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Shadow banking, macroprudential regulation and redistributional effects*

Margarita Rubio

Economics, University of Nottingham, Nottingham, UK

ABSTRACT

This paper studies the implications of increasing the size of the shadow banking sector for economic activity, financial stability, and welfare. I consider a DSGE model in which lending can come from two different sources; a formal bank or private lending. Banking regulation, in the form of capital requirements, only applies to the formal banking sector. Private lenders represent the shadow banking system. Results show that an increase in shadow banking leads to a higher amount of credit in the economy, which in turn implies higher consumption by borrowers. However, after a certain threshold, a large proportion of shadow banking is welfare decreasing. Moreover, the presence of an unregulated banking sector can lead to unintended effects of macroprudential policy. That is, stricter regulation in the traditional banking sector by the authorities may result in an increase in credit flows to those banks with lower regulatory levels, especially when this regulation comes from borrower-based instruments. Thus, macroprudential authorities should take into account these redistributional effects of shadow banking when considering their regulatory perimeter.

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> Shadow banking, as usually defined, comprises a diverse set of institutions and markets that, collectively, carry out traditional banking functions – but do so outside, or in ways only loosely linked to, the traditional system of regulated depository institutions. Former US Federal Reserve Chair Ben Bernanke, November 2013

1. Introduction

In the aftermath of the financial crisis, there is consensus on the need for macroprudential policies to smooth the financial system and therefore enhance its resilience. However, the jurisdiction to which macroprudential policies are applied may matter for their effects. If there are financial institutions that escape regulation, this latter may not have the desired effects on financial stability.

This is precisely the case with shadow banking. The definition of shadow banking is broad but it usually responds to the following features: (i) in credit intermediation, it performs a function similar to that of regular banks, and (ii) shadow banking entities are neither subject to banking regulation or oversight, nor do they have access to deposit guarantee schemes or central bank money (see Hodula et al. 2020 for other definitions of shadow banking).[1] Thus, shadow institutions are not subject to the same prudential regulations as traditional banks.[2] In the shadow banking system, credit intermediation takes place in an environment where prudential

CONTACT Margarita Rubio margarita.rubio@nottingham.ac.uk

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regulatory standards and supervisory oversight are either not applied or are applied to a materially lesser or different degree than is the case for regular banks engaged in similar activities. Shadow banking poses then regulatory arbitrage concerns: on the one hand, shadow banking activity can be used to circumvent and undermine banking regulations, leading to unintended spillovers of regulation. Moreover, when non-bank financial entities, which are subject to no regulation or a lighter regulation, undertake bank-like functions, large risks are created which could potentially be destabilizing for the entire financial system.[3]

Shadow banking has grown in importance to rival traditional banking, and was a primary factor in the subprime mortgage crisis of 2007–2008 and the global recession that followed. In fact, during the 90s, the shadow banking system steadily gained ground on the traditional banking sector and actually surpassed the banking sector for a brief time after 2000.[4] After the crisis, the shadow banking sector has kept growing significantly. A large proportion of this activity centers on the creation of collateralized loans. Non-bank lenders account for an increasing share of mortgages in the United States and other countries.[5] However, estimating the actual size of the shadow banking system is particularly difficult because many of its entities do not report to government regulators. Although the shadow banking industry plays a critical role in meeting rising credit demand in the United States, its operation outside of traditional banking regulations raises concerns over the financial risk it poses to the financial system. The reforms enacted through the 2010 Dodd-Frank Act focused primarily on the banking industry, leaving the shadow banking sector largely intact. However, as the financial system becomes increasingly reliant on non-bank financing, it gives rise to both economic gains and new vulnerabilities. It is therefore a key priority to transform shadow banking into resilient market-based finance.

To understand the rapid growth of shadow banking, both supply-side and demand-side aspects need to be taken into account. On the supply side, shadow banking comes from regulatory arbitrage. From the demand side, it comes from the increase in demand for safe and highly liquid investment opportunities from outside the financial sector. However, both regulatory arbitrage and riskier investment opportunities may become a threat to financial market stability if it creates systemic risks. In view of the experience faced during the financial crisis, it is important to analyze the specific risks of shadow banking to financial stability and assess whether they may call for the same financial market business to be subject to the same regulatory rules.

Like regular banks, shadow banks provide credit and generally increase the liquidity of the financial sector. In contrast to traditional banks, shadow banks do not take deposits. Instead, they rely on short-term funding, in which borrowers offer collateral as security against a loan. Shadow banking institutions generally serve as intermediaries between investors and borrowers, providing credit and capital for investors, institutional investors, and corporations, and profiting from fees and/or from the arbitrage in interest rates. Just like a traditional lender, the private lender will register their interest on the title of the property of the borrower. Most private lenders will not provide loans that go beyond a loan to value (LTV) ratio of 75 to 85 per cent. Due in part to their specialized structure, shadow banks can sometimes provide credit more cost-efficiently than traditional banks. In the US, prior to the 2008 financial crisis, the shadow banking system had overtaken the regular banking system in supplying loans to various types of borrower; as they are often less risk averse than regular banks, entities from the shadow banking system will sometimes provide loans to borrowers who might otherwise be refused credit. However, while all investments expose the investor to some level of risk, the unknown consequences of having such a large shadow banking system may lead some investors to prefer more conservative investment strategies.

