1. INTERMEDIATION VERSUS MONEY CREATION FUNCTION IN BANKING: A DSGE PERSPECTIVE

Ibrahima Sangaré*

ABSTRACT

Most macro-financial models consider banks as simple intermediaries of loanable funds between savers and borrowers, ignoring the money creation function of the banking system. Therefore, we address this issue directly by incorporating a mechanism for banks' money creation function as in Jakab and Kumhof (2015, 2019).

This study compares the macro-financial outcomes of the intermediation of loanable funds model of banking and the financing through money creation model and assesses the role of macroprudential policy in the context of a tightening monetary policy environment when banks finance the real economy through money creation. In the context of the DSGE model, we find that the money creation mechanism attenuates the contractionary effects on output from monetary policy tightening compared to the intermediation of loanable funds approach to banking. Furthermore, for both models we find that a tighter macroprudential policy stance helps to attenuate the severity of the monetary policy shock in terms of macro-financial stabilization, suggesting that it may be appropriate to have higher macroprudential capital buffers during periods of tightening monetary policy conditions. However, in terms of welfare the comparison is more complicated.

Keywords: *DSGE, banks, financial intermediation, money creation, monetary policy, Macroprudential policy.*
JEL-Classification: *E4, E5, G21.*

** International Monetary Fund, isangare@imf.org. This study was conducted when the author was working at the BCL's Financial Stability and Macroprudential Surveillance Department. The views expressed in this study are those of the author and do not necessarily reflect those of the BCL, the Eurosystem or the IMF.*

1. INTRODUCTION

The 2007-2008 global financial crisis (GFC) demonstrated the important role of the banking sector in amplifying and prolonging economic crises. Consequently, macroeconomic models have increasingly incorporated banks to better assess their role during crisis times[1]. However, the way banks are introduced in these models matters for the analysis of the interactions between the banking sector and the rest of the economy. In particular, the most common modelling framework in the literature considers banks as intermediaries of loanable funds. This is the so-called intermediation of loanable-funds approach to banking. Under this approach, bank loans to borrowers are assumed to originate from the accumulation of savings or loanable funds by savers. Therefore, the intermediation chain starts with savers' deposits being collected by banks and then ends with the lending of those funds by banks to borrowers. The intermediation of loanable-funds framework is somewhat misleading as it ignores the fact that, in the modern economy, banks create deposits through lending[2]. Moreover, as argued by Jakab and Kumhof (2015), many of the unresolved issues in macro-financial economics (e.g., understanding the co-movement of bank assets and debt, amplification of financial and business cycles via the banking sector) are linked to the use of the intermediation of loanable funds (ILF) model of banking. These authors explain that model economies based on the intermediation of loanable funds are entirely fictitious as such institutions simply do not exist in the real world. In fact, they show that models based on this framework do not adequately capture the lending activities of banks.

There is an emerging stream of the academic literature that highlights the provision of financing as the key economic function of banks. In practice, this implies that banks create new monetary purchasing power through loans to borrowers who simultaneously become depositors (Jakab and Kumhof (2015, 2019), McLeay *et al.* (2014a, 2014b), Faure and Gersbach (2022)). More specifically, whenever a bank extends a new loan to a borrower, it creates a new loan entry in the name of that borrower on the asset side of its balance sheet, and simultaneously creates a new (and equal-sized) deposit entry on the liability side of its balance sheet, also in the name of the same borrower. The bank therefore creates deposits in the act of lending through a pure bookkeeping transaction that involves no intermediation. This framework is called the money-creation approach to banking (Faure and Gersbach (2022).

Incorporating these insights into the DSGE models remains one of the main challenges facing macro-financial modellers. Nevertheless, there exist a few DSGE models that include the money creation approach to banking (i.e., financing through money creation (MC) models). To the best of our knowledge, only the works of Jakab and Kumhof (2015, 2019) and Faure and Gersbach (2022) have developed DSGE models that incorporate and subsequently investigate the money creation framework. By comparing the outcomes of the ILF and FMC models, Jakab and Kumhof (2015, 2019) show that the ILF models provide relatively poor empirical predictions compared to the money creation models and that these latter models amplify the effects of shocks compared to the former. Faure and Gersbach (2022) find that, in the absence of uncertainty, both the intermediation of loanable funds and money creation models yield the same goods allocation and, therefore, under these conditions using the former approach does not imply any loss of generality.

Despite the fact that the money creation approach to banking is relatively new in the DSGE literature, the rather small number of existing studies does not investigate how the money creation function of banks interacts with macroprudential policy. The modern money creation process by banks through extensive

1 See for example, Gerali *et al.* (2010), Christiano *et al.* (2014), Boissay *et al.* (2013), Gertler and Karadi (2011), Gertler and Kiyotaki (2011), Clerc *et al.* (2015), De Walque *et al.* (2010), among others.

2 See McLeay *et al.* (2014b) for more details on the money creation process in the modern economy.

possibilities to extend credit, as an unexplored facet of the banking system by regulators, could pose risks to financial stability. A model that will trace out the main channels of such an approach of banks should be welcome for analysing the macroprudential policy implications. Therefore, our contribution to the literature in the context of the current study explores the interaction between macroprudential policy and the money creation function of banks, which is a sparse topic in the literature.

Specifically, our work explores the role of the macroprudential policy in a DSGE model that incorporates the money creation function of banks. The research question addressed is whether the money creation model and the intermediation of loanable funds model could yield similar outcomes. In particular, we analyse the role of macroprudential policy in the money-creation framework. In other words, we assess the effectiveness of macroprudential policy in a money-creation framework.

To this end, we build two realistic DSGE models. The first model includes banks as intermediaries of loanable funds (i.e., the ILF model) and the second model considers banks as money creators with no intermediation function (i.e., the MC model). In the modelling framework, our models are closest to those developed by Jakab and Kumhof (2015, 2019) but are much more tractable as, by introducing financial frictions through a costly enforcement mechanism (Kiyotaki and Moore (1997)) instead of the costly state verification mechanism (Bernanke, Gertler, and Gilchrist (1999)), they facilitate the assessment of the main channels of shock transmission. In addition, our models integrate both capital and borrower-based macroprudential policy measures and are calibrated using macro-financial data for the euro area.

We compare the two models under the effects of a positive shock on the monetary policy rate in the context of the current tightening in the monetary policy stance. We also assess macroprudential policy where the banking function is modelled with a money creation mechanism. The welfare-based approach is used in our analysis in order to perform a quantitative assessment of the two models.

Our model comparison exercise shows that, following an identical positive shock to the policy rate, the money creation model predicts a much faster contraction in bank lending and a less contractionary effect on output compared to the intermediation model. This suggests that banks' financing through money creation amplifies the effects of the monetary policy shock on bank lending, which is in line with the findings of Jakab and Kumhof (2015, 2019), while it attenuates the effects of the same shock on output. The result on bank lending can be attributed to the fact that banks in the ILF model can only extend loans after obtaining savings that can only be accumulated gradually over time. On the other hand, banks in the MC model can create new money instantaneously and independently of the available quantity of aggregate savings. The effect on output is a consequence of the fact that the MC model implies relatively high lending interest rates, which increase bank profitability and capital in the short run. In addition, the consumption/leisure distortion stemming from transaction costs encourages households to work more in the MC model than in the ILF, contributing to the resilience of output.

Furthermore, we find that a higher macroprudential capital buffer is likely to be effective in dampening the effects of the shock on the macro-financial variables of the economy, mainly due to the positive relationship between loan supply and the level of bank capital (and bank profits). This finding suggests that in a tightening monetary policy environment macroprudential policy mitigates the amplifying effects of bank financing through money creation. A quantitative welfare-based comparison of the different models and alternative macroprudential policy calibrations strengthen these conclusions.

