} = \frac{\tilde{\bar{n}}\widetilde{I}\left(1 - \frac{\widetilde{q}p^H\mu}{\Delta p\left(1+\widetilde{r}^a\right)} - \widetilde{q}p^H\eta^b\beta\left(R - \frac{B+\mu}{\Delta p}\right)\right)}{1 + \widetilde{I}\left(1 - \frac{\widetilde{q}p^H\mu}{\Delta p\left(1+\widetilde{r}^a\right)} - \widetilde{q}p^H\eta^b\beta\left(R - \frac{B+\mu}{\Delta p}\right)\right)}\,,$$

abusing the notation $\tilde{\bar{n}}$ and $\tilde{\hat{n}}$ denote the steady states of the equity limits for direct and indirect finance, respectively.

[35] Remember, banker and entrepreneurs supply one unit of labour inelastically.

- Intermediate goods producing firms:

$$
\begin{aligned}
\widetilde{P} &= 1\,, \\
\widetilde{s} &= \frac{\xi_P - 1}{\xi_P}\,, \\
\widetilde{r} &= \frac{\widetilde{q}}{\beta} - (1-\delta)\widetilde{q}\,, \\
\widetilde{r} &= \widetilde{s}\theta_k \widetilde{K}^{\theta_k - 1}\widetilde{L}^{\theta_h}(\eta^e)^{\theta_e}(\eta^b)^{\theta_b}\,, \\
\widetilde{w}^e &= \widetilde{s}\theta_e \widetilde{K}^{\theta_k}\widetilde{L}^{\theta_h}(\eta^e)^{\theta_e - 1}(\eta^b)^{\theta_b}\,, \\
\widetilde{w}^b &= \widetilde{s}\theta_b \widetilde{K}^{\theta_k}\widetilde{L}^{\theta_h}(\eta^e)^{\theta_e}(\eta^b)^{\theta_b - 1}\,, \\
\widetilde{w} &= \widetilde{s}\theta_h \widetilde{K}^{\theta_k}\widetilde{L}^{\theta_h - 1}(\eta^e)^{\theta_e}(\eta^b)^{\theta_b}
\end{aligned}
$$

- Households:

$$
\begin{aligned}
\widetilde{\lambda} &= \frac{1-\gamma\beta}{(1-\gamma)\widetilde{C}^h}\,, \\
\widetilde{\lambda} w &= \psi l^\eta\,, \\
\widetilde{l} &= \widetilde{L}\,, \\
\widetilde{d} &= \widetilde{q}\beta p^H \left(R - \frac{\underline{B}+\mu}{\Delta p}\right)\frac{\widetilde{I}}{n^{\max}}(\widetilde{\bar{n}} - \widetilde{\bar{\bar{n}}})\,, \\
\widetilde{\mathfrak{b}} &= \widetilde{q}\beta p^H \left(R - \frac{\overline{B}}{\Delta p}\right)\frac{\widetilde{I}}{n^{\max}}(n^{\max} - \widetilde{\bar{n}})\,, \\
\widetilde{\Pi} &= (1-\widetilde{s})\widetilde{Y}
\end{aligned}
$$

- Entrepreneurs and bankers:

$$
\begin{aligned}
\widetilde{C}^e &= \frac{\widetilde{q}(1-\tau^e)p^H}{n^{\max}}\left(\frac{\underline{B}}{\Delta p}(\widetilde{\bar{\bar{n}}} - \widetilde{\bar{n}}) + \frac{\bar{B}}{\Delta p}(n^{\max} - \widetilde{\bar{n}})\right)\widetilde{I}\,, \\
\widetilde{C}^b &= \widetilde{q}(1-\tau^b)p^H \frac{\mu}{\Delta p}\frac{\widetilde{I}}{n^{\max}}(\widetilde{\bar{\bar{n}}} - \widetilde{\bar{n}})\,, \\
\widetilde{K}^e &= \frac{\tau^e p^H}{n^{\max}}\left(\frac{\underline{B}}{\Delta p}(\widetilde{\bar{\bar{n}}} - \widetilde{\bar{n}}) + \frac{\bar{B}}{\Delta p}(n^{\max} - \widetilde{\bar{n}})\right)\widetilde{I}\,, \\
\widetilde{K}^b &= \tau^b p^H \frac{\mu}{\Delta p}\frac{\widetilde{I}}{n^{\max}}(\widetilde{\bar{\bar{n}}} - \widetilde{\bar{n}})
\end{aligned}
$$