In fact, shadow banking activities constitute a very useful part of the financial system. The main advantages of shadow banks lie in their ability to lower the transaction costs of their operations, their quick decision-making ability, customer orientation and prompt provision of services. Notwithstanding the complementary role played by shadow banks to the banking system, their activities, on the flip side, create risks which can assume a systemic dimension, due to their complexity, cross-jurisdictional nature, as well as their interconnections with the banking system.[6]

In this paper, I touch upon these issues, providing an analytical framework to disentangle the mechanisms behind the implications of a shadow banking sector, in terms of redistributional effects and regulation. I use a DSGE model with housing, and two types of agents; borrowers and savers. Borrowers can borrow from private lenders, who represent the shadow banking system, and regulated banks. Borrowers face collateral constraints. Financial regulation comes in the form of both capital requirements and the loan-to-value ratio (LTV). However, private lenders are not subject to the same banking regulation as traditional banks. In the basic version of

the model, I consider the proportion of shadow banking to be fixed and exogenous. While this assumption is unrealistic, it helps us to understand the mechanisms of the model abstracting from a varying share of shadow banking. This understanding helps identifying the key questions that need to be analyzed. Within this setting, I study first how the proportion of shadow banking affects the dynamics of the model. Results show that shadow banks increase the availability of credit in the economy and this is beneficial for borrowers, because they can consume more of both consumption goods and housing, causing a redistributional effect. However this comes at the cost of more credit variability. Welfare analysis shows that even though shadow banking is initially beneficial for households, after a certain threshold, welfare starts to decrease. Then, I extend the model to endogeneize the proportion of shadow banking and I find that this proportion, in the steady state, mainly depends on the private lender and bank LTVs. LTVs directly affect the borrower choice on whether to obtain loans in the shadow or regulated banking sector because of the presence of collateral constraints. When there is a decrease in the banking sector LTV, borrowers will prefer to borrow from private lenders instead, that is, credit will flow to the industry that is less regulated. Then, I study how the presence of shadow banks may endanger the effects of Basel III. Results also show that if Basel regulation could also be applied to the shadow banking sector, it would be more effective in achieving its macroprudential goal of decreasing credit variability. That is, I find that, making regulation stricter through increasing the CRR is not as effective as it would be if there were not shadow banks. In other words, there are leakages or spillovers in regulation and lending flows to the less unregulated sector. Thus, I propose the use of stricter borrower-based measures on shadow banks to compensate this fact. Cutting the loan-to-value ratio (LTV) on shadow banks would at least partially 'undo' the undesired spillovers of banking regulation.

This paper is related to several strands of the literature. First, it is closely related to studies that analyze macroprudential rules in a DSGE setting, such as Kannan, Rabanal, and Scott (2012), Rubio and Carrasco-Gallego (2014), or Angelini, Neri, and Panetta (2014), among others. Nevertheless, this literature has not touched upon the implications of shadow banking for the effects of macroprudential policies. The paper also resembles the literature with two types of financing sectors, on the coexistence of banks and bondholders (among others, Chang, Fernández, and Gulan 2017; De Fiore and Uhlig 2011). The paper is also related to the literature that tries to explain the implications of shadow banking. For instance, Verona, Martins, and Drumond (2013) have a DSGE model with shadow banks in which they focus on the effects of monetary policy under the existence of this sector. However, they do not touch upon banking regulation. Luck and Schempp (2014), study the presence of shadow banking in a banking model of maturity transformation in which regulatory arbitrage induces the coexistence of regulated commercial banks and unregulated shadow banks. As in my paper, they find that the relative size of the shadow banking sector determines the stability of the financial system. Gola et al. (2017) analyze the Italian shadow banking system and find that it is possible to set up a well-balanced prudential framework, where both bank and non-bank regulation contribute to reducing systemic risks and regulatory arbitrage. Similarly, Wang and Zhao (2016), study the shadow banking system in China, focusing on its effects on the monetary policy transmission mechanism. Meeks, Nelson, and Alessandri (2017) use a macroeconomic model to study the effects of government securitized asset purchases on the shadow banking sector. Results are also related to some recent research papers such as Gebauer and Mazelis (2023) and Le et al. (2021). That is, tightening commercial banks would boost the shadow banking lending channel. In the present paper, which is a real model with no monetary policy, this action would generate more share of shadow banking and boost credit, consumption and welfare, up to a certain point. This implies an optimal proportion of shadow banking, which can be brought about by regulating the shadow banking. This conclusion was based on the model's dynamic response to a technology shock, where credit and consumption expand. In Gebauer and Mazelis (2023) and Le et al. (2021), the analysis is based on impulse responses to the monetary shock. That is, in response to monetary tightening, a higher regulation on commercial bank would boost shadow credit, but aggregate credit would decrease and so would output. These examples therefore advocate that tightening regulations on commercial banks can lower the effectiveness of monetary policy and that using monetary policy, rather than regulation, in order to achieve the financial stability. To my knowledge, my paper is the first one in which macroprudential policies, in the form of capital requirements and LTV regulation, are introduced in a DSGE framework together with shadow banking, looking at the interaction of the macroprudential toolkit. The heterogeneous nature of