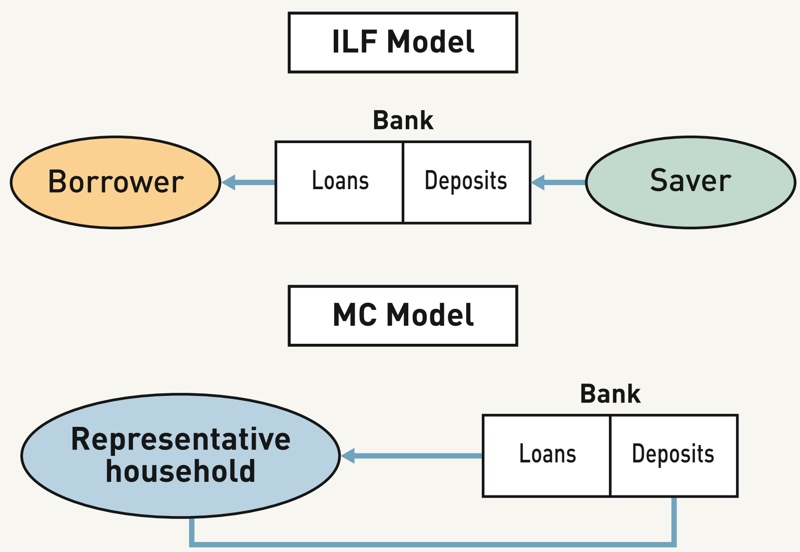
The rest of the paper is organised as follows. Section 2 outlines the two models and Section 3 presents the model calibration. Section 4 analyses the results of the model simulation and Section 5 concludes.

2. THE MODELS

We develop and simulate two versions of DSGE models with banking. The first version consists of the intermediation of loanable funds (ILF) model and the second version is the financing through money creation (MC) model. The main difference between the two models is the set of agents with whom banks interact. We impose that the real steady states of the two models are identical in order to allow for an effective comparison of the two models.

As illustrated by Figure 1, under the ILF model, banks collect deposits from households who save (i.e. savers) and lend them out to households who borrow (i.e. borrowers). Under the MC model, banks interact only with a single representative household in whose name banks simultaneously register both loans and deposits on their books (i.e., a given bank's debtor and creditor are the same household). Therefore, the banking sector intermediates loanable funds between savers and borrowers in the ILF model while it creates new money for a single representative household in the MC model.

Figure 1:
Bank balance sheet in each model



Source: BCL.

We introduce a monopolistically competitive banking sector à la Gerali *et al.* (2010) and assume that banks are subject to a constraint stemming from a risk-weighted capital requirement that translates into an exogenous target for the leverage ratio. We assume that any deviation from this target results in a quadratic cost. Moreover, we model the demand for bank deposits by way of a transactions cost technology, as in Schmitt-Grohe and Uribe (2004). This is essential only for the MC model, but it is also done in the ILF model in order to maintain the symmetry of the steady states. In both models, households consume, work and are subject to a borrowing constraint (i.e., a limit on their loan-to-income ratio).

On the production side, monopolistically competitive non-financial firms produce heterogeneous intermediate goods using labour supplied by households in exchange for flexible wages and capital purchased from households, which are also capital producers. These intermediate-goods-producing firms borrow from banks to finance their capital acquisition and are subject to corporate loan to value ratio limits (i.e., LTV limit). The prices of intermediate goods are set in a staggered fashion à la Rotemberg (1984). Final goods-producing firms, who bundle intermediate goods into final goods, operate in perfectly competitive markets.

Finally, a passive government covers its expenditures through retention of a constant fraction of long-run aggregate production. The interest rate is set by a monetary authority that follows a standard Taylor-type interest rate rule.

2.1 HOUSEHOLDS

As mentioned, the formal difference between the two models comes from the specification of the budgetary constraint on bank clients. In particular, two types of households (i.e., savers and borrowers) characterize the model with intermediation of loanable funds, while the money creation model embeds a single representative household.

A. The intermediation of loanable funds (ILF) model

For this first model, we assume that the economy is composed of two types of households: savers and borrowers. Both types of households derive utility from consumption, $c_{z,t}$, and disutility from the number of hours worked, $n_{z,t}$ and have an identical utility function which corresponds, in real terms, to:

$$E_0\sum_{t=0}^{\infty} \beta_z^t U(c_{z,t}; n_{z,t}) = E_0\sum_{t=0}^{\infty} \beta_z^t \left[A_{c,t}(1-a)\ln(c_{z,t} - a.C_{z,t-1}) - \frac{\chi_n n_{z,t}^{1+\gamma}}{1+\gamma}\right] \quad (1)$$

where $z = \{s, b\}$ with s and b, respectively representing borrowers and savers. Current individual consumption depends on lagged smoothed aggregate consumption, $a.\mathrm{C}_{z,t-1}$, of household group z, where the parameter a, denotes the degree of habit formation in consumption for non-durable goods. The parameter χ_n denotes the weight on hours worked and γ is the elasticity of labour supply. All preference parameters that affect the model dynamics, β_z, a, γ, are identical across savers and borrowers, thereby guaranteeing that the steady states of the two models are identical. The equality of discount factors (β_z) among savers and borrowers implies that we abstract from the degree of households' patience. As argued in Jakab and Kumhof (2015), in models where bank liabilities are held for their monetary services rather than as a saving instrument, there is no necessary correlation between the status of an agent as a bank depositor and greater patience. $A_{c,t}$ is a preference shock on consumption and follows an AR(1) process. Aggregate consumption and labour supply in the economy are defined as $c_t = c_{s,t} + c_{b,t}$ and $n_t = n_{s,t} + n_{b,t}$, respectively.

A.1 Savers

In the context of the models, money facilitates consumption and investment-good purchases as in Schmitt-Grohe and Uribe (2004). We assume that the balance of money deposited for consumption and investment purposes, $d_{c,t}$ and $d_{I,t}$ are held exclusively by saver households. We adopt the money demand specification from Schmitt-Grohe and Uribe (2004). Specifically, consumption and investment-good purchases are subject to proportional transaction costs, $s_{c,t}$ and $s_{I,t}$, that respectively depend on households' consumption and investment-based money velocities, $v_{c,t}$ and $v_{I,t}$, such that $v_{c,t} = c_{s,t}/d_{c,t}$ and $v_{I,t} = I_t/d_{I,t}$. The proportional transaction costs evolve as,

$$s_{z,t} = Av_{z,t} + \frac{B}{v_{z,t}} - 2\sqrt{AB} \quad (2)$$

Where $z \in \{c, I\}$ and A and B are the constant transaction cost parameters.

At the beginning of each period t savers are split into consumers/workers/capital holders and capital producers. Capital producers purchase the depreciated capital stock, $q_t K_{t-1}(1-\delta_k)$ at price q_t, from producers of intermediate goods, investment goods I_t from producers of final goods and use resources to pay for monetary transaction costs and real investment adjustment costs $s_{I,t} I_t + G_{I,t}$, where $G_{I,t} = \frac{\zeta_I}{2} I_t \left(\frac{I_t}{I_{t-1}} - 1\right)^2$. They sell the sum of old and new capital $q_t[K_{t-1}(1-\delta_k) + I_t]$ to intermediate goods producers.

The representative saver maximises their expected utility (1) subject to the following real budget constraint:

$$c_{s,t}(1+s_t) + d_t + G_{I,t} = w_t n_{s,t} + \frac{R_{t-1}}{\Pi_t} d_{t-1} + (q_t - 1 - s_{I,t}) I_t + \Lambda_t \tag{3}$$

where the left-hand side of the budget constraint represents the expenditure side: consumption spending, including transaction costs, monetary deposit holdings (i.e., $d_t = d_{c,t} + d_{I,t}$) and investment adjustment costs. The right-hand side disaggregates income. Savers receive the wage rate, w_t, for supplying hours of work and earn R_{t-1} on the risk-free deposit from the previous period, d_{t-1}, which depends on gross inflation, $\Pi_t = \frac{P_t}{P_{t-1}}$. They also receive the net revenue from their investment and dividends from both firms and banks, Λ_t.