- Equilibrium Conditions:

$$\widetilde{K} = \widetilde{K}^h + \widetilde{K}^e + \widetilde{K}^b\,,$$
$$\widetilde{Y} = \widetilde{C} + \widetilde{\mathfrak{I}}\,,$$
$$\widetilde{\mathfrak{I}} = \frac{\delta}{p^H R}\widetilde{K}\,,$$
$$\widetilde{C} = \widetilde{C}^h + \widetilde{C}^b + \widetilde{C}^e\,,$$
$$\widetilde{\mathfrak{I}} = \frac{1}{n^{\max}}(n^{\max} - \tilde{\tilde{n}})\widetilde{I}\,,$$

$$\eta^e\widetilde{\mathfrak{b}} + \widetilde{N}^e + (1-\widetilde{\Gamma})\widetilde{\mathfrak{Res}} = \frac{1}{n^{\max}}(n^{\max} - \tilde{\tilde{n}})\left(\widetilde{I} - \frac{\widetilde{q}}{\beta}\widetilde{K}^e - \eta^e\widetilde{w}^e\right)\,,$$

$$\tilde{C}^h + \tilde{K}^h + \eta^b\tilde{d} + \eta^e\tilde{\mathfrak{b}} = (\tilde{r} + \tilde{q}(1-\delta))\tilde{K}^h + \tilde{\Pi} + \tilde{w}\tilde{L} + (1+\tilde{r}^d)(\eta^b\tilde{d} + \eta^e\tilde{\mathfrak{b}})\,,$$

$$\eta^e\widetilde{\mathfrak{b}} + \widetilde{N}^e + \widetilde{A} + \eta^b\widetilde{d} + (1-\widetilde{\Gamma})\widetilde{\mathfrak{Res}} = \frac{1}{n^{\max}}(n^{\max} - \tilde{\tilde{n}})\left(\widetilde{I} - \frac{\widetilde{q}}{\beta}\widetilde{K}^e - \eta^e\widetilde{w}^e\right) + \widetilde{\mathfrak{Res}}$$

- Bond issuance (Financial market funding)

$$\widetilde{CML} = \frac{1}{n^{\max}}\left(n^{\max} - \tilde{\tilde{n}}\right)\left(\widetilde{I} - \widetilde{N}\right)$$

- Bank lending

$$\widetilde{BL} = \frac{1}{n^{\max}}\left(\tilde{\bar{n}} - \tilde{\hat{n}}\right)\left(\tilde{I} - \widetilde{N}\right) + (1-\widetilde{\Gamma})\widetilde{\mathfrak{Res}}$$

D Linearised Model

We denote by $\widehat{X_t}$ the percentage deviation of the variable X_t from its steady-state value $\widetilde{X}$. Then, we get the following system of equations:

D.1 Capital Good Production:

- Net wealth available:
  - to the entrepreneur

$$\widehat{N_t} = \frac{\widetilde{K^e}}{\widetilde{N}}\left[\tilde{r}\widehat{r}_t + \widetilde{q}(1-\delta)\widehat{q}_t + \frac{\widetilde{q}}{\beta}\widehat{K^e_t}\right] + \eta^e\frac{\widetilde{w^e}}{\widetilde{N}}\widehat{w}^e$$
$$\widehat{N^e_t} = \hat{\tilde{n}}_t + \frac{\tilde{\tilde{n}}\widetilde{K^e}}{n^{\max}\widetilde{N^e}}\left(\frac{\widetilde{q}}{\beta}\widehat{K^e_t} + \tilde{r}\widehat{r}_t + \widetilde{q}(1-\delta)\widehat{q}_t\right)$$