the model, in the sense that it displays several types of consumers; borrowers, savers and banks, also allows us to see the different effects that shadow banking has among agents, that is, its redistributional effects.

The rest of the paper continues as follows. Section 2 presents some extra evidence on shadow banking. Section 3 describes the basic model. Section 4 displays results from simulations from the basic model, including welfare results. Section 5 introduces the full model with an endogenous size of the shadow banking sector. Section 6 describes the interaction between shadow banking and regulation and gives some policy recommendations. Section 7 concludes.

2. Evidence on shadow banking

The presence of shadow banking constitutes a growing concern for international policy institutions. The Financial Stability Board (FSB) closely monitors the evolution of this sector and raises issues on the risks it poses for financial stability. The FSB acknowledges that non-bank financing provides a valuable alternative to bank funding and helps support real economic activity, providing healthy competition for banks. However, its main concern is that it can become a source of systemic risk. To monitor these risks, the Financial Stability Board (FSB) has been conducting an annual monitoring exercise since 2011 to assess global trends and risks in the shadow banking system.[7]

According to its most recent report, the activity-based, narrow measure of shadow banking was $34 trillion in 2015, increasing by 3.2% compared to the prior year, and equivalent to 13% of total financial system assets and 70% of GDP of the jurisdictions analyzed. The aggregated numbers do not show considerable heterogeneity between jurisdictions in terms of the importance and growth of other financial intermediaries in the respective domestic financial and economic systems. Loans extended by other financial intermediaries have been growing in 14 jurisdictions and the euro area since 2011. In some jurisdictions the growth in these loans since 2011 has been substantial, increasing at an annual rate of 10% or more in Australia, China, Germany, Indonesia, Korea, and South Africa, with China reporting the highest increase of 35%. The euro area as a whole had the largest sector of other financial intermediaries at end-2015 with assets totaling 30 trillion, followed by the US (26 trillion), the UK (8 trillion), China (8 trillion), the Cayman Islands (6 trillion), Canada and Japan (each 4 trillion). Compared to 2011, the euro area's share of total other financial intermediaries increased marginally from 32% to 33%, whereas the US' share decreased from 33% to 28% and the UK's share from 14% to 9%. In particular, non-bank financial intermediation continued to grow in 2015 for 21 jurisdictions and the euro area, although at a more moderate rate compared to previous years. In terms of the relative size of the shadow banking sector, the US had the largest shadow banking sector across jurisdictions in 2015, representing 40% of the total shadow banking sector. The Cayman Islands reported the second-largest shadow banking sector, followed by Japan, and Ireland. Combined together, the US, the UK, and participating euro area jurisdictions represented 65% of the total global shadow banking in end-2015. According to the European Systemic Risk Board (ESRB), the EU financial system remains primarily bank-based, but the non-bank component of the financial system has grown much faster since the crisis. While the aggregate growth of bank balance sheets is flat, a measure of EU market-based financing (other financial institutions, or OFIs, and investment funds) has almost doubled since 2008, and insurance companies and pension funds (ICPFs) have grown by 65%. Thus, evidence shows that shadow banking has been increasing over time and that in some areas it represents a large share of total banking activities.[8]

In light of this evidence, the ESRB places the increasing presence of shadow banking at the top of its priorities, since it may represent risks for financial stability. The ESRB acknowledges that current macroprudential requirements mainly apply to bank credit, which is only one component of total credit. Therefore, macroprudential instruments to address financial stability risks beyond the banking sector should be part of a wider macroprudential policy strategy. Cizel et al. (2019) perfectly summarize the risks of a large presence of shadow banking. These authors focus on how macroprudential policy may shift activities and risks to both non-bank entities, that is, shadow banking, and market-based financing. They estimate empirically the unintended effects of these policies producing cross-sector substitution effects. Their results support the hypothesis that macroprudential policies reduce bank credit growth. In their sample, in the two years after the activation of macroprudential

policies, bank credit growth falls on average by 7.7 percentage points relative to the counterfactual of no measure. This evidence supports the idea that there is the need to extend macroprudential policy beyond banking, especially in advanced economies.