The first order conditions with respect to $c_{s,t}$, $n_{s,t}$, $d_{c,t}$, $d_{I,t}$ and I_t are the following:

$$U^c_{s,t} = \lambda_{s,t}(1 + s_{c,t} + v_{c,t} s'_{c,t}) \tag{4}$$

$$w_t = \frac{-U^n_{s,t}}{U^c_{s,t}}(1 + s_{c,t} + v_{c,t} s'_{c,t}) \tag{5}$$

$$\lambda_{s,t}(1 - v^2_{c,t} s'_{c,t}) = \beta \lambda_{s,t+1} \frac{R_t}{\Pi_{t+1}} \tag{6}$$

$$\lambda_{s,t}(1 - v^2_{I,t} s'_{I,t}) = \beta \lambda_{s,t+1} \frac{R_t}{\Pi_{t+1}} \tag{7}$$

$$q_t = (1 + v_{I,t} s'_{I,t} + s_{I,t}) + \zeta_I \left(\frac{I_t}{I_{t-1}}\right)\left(\frac{I_t}{I_{t-1}} - 1\right) + \frac{\zeta_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 - \beta E_t \left(\frac{\lambda_{s,t+1}}{\lambda_{s,t}}\right) \zeta_I \left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2 \tag{8}$$

where $\lambda_{s,t}$ denotes the Lagrange multiplier with respect to the saver's budget constraint. $U^c_{s,t}$ and $U^n_{s,t}$ are savers' marginal utilities for consumption and labour.

A.2 Borrowers

At period t the representative borrower also maximises their expected utility (1) subject to the following real budget constraint:

$$c_{b,t} + \frac{R_{L,t}}{\Pi_t} l_{h,t-1} = w_t n_{b,t} + l_{h,t} \tag{9}$$

where the borrower spends resources on consumption and loan interest payments and receives the wage, w_t, as revenue from firms and loans, $l_{h,t}$, from banks.

Borrowers are subject to a borrowing constraint:

$$R_{L,t} l_{h,t} \leq \phi_{h,t} w_t n_{b,t} \tag{10}$$

where ϕ_t is the regulatory loan-to-income limit that banks apply to borrowers.

The first order conditions of the borrower with respect to $c_{b,t}$, $n_{s,t}$ and $l_{h,t}$ are combined and summarised as:

$$w_t = \frac{-U_{b,t}^n}{U_{b,t}^c + \phi_{h,t}\mu_{b,t}} \tag{11}$$

$$U_{b,t}^c = \mu_{b,t} R_{L,t} + \beta U_{b,t+1}^c \frac{R_{L,t}}{\Pi_{t+1}} \tag{12}$$

where $U_{b,t}^c$ and $U_{b,t}^n$ are savers' marginal utilities with respect to consumption and labour, and $\mu_{b,t}$ is the Lagrange multiplier with respect to the borrowing constraint.

B. The money creation (MC) model

For this model, we assume that the economy consists of a single representative household that both borrows from the bank and holds money deposits at the bank. This version of the model is a condensed version of the money-creation approach to banking in Jakab and Kumhof (2015, 2019). The preferences of the representative household are identical to (1), after dropping all subscripts z. The household maximises its expected utility subject to the following real budget constraint:

$$c_{s,t}(1 + s_{c,t}) + d_t + G_{I,t} + \frac{R_{L,t}}{\Pi_t} l_{h,t-1} = l_{h,t} + \frac{R_{t-1}}{\Pi_t} d_{t-1} + w_t N_t + (q_t - 1 - s_{I,t}) I_t + \Lambda_t \tag{13}$$

From the left-hand side of the budget constraint, the household consumes with the transaction costs (s_t)[3], holds deposits at the bank and pays investment adjustment costs and the interest rate on loans from the bank. The right-hand side of the budget constraint shows that households borrow from banks, earn gross interest on deposits and receive wages, as well as the net value of their investment and any profits from firms and banks (Λ_t).

The representative household is subject to the same borrowing constraint as in the IL model (see equation 10).

3 While the transaction cost technology is a feature of the ILF model, it is introduced in the MC model in order to make the two models comparable.

The main difference between the ILF model and the MC model is found in the budget constraint of households (banks' customers), where the separate constraints (3) and (9) of the former model become a single constraint (13) in the latter. In the MC Model, deposits and loans are fast-moving variables, created by matching gross positions on the balance sheets of banks, while they are predetermined variables in the ILF Model, representing slow-moving savings.

The first-order optimality conditions for consumption, investment and bank deposits are identical to those of the saver household in the ILF model, while those for loans and labour are identical to the ones of the borrower household in the ILF model, taking into account transaction costs.

2.2 BANKS

In the ILF model, a monopolistically competitive banking sector extends loans to borrowers and collects deposits from savers, while in the MC model banks perform both operations with a single representative household. In addition, the banking sector lends to non-financial firms. Banks balance sheets are subject to an adjustment cost. As in Gerali *et al.* (2010), we assume that the representative bank has a target τ_t for their capital-to-assets ratio (i.e., the leverage ratio) and pays a quadratic cost whenever it deviates from that target. The target can be interpreted as an exogenous regulatory capital requirement that imposes a constraint on the amount of own resources to hold. The existence of a cost for deviating from the target ratio of capital-to-assets τ implies that bank leverage affects credit conditions in the economy.

In the ILF model, the monopolistic banking sector collects deposits, $d_t = d_{c,t} + d_{I,t}$, from households, paying a net interest rate r_t set by the central bank and issues loans $l_t = l_{h,t} + l_{f,t}$ to households ($l_{b,t}$) and intermediate goods producers ($l_{f,t}$) on which it earns the loan net interest rate $r_{L,t}$. In the MC model, the monopolistic banking sector performs a bookkeeping transaction with a lending net interest rate of $r_{L,t}$ and pays r_t for the change in its liabilities that compensates the change on its asset side.

The representative bank's real profits are the loan interest payments minus deposit interest payments as well as the quadratic cost that the bank is assumed to pay for deviating from its target leverage:

$$\Lambda_{B,t} = r_{L,t} l_t - r_t d_t - \frac{\chi}{2}\left(\frac{k_{B,t}}{l_t} - \tau_t\right)^2 k_{B,t} \tag{14}$$

where $k_{B,t}$ is the bank's capital and χ denotes the parameter that captures the sensitivity of the bank's profit, and thus the bank's lending rate, to the penalty cost for deviating from the target capital-to-assets ratio.

The representative bank chooses the optimal loan supply and deposits in order to maximise its real profit (14) subject to the following balance sheet constraint, $l_t = d_t + k_{B,t}$. Solving the maximisation programme leads to the loan net interest rate that would be optimal under perfect competition, to which we add a premium m_b:

$$r_t^L = r_t - \chi\left(\frac{k_{B,t}}{l_t} - \tau_t\right)\left(\frac{k_{B,t}}{l_t}\right)^2 + m_b \tag{15}$$

where m_b is a constant mark-up representing the finance premium assumed in Gambacorta and Signoretti (2014).

Furthermore, bank's capital $k_{B,t}$ is accumulated out of reinvested profits and evolves as follows:

$$k_{B,t}\Pi_t = (1-\delta_B)k_{B,t-1} + (1-\upsilon)\Lambda_{B,t-1} \quad (16)$$

where δ_B is the bank capital depreciation rate (i.e., bank capital used in banking activities) and υ is the parameter governing the bank dividend policy.

2.3 FIRMS

2.3.1 Final good producers

Final good producers operate under perfect competition, buying differentiated intermediate goods, $j \in [0,1]$, which they bundle into final goods, Y_t, via the Dixit-Stiglitz aggregator:

$$Y_t = [\int_0^1 (Y_t(j))^{\frac{\epsilon-1}{\epsilon}} dj]^{\frac{\epsilon}{\epsilon-1}} \quad (17)$$

where ϵ denotes the elasticity of substitution between the various types of goods. Final good producers generate the following demand equation for each intermediate good:

$$Y_t(j) = (\frac{P_t(j)}{P_t})^{-\epsilon} Y_t \quad (18)$$

where $P_t(j)$ is the price of the intermediate good j and P_t is the aggregate price of final goods set as:

$$P_t = [\int_0^1 (P_t(j))^{1-\epsilon} dj]^{\frac{1}{1-\epsilon}} \quad (19)$$

2.3.2 Intermediate good producers

Intermediate good producers operate under monopolistic competition. Assuming perfect symmetry across firms, an intermediate good producer relies on the following technology:

$$Y_t = A_{F,t}\, N_t^{1-\alpha} K_{t-1}^{\alpha} \quad (20)$$

where N_t stands for the aggregate labour supplied in the economy (with $N_t = n_{s,t} + n_{b,t}$ in the ILF model), K_{t-1} is the previous period's physical capital stock and $A_{F,t}$ is an aggregate productivity shock.