– to the banker:

$$\widehat{A}_t = \frac{\widetilde{q}\widetilde{K}^b}{\beta\widetilde{A}}\widehat{K}_t^b + \frac{\widetilde{K}^b}{\widetilde{A}}\left[\widetilde{r}\widehat{r}_t + \widetilde{q}(1-\delta)\widehat{q}_t\right] + \eta^b\frac{\widetilde{w}^b}{\widetilde{A}}\widehat{w}_t^b$$

- Deposit demand:

$$\widehat{d}_t = \widehat{q}_t + \hat{I}_t - (1-\beta)\widehat{r}_t^d + \frac{1}{\widetilde{\bar{n}} - \widetilde{\hat{n}}}\left(\widetilde{\bar{n}}\hat{\bar{n}}_t - \widetilde{\hat{n}}\hat{\hat{n}}_t\right)$$

- Bond demand:

$$\hat{\mathfrak{b}}_t = \hat{q}_t + \hat{I}_t - (1-\delta)\hat{r}_t^d - \frac{\widetilde{\bar{n}}}{n^{\max} - \widetilde{\bar{n}}}\hat{\bar{n}}_t$$

- Interest rate on uninformed capital using $R_t^a = 1 + r_t^a$:

$$\widehat{R}_t^a = \widehat{q}_t + \hat{I}_t - \widehat{A} + \frac{1}{\widetilde{\bar{n}} - \widetilde{\hat{n}}}\left(\widetilde{\bar{n}}\hat{\bar{n}}_t - \widetilde{\hat{n}}\hat{\hat{n}}_t\right)$$

- Minimum entrepreneurial equity for indirect finance deviation from steady state $\hat{\hat{n}}_t$ is given by:

$$\hat{\hat{n}}_t = \hat{\bar{n}}_t + \frac{1}{(1+\widetilde{\zeta}\widetilde{I})}\hat{I}_t + \frac{\widetilde{\zeta}-1}{\widetilde{\zeta}(1+\widetilde{\zeta}\widetilde{I})}\widehat{q}_t + \frac{\widetilde{q}p^H\mu}{\widetilde{\zeta}(1+\widetilde{\zeta}\widetilde{I})\Delta p\widetilde{R}^a}\widehat{R}_t^a + \frac{(1-\beta)p^H\beta\eta^b\widetilde{q}\left(R - \frac{B+\mu}{\Delta p}\right)}{\widetilde{\zeta}(1+\widetilde{\zeta}\widetilde{I})}\widehat{r}_t^d$$

- Minimum entrepreneurial equity for direct finance deviation from steady state $\hat{\bar{n}}_t$ is given by:

$$\hat{\bar{n}}_t = \frac{1}{(1+\widetilde{\chi}\widetilde{I})}\hat{I}_t + \frac{\widetilde{\chi}-1}{\widetilde{\chi}(1+\widetilde{\chi}\widetilde{I})}\widehat{q}_t + \frac{(1-\beta)(\widetilde{\chi}-1)}{\widetilde{\chi}(1+\widetilde{\chi}\widetilde{I})}\widehat{r}_t^d$$

D.2 Household Sector

- (Aggregate) consumption:

$$\widehat{C}_t^h = \frac{1+\gamma\beta+\gamma^2\beta}{1+\gamma+\gamma^2\beta}E_t\widehat{C}_{t+1}^h - \frac{\gamma\beta}{1+\gamma+\gamma^2\beta}E_t\widehat{C}_{t+2}^h + \frac{\gamma}{1+\gamma+\gamma^2\beta}\widehat{C}_{t-1}^h - \frac{(1-\gamma\beta)(1-\gamma)}{1+\gamma+\gamma^2\beta}E_t\left((1-\beta)\widehat{r}_{t+1}^d - \widehat{\pi}_{t+1}\right)$$

- Household capital decision:

$$\widehat{q}_t = E_t\widehat{\pi}_{t+1} - (1-\beta)\widehat{r}^d_{t+1} + (1-\beta(1-\delta))E_t\widehat{r}_{t+1} + \beta(1-\delta)E_t\widehat{q}_{t+1}$$