However, the development of this strategy needs to take account of different degrees of systemic risk in different parts of the financial sector, as well as weighing both the benefits of financial stability against the possible costs in terms of constraints on credit provision. The ESRB is also concerned about the lack of a comprehensive macroprudential policy framework that can cause activities and risks to migrate across sectors. The impact of migration across sectors is more nuanced, as a shift to more non-bank finance may also reflect a rise in new systemic risks. A lack of supervisory data and differences in the regulatory framework imply that such cross-sector migration is difficult to capture. Then, the development of macroprudential policy beyond banking is a key policy priority. As the non-bank financial sector grows and increases in systemic importance, it becomes more important to address financial stability risks beyond banking in a preventive manner. While all regulation seeks to strike the right balance between the costs and benefits of policy intervention, there is a strong case for a prudent approach to systemic risks in rapidly changing and developing areas of the financial system.

In this paper, I develop a model that constitutes a policy framework to evaluate the unintended effects of macroprudential policies when they leak to the shadow banking sector. The model aims to include all the relevant ingredients that account for the presence of a sector that is not regulated, that is, benefits and costs, as well as redistributional effects among agents.[9] Ultimately, some policy implications about how to approach regulation in this context can be given. The model is described in the next section.

3. The basic model

I consider an infinite-horizon economy. The economy is populated by the same measure of infinitely lived agents, borrowers, lenders and banks (financial intermediaries). Borrowers and lenders work, consume the final good and housing services; Borrowers can borrow and choose whether to borrow directly from private lenders or banks. In borrowing, borrowers face credit constraints from both types of institutions. Additionally, banks are credit constrained by regulation in how much they can borrow from private lenders, in other words, they are subject to capital requirements. Private lenders are not subject to banking regulation and therefore represent the shadow banking system of the economy.[10] There is a representative firm that converts household labor into the final good.

In this version of the model, the proportion of shadow banking is fixed and endogenous, while the liquidation technology in the two sectors is symmetric. While these are unrealistic assumptions, this basic model helps understanding the mechanisms that drive the results, abstracting from changes in the shadow banking share and asymmetries coming from other sources than regulation. These assumptions are however dropped in the extended version of the model.

3.1. Borrowers

Borrowers maximize their lifetime utility from the consumption flow. We denote with E_t the expectation operator conditional on time t information and with $\gamma \in (0,1)$ the borrowers' discount factor. Borrowers solve the following problem:

$$\max_{b_t^F, b_t^L, h_t, l_t} E_0 \sum_{t=0}^{\infty} \gamma^t \left(\ln c_t + j_t \ln h_t - \frac{(l_t)^\eta}{\eta} \right)$$

where c_t, h_t and l_t represent consumption at time t, the housing stock and working hours, respectively. I assume that $\log(j_t) = \log(j) + u_{Jt}$, where u_{Jt} follows an autoregressive process, where j is the steady-state value of the weight of housing. A shock to j_t represents a shock to the marginal utility of housing. These shocks directly affect housing demand and, therefore, can be interpreted as a proxy for exogenous disturbances to house prices or, in other words, as a house price shock. $1/(\eta - 1)$ is the labor supply elasticity, $\eta > 0$. Subject to the flow of funds:

$$c_t + q_t (h_t - h_{t-1}) + R_{t-1}^F b_{t-1}^F + R_{t-1}^L b_{t-1}^L = b_t^F + b_t^L + w_t l_t \tag{1}$$

Variables and parameters with the superscript L refer to private lenders, while the superscript F denotes the financial intermediary. Assuming that h_t is collateralizable, we denote m_F as the loan-to-value for the regulated banking sector and α the share of collateral which is pledged to this sector. m_L is the private lender (shadow banking) LTV for housing.[11] b_t^F, b_t^L, R_t^F and R_t^L are the share of borrowing and the interest rate for debt repayments in the regulated and unregulated sector, respectively. Then, the borrower faces the following borrowing constraints:

$$R_t^F b_t^F \leq m_F \alpha q_{t+1} h_t \tag{2}$$

$$R_t^L b_t^L \leq m_L (1-\alpha) q_{t+1} h_t \tag{3}$$

Borrowers choose labor and assets; in the basic model, the proportion of borrowing from private lenders and banks is assumed to be exogenous and the liquidation technology symmetric between the two lenders[12]; The first-order conditions are as follows:

$$\frac{1}{c_t} = E_t\left(\frac{\gamma R_t^F}{c_{t+1}}\right) + \lambda_t^F R_t^F \tag{4}$$

$$\frac{1}{c_t} = E_t\left(\frac{\gamma R_t^L}{c_{t+1}}\right) + \lambda_t^L R_t^L \tag{5}$$

$$\frac{j_t}{h_t} = E_t\left(\frac{1}{c_t} q_t - \frac{\gamma q_{t+1}}{c_{t+1}}\right) + \lambda_t^F m_F \alpha q_{t+1} + \lambda_t^L m_L (1-\alpha) q_{t+1} \tag{6}$$

$$w_t = (l_t)^{\eta-1} c_t \tag{7}$$

where λ_t^F and λ_t^L are the Lagrange multipliers of the bank and the private lender borrowing constraint, respectively. The first-order conditions are the consumption Euler Equations (4) and (5), asset demand (6), and labor supply (7).