Intermediate good producers earn revenues from sales of their differentiated intermediate output minus expenditures on labour services supplied by households in exchange for the wage, w_t. In addition, non-financial intermediate good producers borrow from banks ($l_{f,t}$) and pay off interest plus principal on loans. They also spend on business investment at price q_t. Therefore, the representative firm's real dividend payoff is:

$$\Lambda_{f,t} = (Y_t - w_t N_t) + (l_{f,t} - \frac{R_{L,t-1}}{\Pi_t} l_{f,t-1}) - q_t I_t \quad (21)$$

The representative firm faces the following borrowing (collateral) constraint:

$$R_{L,t} l_{f,t} \leq \psi_{f,t}\, q_{t+1} K_t \quad (22)$$

where $\psi_{f,t}$ is the regulatory limit on the corporate loan to value ratio.

Intermediate good producers enter period t with previously accumulated physical capital stock, K_{t-1}, which evolves according to:

$$K_t = I_t + (1-\delta_k)K_{t-1} \tag{23}$$

Solving firms' expected discount profit maximisation, subject to the production function (20), the physical capital accumulation equation (23) and the borrowing constraint (22), entails the following first order conditions:

$$q_t = \mu_{ft}\Phi_{f,t}q_{t+1} + \beta E_t\,(\frac{\lambda_{s,t+1}}{\lambda_{s,t}})\,[\frac{\alpha Y_{t+1}mc_{t+1}}{K_t} + q_{t+1}(1-\delta_k)] \tag{24}$$

$$[\mu_{ft} + \beta E_t\,(\frac{\lambda_{s,t+1}}{\lambda_{s,t}})\,\frac{1}{\Pi_{t+1}}]\,R_{L,t} = 1 \tag{25}$$

$$w_t = (1-\alpha)\frac{Y_t}{N_t}mc_t \tag{26}$$

Intermediate good producers are subject to Rotemberg price setting. As in Rotemberg (1984), it is assumed that price changes are subject to quadratic price adjustment costs. In period t, intermediate good producer (j) can adjust its price optimally and it does so to maximize its expected discount profit (21) subject to production function (20) and intermediate good demand function (18).

The necessary first order condition implicitly provides the following optimal price for intermediate goods:

$$\begin{aligned}-\epsilon\,(\frac{P_t(j)}{P_t})^{-\epsilon-1}\frac{P_t(j)}{P_t}\frac{Y_t}{P_t} + (\frac{P_t(j)}{P_t})^{-\epsilon}\frac{Y_t}{P_t} - \zeta_P\,(\frac{P_t(j)}{P_{t-1}(j)} - 1)\,\frac{Y_t}{P_{t-1}(j)} + \epsilon.mc_t(j)\,(\frac{P_t(j)}{P_t})^{-\epsilon-1}\frac{Y_t}{P_t} \\ + \zeta_P\beta E_t\,[\frac{\lambda_{s,t+1}}{\lambda_{s,t}}(\frac{P_t(j)}{P_{t-1}(j)} - 1)\,Y_{t+1}\,(\frac{P_{t+1}(j)}{(P_t(j))^2})\,] = 0\end{aligned} \tag{27}$$

where ζ_P denotes the price adjustment cost parameter.

As perfect symmetry is assumed across firms, they all fix the same price and consequently, the index j can be dropped. Hence, the inflation rate is:

$$\zeta_P\Pi_t(\Pi_t - 1) = \zeta_P\beta E_t\,[\frac{\lambda_{s,t+1}}{\lambda_{s,t}}\Pi_{t+1}(\Pi_{t+1} - 1)\frac{Y_{t+1}}{Y_t}] + (1-\epsilon) + \epsilon.mc_t \tag{28}$$

2.4 MONETARY POLICY AND GOVERNMENT SPENDING

The central bank sets monetary policy according to a Taylor-type rule.

$$R_t = R^{1-\phi_R}R_{t-1}^{\phi_R}\,(\frac{\Pi_t}{\Pi})^{\phi_\Pi(1-\phi_R)}\,(\frac{Y_t}{Y})^{\phi_Y(1-\phi_R)}\,A_{R,t} \tag{29}$$

where R denotes the steady-state nominal interest rate.ϕ_R denotes the interest rate smoothing parameter. ϕ_Π and ϕ_Y are the weights assigned to inflation and output deviations from their target values. $A_{R,t}$ represents a monetary policy shock following an AR(1) process.

It is assumed that government spending is exogenous and represents a constant fraction of the steady state output, such as $G_t = g\bar{Y}$.

2.5 MACROPRUDENTIAL POLICY

The macroprudential authority holds three macroprudential instruments: the bank capital-to-assets ratio requirement on the loan supply side, household loan-to-income ratio (LTI) and corporate loan to value ratio (LTV) on the loan demand side.

Following Adrian *et al.* (2022), the regulatory bank capital requirement satisfies a countercyclical capital buffer rule exhibiting partial adjustment dynamics of the form:

$$\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_\tau)\tau + (1-\rho_\tau)\chi_\tau(l_t - l) \quad (30)$$

where $0 \leq \rho_\tau < 1$ denotes the degree of persistence of the capital requirement, $\chi_\tau \geq 0$ is the policy response coefficient to growth in total bank loans with respect to its steady state value and τ is the steady state value of the capital-to-assets ratio.

The regulatory limit on household loan-to-income ratios satisfies a partial adjustment rule of the form:

$$\phi_{h,t} = \rho_\phi \phi_{h,t-1} + (1-\rho_\phi)\phi + (1-\rho_\phi)\chi_\phi(l_{b,t} - l_b) \quad (31)$$

where $0 \leq \rho_\phi < 1$ denotes the degree of persistence in the loan-to-income limit, , $\chi_\phi \geq 0$ is the policy response coefficient to the growth of household borrowing with respect to its steady state value and ϕ is the steady state value of the loan-to-income ratio.

As in Adrian *et al.* (2022), the regulatory limit on the corporate loan-to-value ratio satisfies a partial adjustment rule of the form:

$$\psi_{f,t} = \rho_\psi \phi_{f,t-1} + (1-\rho_\psi)\psi + (1-\rho_\psi)\chi_\psi(l_{f,t} - l_f) \quad (32)$$

where $0 \leq \rho_\psi < 1$ denotes the degree of persistence in the limit on the loan-to-value ratio, $\chi_\psi \geq 0$ is the policy response coefficient to growth in corporate borrowing with respect to its steady state value and ψ is the steady state value of the limit on the loan-to-value ratio.

2.6 RESOURCE CONSTRAINT

For the ILF model, the market clearing condition in the goods market is given by:

$$Y_t = c_{s,t}(1+s_{c,t}) + c_{b,t} + I_t(1+s_{I,t}) + G_{I,t} + G_t + \delta_B \frac{k_{B,t-1}}{\Pi_t} + \frac{\zeta_P}{2}(\Pi_t - 1)^2 Y_t + \frac{\chi}{2}\left(\frac{k_{B,t-1}}{l_{t-1}} - \tau\right)^2 \frac{k_{B,t-1}}{\Pi_t} \quad (33)$$

In the money-creation model, the goods market clearing condition is Equation (33) excluding the term $c_{b,t}$.

3. CALIBRATION OF THE MODEL

In order to simulate the model, we set some model parameters using euro area data and set others to values from the broader literature. Table 1 below presents the calibrated values of parameters and time is measured in quarters.

The degree of habit formation in consumption, a, is set to 0.5 in line with the literature (see Lambertini *et al.* (2017), Darracq Pariès *et al.*(2011)). The goods substitution elasticity, ϵ, is fixed at 6, implying a steady-state markup of 20% as in Chen and Columba (2016) and Hristov and Hülsewig (2017). The inverse of the Frisch elasticity is $\gamma = 1$ following Clerc *et al.* (2015).

Steady-state gross inflation, Π, is set to yield an annual inflation rate of 2% for the euro area. We set the household discount factor β at 0.99 and the average steady-state annual risk-free interest rate at 2%, corresponding to euro area data and yielding a steady-state annual real interest rate of 0%. The average annual bank lending rate is calibrated so that the average annual spread between the risk free and bank loan rates is 200 bps, consistent with euro area data. Following Schmitt-Grohé and Uribe (2004), we set the parameter B of the transaction cost technology to 0.01. The parameter A of transaction costs is calibrated to a higher value (0.29) than in Schmitt-Grohé and Uribe (2004) in order to generate a positive steady-state loan flow to borrowers in the ILF model. The parameter defining capital used in banking activity δ_B is endogenously determined at the steady state.