- Capital law of motion:

$$\widehat{K}_{t+1} = (1-\delta)\widehat{K}_t + \delta\widehat{\mathfrak{I}}_t$$

D.3 Final Good and Intermediate Goods Production

- Aggregated future entrepreneur and banker capital:

$$\widehat{K}^e_{t+1} = \widehat{\kappa}_t + \widehat{I}_t + \frac{p^H\tau^e\widetilde{\bar{n}}\widetilde{I}}{n^{\max}\widetilde{K}^e}\left(\frac{\underline{B}}{\Delta p} - \frac{\bar{B}}{\Delta p}\right)\hat{\bar{n}} - \frac{p^H\tau^e\widetilde{\hat{n}}\widetilde{I}}{n^{\max}\widetilde{K}^e}\frac{\underline{B}}{\Delta p}\hat{\hat{n}}_t$$
$$\widehat{K}^b_{t+1} = \widehat{\kappa}_t + \widehat{I}_t + \frac{1}{\bar{n} - \hat{n}}\left(\widetilde{\bar{n}}\hat{\bar{n}}_t - \widetilde{\hat{n}}\hat{\hat{n}}_t\right)$$

- Aggregated consumption of the entrepreneur and the banker:

$$\widehat{C}^e_{t+1} = \widehat{\kappa}_t + \widehat{q}_t + \widehat{I}_t + \frac{\widetilde{q}p^H(1-\tau^e)\widetilde{\bar{n}}\widetilde{I}}{n^{\max}\widetilde{C}^e}\left(\frac{\underline{B}}{\Delta p} - \frac{\bar{B}}{\Delta p}\right)\hat{\bar{n}}_t - \frac{\widetilde{q}p^H(1-\tau^e)\widetilde{\hat{n}}\widetilde{I}}{n^{\max}\widetilde{C}^e}\frac{\underline{B}}{\Delta p}\hat{\hat{n}}_t$$

$$\widehat{C}^b_{t+1} = \widehat{\kappa}_t + \widehat{q}_t + \widehat{I}_t + \frac{1}{\widetilde{\bar{n}} - \widetilde{\hat{n}}}\left(\widetilde{\bar{n}}\hat{\bar{n}}_t - \widetilde{\hat{n}}\hat{\hat{n}}_t\right)$$

- Aggregate investments:

$$\hat{\mathfrak{I}}_t = \frac{1}{n^{max}}\left(n^{max} - \widetilde{\hat{n}}\right)\widetilde{I}\hat{I}_t - \frac{\widetilde{\hat{n}}\widetilde{I}}{n^{max}}\hat{\hat{n}}_t$$

- Resource constraint:

$$\widehat{Y}_t = \frac{\widetilde{C}}{\widetilde{Y}}\widehat{C}_t + \frac{\widetilde{\mathfrak{I}}}{\widetilde{Y}}\widehat{\mathfrak{I}}_t$$

- Aggregate consumption:

$$\hat{C}_t = \frac{\widetilde{C}^e}{\widetilde{C}}\hat{C^e}_t + \frac{\widetilde{C}^h}{\widetilde{C}}\hat{C^h}_t + \frac{\widetilde{C}^b}{\widetilde{C}}\hat{C^b}_t$$

- Aggregated output:

$$\widehat{Y}_t = \varphi\theta_k\widehat{K}_t + \varphi\theta_h\widehat{L}_t$$

with $\varphi = 1 + \frac{\Theta}{\widetilde{Y}}$

- Aggregated capital:

$$\widehat{K}_t = \frac{\widetilde{K}^h}{\widetilde{K}}\widehat{K}_t^h + \frac{\widetilde{K}^e}{\widetilde{K}}\widehat{K}_t^e + \frac{\widetilde{K}^b}{\widetilde{K}}\widehat{K}_t^b$$

- New-Keynesian Phillips curve:

$$\widehat{\pi}_t = \frac{\beta}{1+\beta}E_t\widehat{\pi}_{t+1} + \frac{\widehat{\pi}_{t-1}}{1+\beta} + \frac{\kappa}{1+\beta}\left(\theta_k\widehat{r}_t + \theta_h\widehat{w}_t + \theta_b\widehat{w}_t^b + \theta_e\widehat{w}_t^e - \widehat{z}_t\right)$$

with $\kappa = \frac{(1-\beta\phi_P)(1-\phi_P)}{\phi_P}$.