3.2. Private lenders

Let us denote private lenders variables with a prime. Lenders enter each period with assets and a bond coming to maturity. They derive utility from consumption, leisure and from housing. They rent labor and lend b_t^L to borrowers, while receiving back the amount lent in the previous period times the agreed gross interest rate R_t^L, respectively.

Preferences are given by:

$$\max_{b_t^L, d_t, h_t', l_t} E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln c_t' + j_t \ln h_t' - \frac{(l_t')^{\eta}}{\eta}\right)$$

where $\beta \in (0,1)$ is their discount factor, which is assumed to be greater than γ, the discount factor for borrowers.[13]

Subject to the budget constraint:

$$c_t' + q_t\left(h_t' - h_{t-1}'\right) + b_t^L + d_t = R_{t-1}^L b_{t-1}^L + R_{t-1}^D d_{t-1} + w_t' l_t' \tag{8}$$

where d_t denotes bank deposits, R_t^D is the gross return from deposits.[14]

The first-order conditions for this optimization problem are as follows:

$$\frac{1}{c_t'} = \beta E_t\left(\frac{R_t^L}{c_{t+1}'}\right) \tag{9}$$

$$\frac{1}{c_t'} = \beta E_t\left(\frac{R_t^D}{c_{t+1}'}\right) \tag{10}$$

$$\frac{q_t}{c'_t} = \frac{j_t}{h'_t} + \beta E_t \left(\frac{q_{t+1}}{c'_{t+1}} \right) \tag{11}$$

$$w'_t = c'_t \left(l'_t \right)^{\eta - 1} \tag{12}$$

Equations (9) and (10) are the Euler equations for both types of bonds, the intertemporal conditions for consumption, which imply that savers smooth consumption over time. Equation (11) represents the intertemporal condition for housing, in which, at the margin, benefits for consuming housing equate costs in terms of consumption. Equation (12) is the labor-supply condition.

3.3. Banks (Financial intermediaries)

Banks solve the following problem:

$$\max_{d_t, b_t^F} E_0 \sum_{t=0}^{\infty} \delta^t \left[\log Div_t \right],$$

where $\delta \in (0,1)$ is the financial intermediary discount factor and Div_t are dividends. Subject to the budget constraint and the collateral constraint[15]:

$$Div_t + R_{t-1}^D d_{t-1} + b_t^F = d_t + R_t^F b_{t-1}^F, \tag{13}$$

where the right-hand side measures the sources of funds for the financial intermediary; household deposits and repayments from borrowers on previous loans. The funds can be used to pay back depositors and to extend new loans, or can be used as dividends. We assume here that dividends are transformed into consumption by banks, so that $Div_t = c_t^{''}$, denoting banks' variables with a double prime. As in Iacoviello (2015), I assume that the bank, by regulation, is constrained by the amount of assets minus liabilities, as a fraction of assets. That is, there is a capital requirement ratio. We define capital as assets minus liabilities, so that, the fraction of capital with respect to assets has to be larger than a certain ratio:

$$\frac{b_t^F - d_t}{b_t^F} \geq CRR. \tag{14}$$

Simple algebra shows that this relationship can be rewritten as:

$$d_t \leq (1 - CRR)\, b_t^F, \tag{15}$$

If we define $\chi = (1 - CRR)$, we can reinterpret the capital requirement ratio condition as a standard collateral constraint, so that banks' liabilities cannot exceed a fraction of its assets, which can be used as collateral[16]:

$$d_t \leq \chi b_t^F, \tag{16}$$

where $\chi < 1$. The first-order conditions for deposits and loans are as follows:

$$\frac{1}{c_t^{''}} = \delta E_t \left(\frac{1}{c_{t+1}^{''}} R_t^D \right) + \lambda_t^{''}, \tag{17}$$

$$\frac{1}{c_t^{''}} = \delta E_t \left(\frac{1}{c_{t+1}^{''}} R_{t+1}^F \right) + \chi \lambda_t^{''}, \tag{18}$$

where $\lambda_t^{''}$ denotes the multiplier on the financial intermediary's borrowing constraint. Financial intermediaries have a discount factor $\delta < \beta$. This condition ensures that the collateral constraint of the intermediary holds with equality in the steady state, since $\lambda^{''} = \frac{\beta - \delta}{\beta} > 0$. This binding constraint represents the second distortion of the model. The fact that financial intermediaries need to hold a certain amount of capital determines their dividends and therefore their consumption. Thus, like borrowers, they are not consumption smoothers.[17]