We fix the ratio of capital to loans at 8% according to euro area data, which is also in line with the literature (Jakab and Kumhof (2015, 2019)). The banking leverage adjustment cost parameter, χ, is set to 10 following Gerali *et al.* (2010). The adjustment cost parameter related to goods prices (ζ_P) is set to 400 to yield enough price stickiness. We calibrate the weight of labour disutility ($\mathcal{X}n$) for savers in the ILF model and the representative household in the MC model to 0.8 and the dividend policy parameter (υ) to 5% according to the values in Clerc *et al.* (2015). The weight of labour disutility ($\mathcal{X}n$) for borrowers in the ILF model is endogenously set in the steady state.

The steady-state value of the corporate loan-to-value ratio is calibrated to 100%, assuming that the firm is financed by the bank against the entire value of its physical capital. We set the steady-state loan-to-income ratio to 33% corresponding to the value endogenously obtained in the MC model.

Following Gerali *et al.* (2010), the capital share in the production function (α) and the depreciation rate of physical capital (δ_k) are set to 0.25 and 0.025, respectively. The investment adjustment cost parameter (ζ_I) is calibrated to 10 as in Gerali *et al.* (2010).

The ratio of public spending to GDP is 0.2 and is based on euro area data. The monetary policy rule has a smoothing parameter of 0.8, an inflation response of 2 and an output gap response of 0.4 following Gerali *et al.* (2010). Macroprudential policy response to the growth of total bank loans ($\mathcal{X}\tau$), household ($\mathcal{X}_\Phi$) and corporate ($\mathcal{X}_\Psi$) borrowing are fixed at 0.1 following to Adrian *et al.* (2022). The degrees of persistence in the macroprudential rules are all set to 0.8 as in Adrian *et al.* (2022).

Finally, we use 0.8 for the AR(1) coefficients of the shocks, as is common in the literature.

Table 1:
Calibration of the model parameters

PARAMETERS	DESCRIPTION	VALUES
β	Discount factor of households	0.99
a	Degree of habit formation in consumption	0.5
A	Parameter of transaction cost function	0.29
B	Parameter of transaction cost function	0.01
γ	Inverse of Frisch elasticity	1
Ψ	Corporate loan-to-value ratio	1
Φ	Household loan-to-income ratio	0.33
τ	Ratio of Capital to loans	0.08
χ	Banking leverage adjustment cost	20
υ	Banks' dividend policy parameter	0.05
α	Capital share in the production function	0.25
δ_k	Depreciation rate of physical capital	0.025
ζ_I	Investment adjustment cost parameter	10
ζ_P	Parameter of goods price adjustment cost	400
ϵ	Goods substitution elasticity	6
χ_n	Weight of labour in the utility	0.8
g	Government spending to GDP ratio	0.2
ϕ_R	Taylor rule smoothing coefficient	0.8
ϕ_Π	Taylor rule coefficient on inflation	2
ϕ_Y	Taylor rule coefficient on output	0.4
χ_τ	Macroprudential policy coefficient on total loan	0.1
χ_Φ	Macroprudential policy coefficient on household loan	0.1
χ_Ψ	Macroprudential policy coefficient on corporate loan	0.1
$\rho_{\tau,\Phi,\Psi}$	Persistence of the macroprudential rule	0.8
ρ_c	AR consumption preference shock	0.8
ρ_f	AR productivity shock	0.8
ρ_r	AR monetary policy shock	0.8

Source: BCL.

4. QUANTITATIVE IMPLICATIONS AND MODEL DYNAMICS

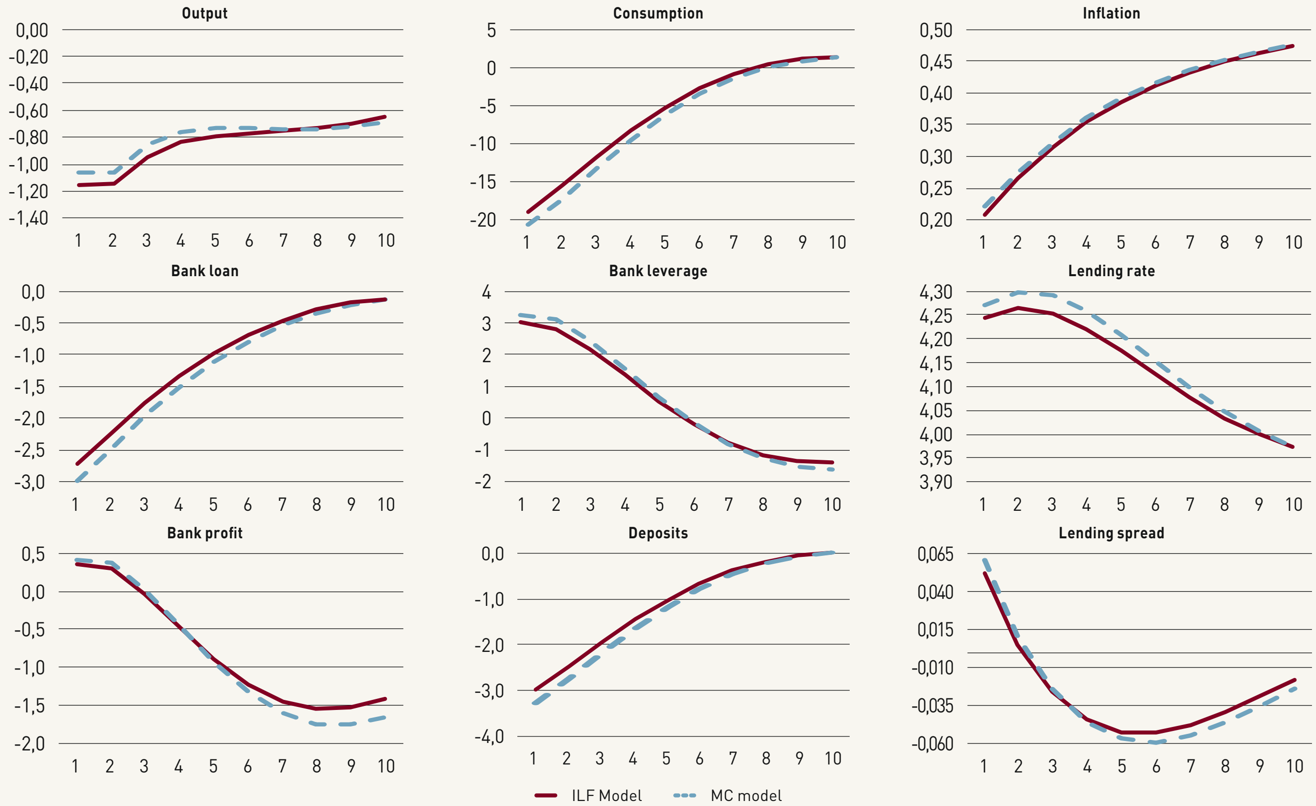
4.1 COMPARISON OF THE INTERMEDIATION OF LOANABLE FUNDS MODEL AND THE FINANCING THROUGH MONEY CREATION MODEL

Figure 2 displays the effects of an unanticipated 50 basis point increase in the monetary policy rate on the main macro-financial variables of the economy.

This shock leads to an increase in the bank lending rate, which, combined with movements in the bank lending spread, immediately improves bank profits in relation to the existing balance sheet and pricing structure (i.e., price effect). As in Gerali *et al.* (2010), this price effect outweighs the decline in bank loans to households and firms (i.e. quantity effect). More specifically, at the time of impact, the bank lending spread increases, which more than offsets the reduction in bank loans. A few quarters later, the spread falls below its steady state level when the marginal effect of deviating from the target capital-to-assets ratio on lending (i.e., the benefit from the bank's capital position) outweighs the change in the policy rate. This compression of the spread causes bank profits to decline after their initial increase.

Figure 2:

Effects of a 50bps tightening of monetary policy on the main macro-financial variables using the ILF and MC models



Source: BCL.

Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in % deviation from the steady state, with the exception of the lending rate and inflation, which are measured in percentage levels.