- Capital-to-household-labour-ratio:

$$\widehat{L}_t = \widehat{r}_t + \widehat{K}_t - \widehat{w}_t$$

- Capital-to-entrepreneur-labour-ratio:

$$0 = \widehat{r}_t + \widehat{K}_t - \widehat{w}_t^e$$

- Capital-to-banker-labour-ratio:

$$0 = \widehat{r}_t + \widehat{K}_t - \widehat{w}_t^b$$

- Wage rate:

$$\widehat{w}_t = \eta\widehat{l}_t - \left(\frac{\gamma\beta}{(1-\gamma\beta)(1-\gamma)}E_t\widehat{C}_{t+1}^h - \frac{1+\gamma^2\beta}{(1-\gamma\beta)(1-\gamma)}\widehat{C}_t^h + \frac{\gamma}{(1-\gamma\beta)(1-\gamma)}\widehat{C}_{t-1}^h\right)$$

- Marginal costs:

$$\widehat{s}_t = \theta_k\widehat{r}_t + \theta_h\widehat{w}_t + \theta_b\widehat{w}_t^b + \theta_e\widehat{w}_t^e - \widehat{z}_t$$

D.4 Regulatory Authority

- Aggregate leverage restriction:

$$\begin{aligned}\widetilde{lev}\widetilde{A}(\widehat{lev}_t + \widehat{A}_t) = {} & \frac{1}{n^{\max}}\left(\widetilde{\bar{n}} - \widetilde{\hat{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right) \\ & + \frac{1}{n^{\max}}\left(\tilde{I} - \widetilde{N}\right)\left(\widetilde{\bar{n}}\widehat{\bar{n}}_t - \widetilde{\hat{n}}\widehat{\hat{n}}_t\right) + \left(1 - \widetilde{\Gamma}\right)\widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t - \widetilde{\Gamma}\widetilde{\mathfrak{Res}}\widehat{\Gamma}_t\end{aligned}$$

- financial resource constraint:

$$\begin{aligned}
&\widetilde{A}\widehat{A}_t + \eta^b \widetilde{d}\hat{d}_t + \eta^e \widetilde{\mathfrak{b}}\hat{\mathfrak{b}}_t + \widetilde{N}^e \hat{N}^e_t \\
&+ \left(1-\widetilde{\Gamma}\right)\widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t - \widetilde{\Gamma}\widetilde{\mathfrak{Res}}\widehat{\Gamma}_t &= -\frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\tilde{\tilde{n}}\widehat{\tilde{n}}_t \\
&&+ \frac{1}{n^{\max}}\left(n^{\max}-\tilde{\tilde{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right) \\
&&+ \frac{1}{n^{\max}}\left(\tilde{\tilde{n}}-\tilde{\hat{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right) \\
&&+ \frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\left(\tilde{\tilde{n}}\widehat{\tilde{n}}_t - \tilde{\hat{n}}\widehat{\hat{n}}_t\right) + \widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t
\end{aligned}$$

- bond market clearing condition:

$$\begin{aligned}
\eta^e \widetilde{\mathfrak{b}}\hat{\mathfrak{b}}_t + \widetilde{N}^e \hat{N}^e_t + \left(1-\widetilde{\Gamma}\right)\widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t - \widetilde{\Gamma}\widetilde{\mathfrak{Res}}\widehat{\Gamma}_t = &-\frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\tilde{\tilde{n}}\widehat{\tilde{n}}_t + \\
&\frac{1}{n^{\max}}\left(n^{\max}-\tilde{\tilde{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right)
\end{aligned}$$