3.4. Firms

Firms produce the final consumption good. The problem for the final good firms is standard and static. They maximize profits subject to the production function by using labor from both types of households:

$$\begin{aligned} &\max_{l_t, l'_t} \Pi_t = y_t - w_t l_t - w'_t l'_t, \\ &y_t = A_t l_t^{\nu} l_t'^{1-\nu}, \end{aligned} \tag{19}$$

where A_t represents a technology parameter. The problem delivers the standard first-order conditions, which represent the labor-demand equations:

$$w_t = \frac{\nu y_t}{l_t}, \tag{20}$$

$$w'_t = \frac{(1-\nu)\, y_t}{l'_t}. \tag{21}$$

3.5. Equilibrium

The total supply of housing is fixed and it is normalized to unity:

$$h_t + h'_t = 1. \tag{22}$$

The goods market clearing condition is as follows:

$$y_t = c_t + c'_t + c''_t. \tag{23}$$

Labor supply (Equations (7) and (12)) and labor demand (Equations (20) and (21)) are equal to each other, so that labor markets also clear.

3.6. Welfare measure

To assess the normative implications of the different policies, I numerically evaluate the welfare derived in each case, for each agent of the model. As discussed in Benigno and Woodford (2012), the two approaches that have recently been used for welfare analysis in DSGE models include either characterizing the optimal Ramsey policy, or solving the model using a second-order approximation to the structural equations for given policy and then evaluating welfare using this solution. As in Mendicino and Andrea (2007), I take this latter approach to be able to evaluate the welfare of the three types of agents separately.[18] The individual welfare for borrowers, lenders, and the financial intermediary, respectively, is as follows:

$$W_t \equiv E_t \sum_{m=0}^{\infty} \gamma^{\,t} \left[\log c_{t+m} + j_t \log h_{t+m} - \frac{(l_{t+m})^{\eta}}{\eta} \right], \tag{24}$$

$$W'_t \equiv E_t \sum_{m=0}^{\infty} \beta^m \left[\log c'_{t+m} + j_t \log h'_{t+m} - \frac{\left(l'_{t+m}\right)^{\eta}}{\eta} \right], \tag{25}$$

$$W''_t \equiv E_t \sum_{m=0}^{\infty} \delta^m \left[\log c''_{t+m} \right]. \tag{26}$$

To make the results more intuitive, I present welfare changes in terms of consumption equivalents. The consumption equivalent measure defines the fraction of consumption that needs to be given up to equate the welfare under a new scenario to the welfare under the baseline (in this case, an economy with no shadow banking).[19] A

Table 1. Parameter values.

β	.99	Discount Factor for Savers
γ	.98	Discount Factor for Borrowers
δ	.965	Discount Factor for Banks
j	.1	Steady-State weight of Housing in Utility Function
η	2	Parameter associated with labor elasticity
ν	.64	Labor-income share for Savers
m_F	0.7	Bank LTV
m_L	0.9	Private Lending LTV
CRR	10.5	Capital Requirement Ratio
ρ	.9	Shock persistence

positive value means a welfare gain, hence indicates that the new scenario is more desirable from a welfare point of view. The derivation of the welfare benefits in terms of consumption equivalent units is as follows:

$$CE = \exp\left[(1-\gamma)\left(W^{SB} - W^{*}\right)\right] - 1, \tag{27}$$

$$CE' = \exp\left[(1-\beta)\left(W'^{SB} - W^{'*}\right)\right] - 1, \tag{28}$$

$$CE'' = \exp\left[(1-\delta)\left(W''^{SB} - W^{''*}\right)\right] - 1. \tag{29}$$

where the superscripts in the welfare values denote the benchmark case when there is no shadow banking and the case in which there is, respectively.[20]

4. Simulations

In this section, I study how the dynamics of the model change with the presence of shadow banking in the economy. In order to do that, I present impulse responses for three cases: the case in which there is no shadow banking and the whole banking sector is regulated, a case in which shadow banking represents 25% of the whole banking system and a third situation in which it represents 75%. In the same way, I also find the financial volatilities that these three cases have associated, to see the implications of shadow banking for credit variability, as well as a continuum of cases in which shadow banking increases in the economy. Finally, to study redistributional effects, I check how shadow banking affects welfare for the different agents in the model. The next subsection describes the parameter values used for calibration.

4.1. Parameter values

The model time period is a quarter. As in standard models, $\beta = 0.99$, implying an annual real interest rate of 4%; $\gamma = 0.98$, so that borrowers are more impatient thansavers.[21] As in Iacoviello (2015), δ is set to 0.965. The steady-state weight of housing in the utility function, j, is set to 0.1 in order for the ratio of housing wealth to GDP to be approximately 1.40 in the steady state, consistent with the US data. I set $\eta = 2$, implying a value of the labor supply elasticity of 1.[22] The labor-income share for savers is set to 0.64, following the estimate in Iacoviello (2005). The parameters describing the average liquidation ability (the LTVs) are set equal to $m_F = 0.7$ and $m_L = 0.9$ to reflect the fact that, although private lenders also offer collateralized lending, they tend to be looser in their collateral requirements. The CRR is set to 10.5 to match the Basel III accords. I assume that technology follows an autoregressive process with 0.9 persistence and a normally distributed shock. Table 1 presents a summary of the parameter values used:

4.2. Impulse responses

In this subsection, I present impulse responses to both a productivity shock and a house price shock, for comparison. Both shocks are expansionary and make borrowing increase. However, one comes from the supply side

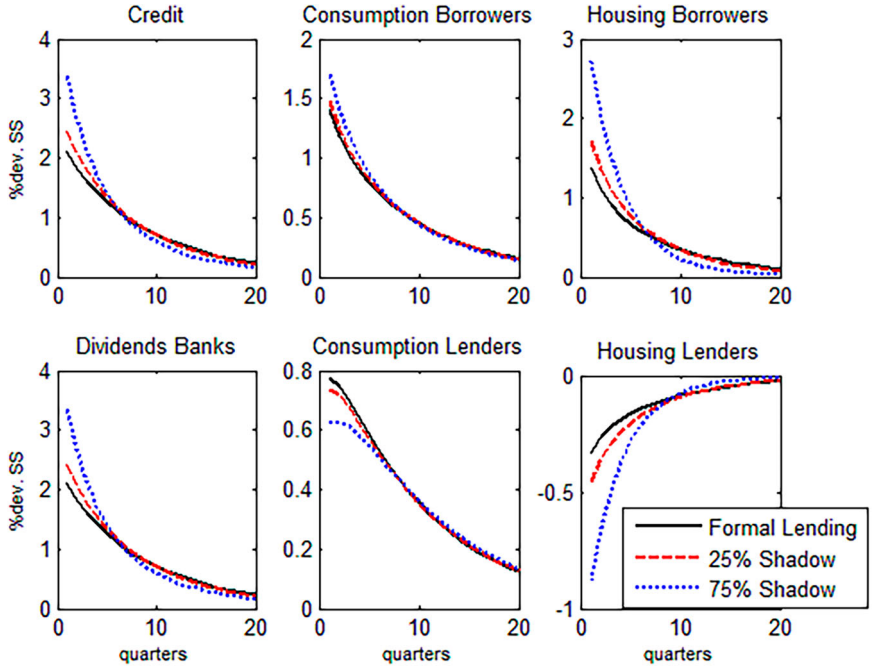

Figure 1. Impulse responses to a technology shock.

while the second one is demand and financially driven. The question that arises is whether the size of the increase in borrowing depends on the proportion of shadow banking in the economy.

In Figure 1, I display the responses for three different cases; one in which there is no shadow banking and all lending is made formally, a second case in which 25% of lending is made through shadow banking and a third case in which 75% of the banking system corresponds to non-regulated lenders. We see that, given a positive productivity shock, credit in the economy increases. However, when the shadow banking sector expands, credit flows increase by even more. Shadow banks are financial firms that perform similar functions to banks, thus its presence generates more credit. Shadow banks can help then increase economic activity by making financial services more widely available. We see that, thanks to shadow banks, borrowers are able to consume more consumption goods and housing, that is, there is a redistribution towards these agents. Banks' dividends also increase with shadow banking. Nevertheless, this comes at the expense of lenders that need to increase their saving to face borrowers' needs and can therefore consume less consumption goods and housing, as a mirror image of what happens to borrowers.

Figure 2, in contrast, displays impulse responses for a house price shocks, also for the same three different cases. We see that, for a demand shock, impulse response results are in the same line as the one for the supply shock. Given a positive productivity shock, because of the collateral effect, credit in the economy also increases as in the case of the technology shock. When the proportion of the shadow banking sector increases, on impact, the increase in credit is larger although it undershoots after some periods. The rest of the variables in the model follow accordingly. The dynamics of the model show the positive effects of having an unregulated sector in the economy. Credit flows more easily and this can finance more productive activities in the economy under both supply and demand shocks.

4.3. Credit variability

However, shadow banking may have both economic benefits and costs. On the positive side, we have seen that shadow banks can help fuel consumption among borrowers. They may also be able to offer services that banks cannot by being less strict in their collateral requirements. However, given that they are not regulated, their