Following profits, bank capital and leverage increase in the short-run but decrease several quarters later, in both models. As bank capital increases in the short-run, banks have no incentive to hold deposits and so the level of deposits declines.

The contraction in lending depresses household consumption and firm investment, resulting in a reduction of inflation, which initially falls before converging back to its steady state level (a quarterly value of 0.5 matches the central bank's annual target of 2 %). The contraction in lending has a recessionary effect on output, since aggregate demand falls and the real interest rate rises.

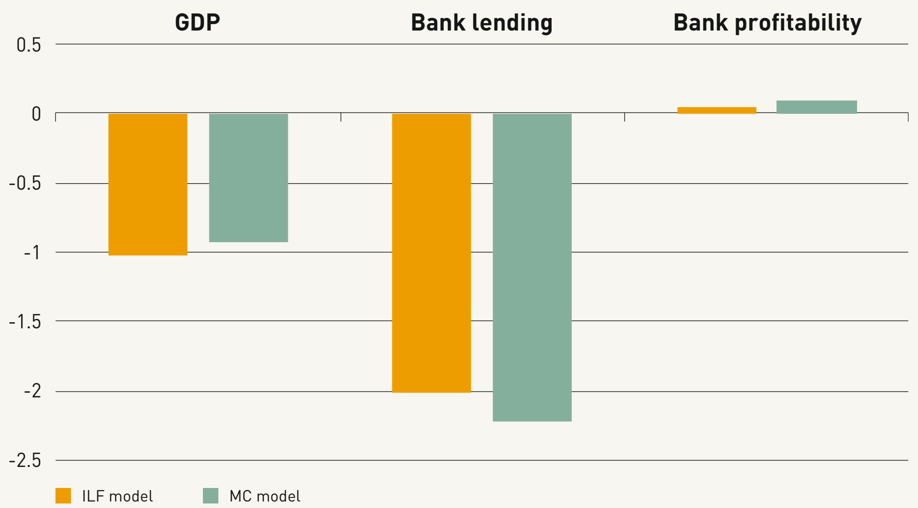
Additional model dynamics are reflected in the impulse responses to monetary policy tightening. Loan supply is positively correlated with the level of bank capital such that it depends positively on bank profits. In other words, an increase in bank profits (and therefore bank capital) leads to a reduction in the lending rate (in the next period) for any given level of lending to the economy.

These responses to monetary policy tightening are in line with those from Gerali *et al.* (2010). They highlight the credit-supply channel created by financial frictions that link the real and financial sides of the economy, as described in Gambacorta and Signoretti (2014).

Comparing the outcomes of the intermediation of loanable funds model to those from the money creation model shows that the latter attenuates the contractionary effects of the monetary policy tightening on output, while it reinforces the effects on other macro-financial variables. In particular, bank loans and household consumption decline more under money creation than under the intermediation of loanable funds. This is explained by the fact that lending flows decline much less under the ILF model than under the MC model, since banks instantaneously reduce their loan supply in the latter while they have to do so gradually in the former model.

More specifically, in the ILF model banks do not contract their lending until they observe a reduction in their deposits. As deposits equal savings from savers and are predetermined variables, lending and deposits cannot jump following the interest rate shock. Moreover, as consumption is the main purpose of household borrowing in our models, consumption decreases less in the ILF model (due to the direct impact of the shock on consumption by borrowers and the indirect effects on consumption by savers). In the MC model, banks face no constraints to adjusting their lending volumes and the increase in the lending rate directly reduces consumption by the representative household, leading to a direct and strong decrease in lending.

Figure 3:
Four-quarter average impact of a 50bps monetary policy tightening (in %)



Source: BCL.

However, output contracts less under money creation than under intermediation of loanable funds, as bank capital and profits increase more under the former. This is because the MC model implies relatively high lending interest rates. In addition, the consumption/leisure distortion stemming from transaction costs encourages households to work more in the MC model than in the ILF, contributing to output growth in the steady state.

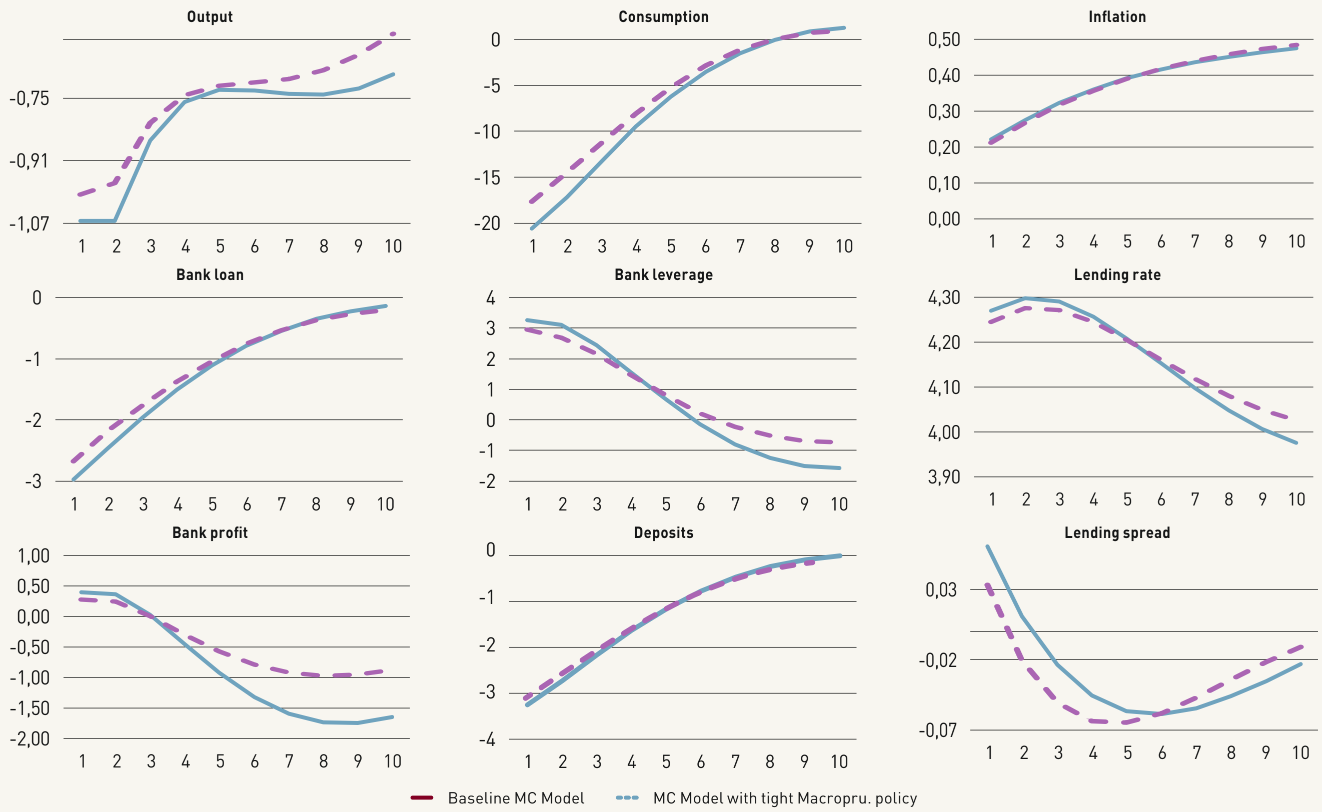
Figure 3 illustrates the one-year average impacts of the 50 basis point increase in the monetary policy rate on GDP, bank loans and bank profitability under alternative model specifications. Over the short-term (one year), GDP decreases on average by 0.94 % in the MC model, which is less than the 1.02 % decrease in the ILF model. In accordance with the impulse responses in Figure 2, bank loans fall, on average, more in the MC model (-2.23 %) than in the ILF model (-2 %). In the short term, the increase in bank profitability is around 0.04 % under the ILF model while it increases about 0.09 % under the MC model.

4.2 INVESTIGATING THE ROLE OF MACROPRUDENTIAL POLICY IN THE MONEY CREATION SETTINGS

In this section, we explore the role of macroprudential policy in our money creation model. We perform a counterfactual analysis by assessing the impact on the main macro financial variables of the economy from choosing alternative targets for the regulatory capital requirement (i.e., the target

Figure 4:

Effects of a tightening monetary policy on the main macro-financial variables using the MC model with and without tight macroprudential policy



Source: BCL.

Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in % deviations from steady state, except the lending rate and inflation, which are measured in % levels.

capital-to-assets ratio). To this end, we compare two scenarios based on the MC model: a baseline scenario in which the bank's target capital-to-assets ratio is set to its level from the data (i.e., baseline calibration = 8%) and an alternative scenario where macroprudential policy sets this to a higher level (i.e., policy tightening calibration = 12%).

The analysis is performed by assuming an exogenous 50 basis point increase in the monetary policy rate. Figure 4 compares the main outcomes of monetary policy tightening in the MC model with the baseline and higher calibration of macroprudential policy.

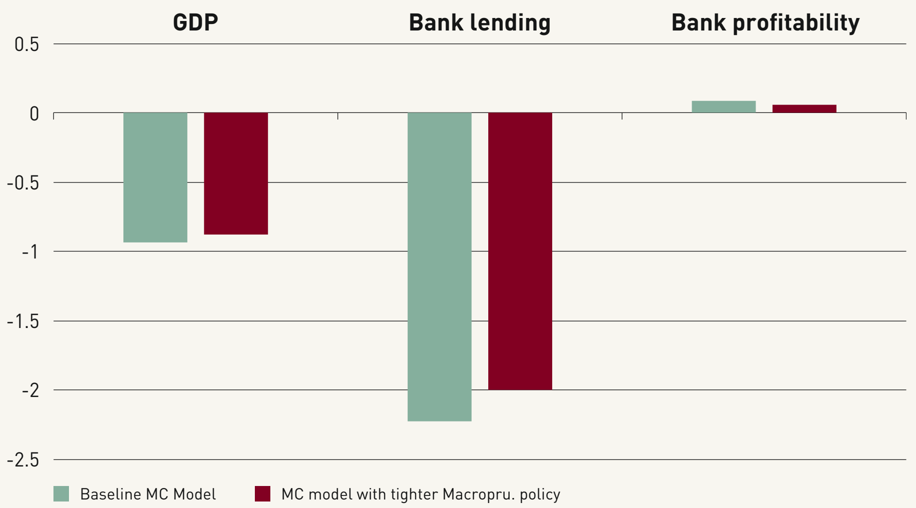
The dynamics of the main variables in the MC model show that a tighter macroprudential policy environment attenuates the contractionary impacts of monetary policy tightening, at least in the short run. In the context of our model, this suggests that the presence of higher capital buffers can attenuate the impact of monetary tightening. The main explanation for this finding is the so-called loan-supply channel mentioned previously. More specifically, the presence of a higher target for the bank leverage position (i.e., a higher bank capital position) reduces the lending rate and spread (which could even decline as shown in Figure 4). In other words, in a monetary policy tightening, resilient banks are likely to increase their lending rates by less than more vulnerable banks. This drives up bank loan supply compared to the scenario with lower capital buffers. Due to this price effect, bank profits increase less under the scenario with a higher capital-to-assets ratio than under the baseline scenario with a lower capital buffer. As a result, bank capital and leverage also increase less under the scenario with higher capital buffers. As bank loans decrease less under the alternative calibration with a high level of capital, the decline in deposits, consumption and output is more limited than in the baseline scenario with a lower capital-to-assets ratio.

For illustrative purposes, Figure 5 shows the one-year averages associated with the 50 basis point tightening of monetary policy under alternative macroprudential policies for the MC model. Figure 5 suggests that the effects on GDP and lending from increasing policy rates are attenuated when the macroprudential policy calibration is tighter (i.e., capital buffers are higher). In particular, under the scenario with a higher capital buffer, GDP declines in the short-term by 0.88% and bank loans decrease by 2%, while under the baseline calibration they fall by 0.94% and 2.23% respectively.

Bank profitability increases by 0.09% under the baseline calibration of macroprudential policy, while it only increases 0.06% under the scenario with the higher capital buffer. The rationale behind these results is that well-capitalized banks attenuate the impact of monetary policy tightening, mainly due to the positive relationship between loan supply and the level of bank capital (and bank profits).

Figure 5:

Four-quarter average impact of a 50 bps monetary policy tightening when macroprudential policy is tighter in the MC Model (in %)



Source: BCL.

4.3 WELFARE ANALYSIS

In order to draw conclusions about the desirability of alternative models and policies, we compare their performance based on welfare criteria. The welfare analysis follows the approach commonly used in the DSGE literature.[4] The individual welfare of households is measured by the conditional expectation of lifetime utility as:

$$W_{z,t} = E_0 \sum_{t=0}^{\infty} \beta_z^t \left[A_{c,t}(1-a)\ln(c_{z,t} - a.C_{z,t-1}) - \frac{\chi_n n_{z,t}^{1+\gamma}}{1+\gamma} \right] \tag{24}$$

In the ILF model, where households are split into two groups, individual welfare (24) is computed separately for each type of household where $z = \{s, b\}$ with s and b standing for borrowers and savers. We define total social welfare as a weighted sum of individual welfare as follows:

$$W_t = (1-\beta_s)W_{s,t} + (1-\beta_b)W_{b,t} \tag{25}$$

where $\beta_s = \beta_b$ as discussed in Section 2.1.A.

In the MC model there is a single representative household, so total social welfare is obtained from a simplified version of Equation (24) after dropping all subscripts, z.

We follow Schmitt-Grohe and Uribe (2007) by computing the conditional welfare of agents using the second order approximation of the model.[5]

To make the results more intuitive, we define a welfare metric in terms of consumption equivalents. This consumption-equivalent welfare measure is the constant fraction of steady-state consumption that households would need in a non-stochastic world in order to yield the same conditional welfare as would be achieved in a stochastic world. A positive value means a welfare gain, which is how much the consumer would be willing to pay to obtain the welfare improvement. A negative value implies a welfare cost, i.e., how much steady-state consumption households would have to sacrifice to reach the same level of deterioration in welfare.

Formally, the welfare loss or gain is given by λ_w:

$$W_t(c_{z,t}; n_{z,t}) = W((1+\lambda_w)c_z, n_z) \tag{26}$$

where variables without subscript "t" denote their steady-state values, c_t, and n_t are aggregate consumption and labour.

Figure 6 presents the conditional welfare costs (in % of steady-state consumption) following a monetary policy tightening for the different models and macroprudential policies. In line with the above results, the money creation model with the baseline calibration of macroprudential policy displays a higher welfare cost (-1.40 %) compared to the baseline ILF model (-1.16 %). This reflects the dynamics of both consumption and leisure which define the welfare metric. Consumption and leisure decline more under the MC model than under the ILF model, implying a higher welfare cost. Moreover, in accordance with the results from the model dynamics, a higher capital buffer reduces welfare under the MC model as

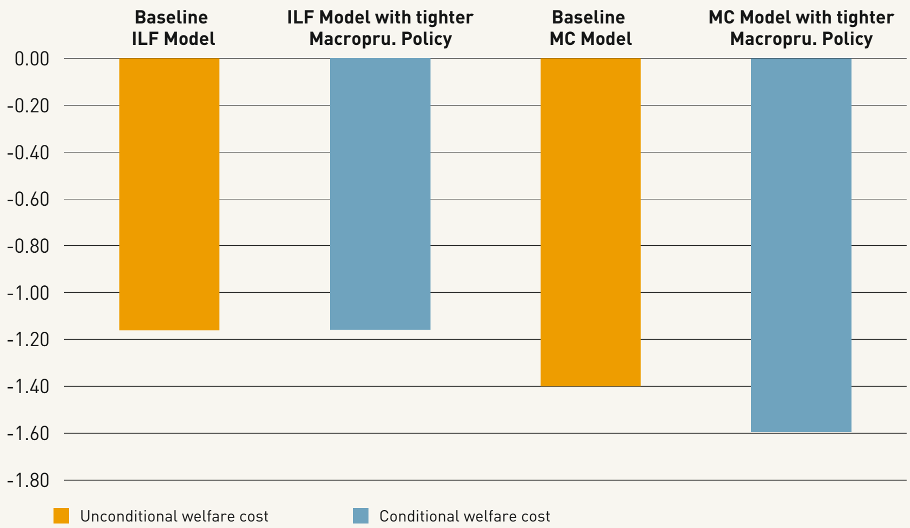
4 See among others, Kim and Kim (2003), Faia and Monacelli (2007), Rubio and Carrasco-Galego (2014), Sangare (2019), Schmitt-Grohe and Uribe (2004, 2007).