- Bond issuance (Financial market funding)

$$\widetilde{CML}\widehat{CML}_t = -\frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\tilde{\tilde{n}}\widehat{\tilde{n}}_t + \frac{1}{n^{\max}}\left(n^{\max}-\tilde{\tilde{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right)$$

- Bank lending

$$\begin{aligned}
\widetilde{BL}\widehat{BL}_t = &\frac{1}{n^{\max}}\left(\tilde{\tilde{n}}-\tilde{\hat{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right) + \frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\left(\tilde{\tilde{n}}\widehat{\tilde{n}}_t - \tilde{\hat{n}}\widehat{\hat{n}}_t\right) \\
&+ \left(1-\widetilde{\Gamma}\right)\widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t - \widetilde{\Gamma}\widetilde{\mathfrak{Res}}\widehat{\Gamma}_t
\end{aligned}$$

- Leverage:

$$\widehat{lev}_t = \hat{\upsilon}_t + \frac{\omega\tilde{x}}{lev_{SS}}\widehat{x}_t$$

with

$$\begin{aligned}
\hat{x}_t = &\frac{1}{\tilde{x}\tilde{Y}}\left(\frac{1}{n^{\max}}\left(\tilde{\tilde{n}}-\tilde{\hat{n}}\right)\left(\tilde{I}\hat{I}_t - \widetilde{N}\widehat{N}_t\right) + \frac{1}{n^{\max}}\left(\tilde{I}-\widetilde{N}\right)\left(\tilde{\tilde{n}}\widehat{\tilde{n}}_t - \tilde{\hat{n}}\widehat{\hat{n}}_t\right)\right) \\
&+ \frac{1}{\tilde{x}\tilde{Y}}\left(\left(1-\widetilde{\Gamma}\right)\widetilde{\mathfrak{Res}}\widehat{\mathfrak{Res}}_t - \widetilde{\Gamma}\widetilde{\mathfrak{Res}}\widehat{\Gamma}_t\right) - \frac{\widetilde{BL}}{\tilde{x}\tilde{Y}}\hat{Y}_t
\end{aligned}$$

- Taylor Rule:

$$\widehat{r}^d_t = \rho_r \widehat{r}^d_{t-1} + (1-\rho_r)\left[\rho_\pi(\widehat{\pi}_{t+1}) + \rho_{dy}(\hat{y}_t - \hat{y}_{t-1}) + \rho_{d\pi}(\widehat{\pi}_t - \widehat{\pi}_{t-1})\right] - \epsilon^{mp}_t$$

- Shock Process:

$$\widehat{\upsilon}_t = \rho_\upsilon \widehat{\upsilon}_{t-1} + \epsilon_t^\upsilon \tag{D.1}$$

E Supplementary Figures

- The following Figure 8 shows the growth rates of (nominal) credit-to-GDP ratio in the Euro area from 2000 to 2022. Credit is measured by total bank credits to the non-financial sector (public and private-owned companies). The average growth rate over that period is 1.6% per year which implies that the credit-to-GDP ratio has been growing since the start of the common currency union. However, the credit-to-GDP ratio remained relatively stable after the Great Recession of 2008 (the average growth rate is zero from 2010 to 2022).