5 Second order approximation methods have the particular advantage of accounting for the volatility of variables around their mean levels. See among others Schmitt-Grohe and Uribe (2004).

it implies a greater decline in leisure, which offsets the lower decline in consumption. However, higher capital buffers under the ILF model attenuate the severity of the monetary policy shock in terms of welfare. This is because consumption and labour decrease less with tighter macroprudential policy, owing to reduced loan supply.

Figure 6:

Conditional welfare costs (in % of steady-state consumption)



Source: BCL.

5. CONCLUSIONS

The dominant macro-financial-modelling approach in the literature considers the banking sector simply as an intermediary of loanable funds between non-bank savers and non-bank borrowers. Under this approach, savers' deposits create bank lending in the intermediation process. However, in reality banks create money through their lending operations by creating deposits that require no intermediation from savers. In practice, banks create new monetary purchasing power through loans, with borrowers simultaneously becoming depositors.

This work compares the intermediation of loanable funds model to the money creation model and investigates the role of macroprudential policy when banks are money creators. The effects of a positive shock to the monetary policy rate is compared in the two models in the context of the current monetary policy tightening in the euro area. Macroprudential policy is introduced as a capital requirement, following Gerali *et al.* (2010), by assuming that banks pay a cost if they deviate from a target leverage ratio. Borrower-based macroprudential instruments are also present in our implementation of both models. The first contribution of this study is to construct two realistic DSGE models to explore how the money creation approach to banking affects the macro-model dynamics following monetary policy tightening. The second contribution of this study consists in exploring the role of macroprudential policy in the money creation framework.

Our model comparison exercise shows that an identical positive shock to the monetary policy rate, leads to a much faster contraction of bank lending and much lower contractionary effects on output in the money creation model than in the intermediation of loanable funds model. The explanation is that banks are able to instantaneously reduce their loan supply in the money creation model while they have to do so gradually in the intermediation of loanable funds model. However, output is more resilient to the monetary policy tightening in the money creation model, as bank profitability and capital increase more, and labour supply decreases less, than in the intermediation model. This result suggests that the money creation model amplifies the effects of monetary policy tightening on bank lending while it attenuates the effects of the same shock on output due to the increase in bank capital and the transaction costs on the use of money by households. Furthermore, we find that a macroprudential policy that limits banks' leverage ratio would be effective in dampening the adverse effects of monetary policy tightening, thanks to accumulated capital buffers. More specifically, well-capitalized banks attenuate the impact of a monetary policy tightening mainly due to a positive relationship between loan supply and the level of bank capital. This finding suggests that macroprudential capital buffers may limit the amplification effects a monetary policy shock through money creation.

A quantitative welfare-based assessment of the different models and alternative macroprudential policy settings complete these conclusions. In particular, a monetary policy tightening yields a higher welfare cost under the money creation model compared to the intermediation of loanable funds model. Moreover, a macroprudential policy that implies a higher bank capital position attenuates the welfare cost of a positive monetary policy shock under the ILF model and exacerbates this cost under the MC model.

6. REFERENCES

Adrian T., Vitor G. and Francis V. (2022), "A Medium-Scale DSGE Model for the Integrated Policy Framework", *IMF Working Paper*, WP/22/15.

Bernanke, B., Gertler M., and Gilchrist S. (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework." In *Handbook of Macroeconomics*, *Volume 1.C*, edited by John B. Taylor and Michael Woodford.

Boissay, F., Collard, F. and Smets, F. (2016), "Booms and Banking Crises", *Journal of Political Economy*, 124(2), 489-538.

Chen, M. J. & Columba, M. F. (2016), 'Macroprudential and monetary policy interactions in a DSGE model for Sweden', *IMF Working Paper* No 16/74.

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

Clerc, L., Derviz, A., Mendicino, C., Moyen, S., Nikolov, K., Stracca, L., Suarez, J. & Var- doulakis, A. (2015), 'Capital regulation in a macroeconomic model with three layers of default', *International Journal of Central Banking 11(3).*

Darracq P. M., Kok C., Rodriguez-Palenzuela D. (2011), "Macroprudential propagation under different regulatory regimes: Evidence from an Estimated DSGE Model for the Euro area", *International Journal of Central banking*, December 2011.

De Walque G., Pierrard O., Rouabah A. (2010), "Financial (in) stability, supervision and liquidity injections: a Dynamic General Equilibrium Approach", *The Economic Journal*, Volume 120, Issue 549, Pages 1234-1261, December 2010.

Faia, E., Monacelli, T., (2007), "Optimal interest rate rules, asset prices and credit frictions", *Journal of Economic Dynamics and Control* 31, 3228–3254.

Faure S. and Gersbach H. (2022), "Loanable funds versus money creation in banking: a benchmark result", *Journal of Economics* (2022) 135, 107–149.

Gambacorta L. and Signoretti F.M. (2014), "Should monetary policy lean against the wind? An analysis based on a DSGE model with banking", *Journal of Economic Dynamics & Control* 43 (2014), 146–174.

Gerali, A., Neri, S., Sessa, L. & Signoretti, F. M. (2010), 'Credit and banking in a DSGE model of the euro area', *Journal of Money, Credit and Banking* 42, 107–141.

Gertler, M. and Karadi, P. (2011), "A Model of Unconventional Monetary Policy", *Journal of Monetary Economics*, 58(1), 17-34.

Gertler, M. and Kiyotaki, N. (2011), "Financial Intermediation and Credit Policy in Business Cycle Analysis", in: Friedman, B. and Woodford, M. (eds.), *Handbook of Monetary Economics*,Volume 3A, North Holland: Elsevier.

Hristov, N. & Hülsewig, O. (2017), 'Unexpected loan losses and bank capital in an estimated DSGE model of the euro area', *Journal of Macroeconomics* 54, 161–186.

Jakab, Z. and M. Kumhof (2019), "Banks are not intermediaries of loanable funds-facts, theory and evidence", *Bank of England Working paper series* N° 761, June.

Jakab, Z. and M. Kumhof (2015), "Banks are not intermediaries of loanable funds- And why this matters", *Bank of England Working paper series* N° 529, May.

Kim, J., Kim, S.H., (2003), "Welfare effects of tax policy in open economies: stabilization and cooperation", *Finance and Economics Discussion Series. Board of Governors of the Federal Reserve System*, 51.

Kiyotaki, N. and J. Moore (1997): "Credit Cycles." Journal of Political Economy 105(2), 211-248.

Lambertini, L., Nuguer, V. & Uysal, P. (2017), 'Mortgage default in an estimated model of the US housing market', *Journal of Economic Dynamics and Control* 76, 171–201.

McLeay, M., A. Radia and R. Thomas (2014a), "Money in the Modern Economy: An Introduction", *Bank of England Quarterly Bulletin* Q1, 4-13.

McLeay, M., A. Radia, and R. Thomas (2014b), "Money Creation in the Modern Economy", *Bank of England Quarterly Bulletin* Q1, 14-27.

Quint, M. D. & Rabanal, P. (2013), 'Monetary and macroprudential policy in an estimated DSGE model of the euro area', *IMF Working Paper* (13-209).

Rotemberg, J. J. (1984), 'A monetary equilibrium model with transactions costs', *Journal of political Economy 92(1)*, 40–58.

Rubio, M. & Carrasco-Gallego, J. A. (2014), 'Macroprudential and monetary policies: Implications for financial stability and welfare', *Journal of Banking & Finance* 49, 326–336.

Sangaré, I. (2019), 'Housing sector and optimal macroprudential policy in an estimated DSGE model for Luxembourg', *Central Bank of Luxembourg, Working Paper Series* N° 129.

Schmitt-Grohé, S. and Uribe, M. (2004), "Optimal Fiscal and Monetary Policy under Sticky Prices", *Journal of Economic Theory*, 114, 198-230.

Schmitt-Grohé, S. & Uribe, M. (2007), 'Optimal simple and implementable monetary and fiscal rules', *Journal of monetary Economics 54(6)*, 1702–1725.