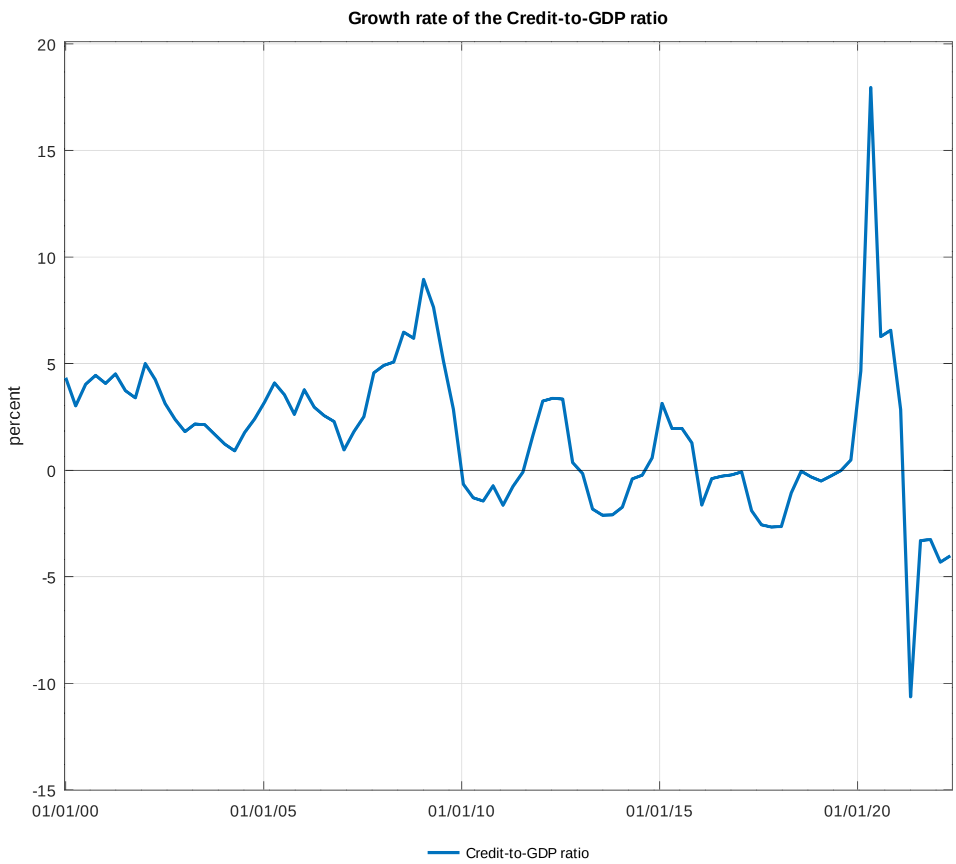


Figure 8. Growth rates of the credit-to-GDP ratio in the Euro area. Source: own calculation.

Bisher erschienene Weidener Diskussionspapiere

1 „Warum gehen die Leute in die Fußballstadien? Eine empirische Analyse der Fußball-Bundesliga“
von Horst Rottmann und Franz Seitz

2 „Explaining the US Bond Yield Conundrum“
von Harm Bandholz, Jörg Clostermann und Franz Seitz

3 „Employment Effects of Innovation at the Firm Level“
von Horst Rottmann und Stefan Lachenmaier

4 „Financial Benefits of Business Process Management“
von Helmut Pirzer, Christian Forstner, Wolfgang Kotschenreuther und Wolfgang Renninger

5 „Die Performance Deutscher Aktienfonds“
von Horst Rottmann und Thomas Franz

6 „Bilanzzweck der öffentlichen Verwaltung im Kontext zu HGB, ISAS und IPSAS“
von Bärbel Stein

7 Fallstudie: „Pathologie der Organisation“ – Fehlentwicklungen in Organisationen, ihre Bedeutung und Ansätze zur Vermeidung
von Helmut Klein

8 „Kürzung der Vorsorgeaufwendungen nach dem Jahressteuergesetz 2008 bei betrieblicher Altersversorgung für den GGF.“
von Thomas Dommermuth

9 „Zur Entwicklung von E-Learning an bayerischen Fachhochschulen- Auf dem Weg zum nachhaltigen Einsatz?“
von Heribert Popp und Wolfgang Renninger

10 „Wie viele ausländische Euro-Münzen fließen nach Deutschland?“
von Dietrich Stoyan und Franz Seitz

11 Modell zur Losgrößenoptimierung am Beispiel der Blechteilindustrie für Automobilzulieferer
von Bärbel Stein und Christian Voith

12 Performancemessung
Theoretische Maße und empirische Umsetzung mit VBA
von Franz Seitz und Benjamin R. Auer

13 Sovereign Wealth Funds – Size, Economic Effects and Policy Reactions
von Thomas Jost

72 Intelligente Verpackungen
von Stephanie Abels-Schlosser

73 Digitale Strategien entwickeln – von der Idee zur Roadmap
von Johann Strassl und Günter Schicker

74 Derivate im Zinsmanagement: Eine Analyse der Hedging-Qualität von Bund Future Kontrakten und deren Einsatzmöglichkeiten in Theorie und Praxis
von Christoph Wontke und Franz Seitz

75 Steigerung der Kundenzufriedenheit durch Gestaltung von Artikeldetailseiten am Beispiel von WITT WEIDEN
von Laura Graser und Marco Nirschl

76 Werkvertragsarbeitnehmerinnen und -arbeitnehmer in der Fleischindustrie
von André Schulte und Ágnes Wörster

77 How to avoid fracture of the locking screw in modular revision arthroplasty of the hip using the MRP Titan Revision System
von Theresa Semmelmann, Alexander Schuh, Horst Rottmann, Reinhard Schröder, Christopher Fleischmann

78 SARS-Cov-2 und Bargeld: Wie ein Virus die weltweite Bargeldnachfrage fördert
von Gerhard Rösl und Franz Seitz

79 Monte-Carlo-Evaluation von Instrumentenvariablenschätzern
von Benjamin R. Auer und Horst Rottmann

80 Euro area house price fluctuations and unconventional monetary policy surprises
von Oliver Hülsewig und Horst Rottmann

81 Euro Area Periphery Countries' Fiscal Policy and Monetary Policy Surprises
von Oliver Hülsewig und Horst Rottmann

82 Überschätzen sich jüngere Personen mehr als ältere? Der Dunning-Kruger-Effekt im Altersvergleich
von V. Benesch, M. Godde, B. Hammami, U. Laufkötter, M. Seidel und B. Mayer

83 Cash demand in times of crises
von Gerhard Rösl und Franz Seitz

84 The relevance of banks to the European stock market
von Andreas Kick und Horst Rottmann

85 CBDC and Cash in the Euro Area: Crowding out or co-circulation?
von Gerhard Rösl und Franz Seitz

86 Nutztierwirtschaft zwischen Tierwohl, Unternehmensstrategie und Verbraucherinteresse – Spannungsfeld oder Zukunftschance im Agrarsektor?
von André Schulte und Ágnes Wörster

Ostbayerische Technische Hochschule
Amberg-Weiden

Die Weidener Diskussionspapiere erscheinen in unregelmäßigen Abständen und sollen Erkenntnisse aus Forschung und Wissenschaft an der Hochschule in Weiden insbesondere zu volks- und betriebswirtschaftlichen Themen an Wirtschaft und Gesellschaft vermitteln und den fachlichen Dialog fördern.

Herausgeber:
Ostbayerische Technische Hochschule (OTH) Amberg-Weiden
Prof. Dr. Horst Rottmann und Prof. Dr. Franz Seitz
Fakultät Betriebswirtschaft

Presserechtliche Verantwortung:
Sonja Wiesel, Hochschulkommunikation und Öffentlichkeitsarbeit
Telefon +49 (9621) 482-3135
Fax +49 (9621) 482-4135
s.wiesel@oth-aw.de

Bestellungen schriftlich erbeten an:
Ostbayerische Technische Hochschule Amberg-Weiden
Abt. Weiden, Bibliothek
Hetzenrichter Weg 15,
D – 92637 Weiden i.d.Opf.
Die Diskussionsbeiträge können elektronisch abgerufen werden unter
http://www.oth-aw.de/aktuelles/veroeffentlichungen/weidener_diskussionspapiere/

ISBN 978-3-98638-005-2

- Abteilung Amberg: Kaiser-Wilhelm-Ring 23, 92224 Amberg, Tel.: (09621) 482-0, Fax: (09621) 482-4991
- Abteilung Weiden: Hetzenrichter Weg 15, 92637 Weiden i. d. OPf., Tel.: (0961) 382-0, Fax: (0961) 382-2991
- E-Mail: info@oth-aw.de | Internet: http://www.oth-aw.de