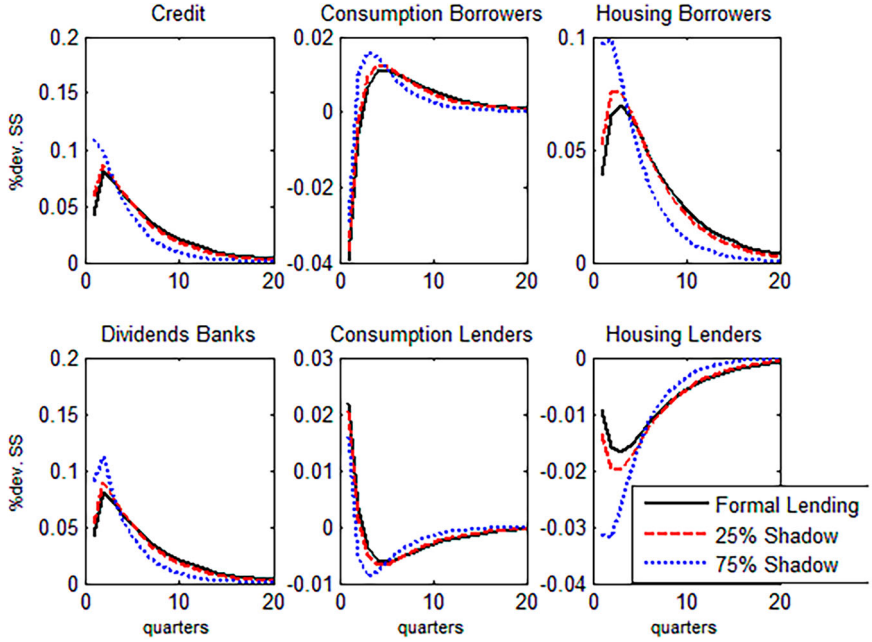

Figure 2. Impulse responses to a house price shock.

Table 2. Credit variability and shadow banking.

	$\sigma(b)$
Formal Lending	4.5122
Shadow Banking (25%)	4.8899
Shadow Banking (75%)	5.7433

presence may increase the risks for financial stability, which is the main reason why there is a focus on shadow banks today. Although shadow banks can help spur the economy by making financial services cheaper and more widely available, there can be a trade-off in terms of reduced financial stability. One reason for this trade-off is that banks, for example, are generally required to have significantly more capital and liquidity than shadow banks may choose to carry, because they are less regulated. Furthermore, shadow banks often lend to riskier customers or in riskier forms, such as by foregoing collateral protection that a bank would require. They also generally operate with much less regulatory supervision, which is designed to curb excessively risky behavior. As result of all this, shadow banks tend to be substantially less stable than banks.

In the model, although it is not possible to account for risk, I use the standard deviation of credit as a proxy for financial stability, in the sense that the banking system will be more stable the lower the volatility of credit is.[23]

Table 2 displays the standard deviation of credit for the three cases studied in the previous subsection. We can see from the table that the standard deviation of credit increases with the presence of shadow banking in the economy. Note that the larger the proportion of shadow banking, the more the credit is relying on a sector which is not collateralized, in the sense that there are no capital requirements. The collateral constraint on banks creates a direct relationship between capital requirements and the volatility of credit and borrower consumption. Thus, in the model, shadow banking increases credit variability, which is not in the interest of the financial regulator. Figure 3 conveys these results for a continuum of values of the proportion of shadow banking. We see that, unambiguously, a larger share of informal lending in the economy increases credit volatility. Thus, the model displays a trade-off in the presence of shadow banking; on the one hand, it fuels credit to the economy, making borrowers more able to consume, but this comes at the expense of more variability in credit markets.

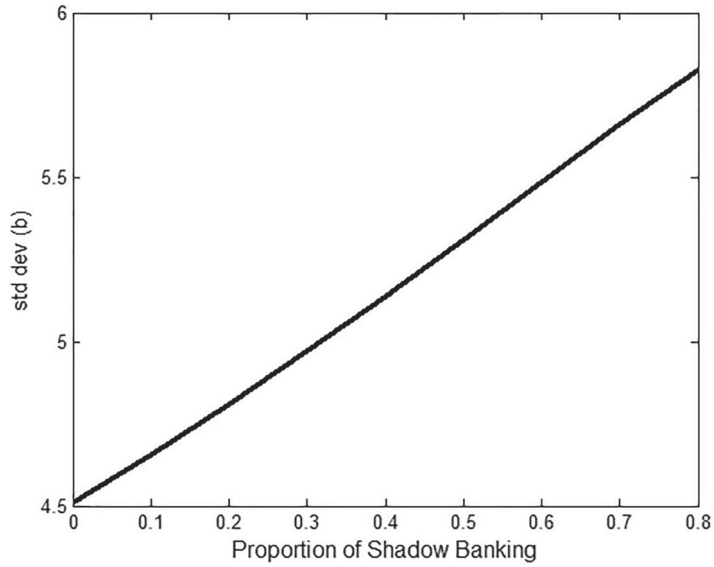

Figure 3. Shadow banking and credit variability.

4.4. Welfare results

Given the costs and benefits of the presence of shadow banking, the next question that arises relates to welfare. In order to give some policy recommendations, it is important to assess the effects of an unregulated sector on the different agents in the economy.

Figure 4 presents welfare values, in consumption equivalents for the different agents of the model, for an increasing proportion of shadow banking in the economy.[24] The benchmark scenario is when the proportion of shadow banking in the economy is inexistent. The horizontal axis represents an increase in this proportion, while the vertical one displays welfare values. This figure conveys the results that we have seen in previous subsections. The top-left panel shows that households' welfare initially increases because of the increase in credit flow in the economy. However, the trade-off that this represents with respect to credit variability makes that benefits start to fade away after a certain threshold and that a large proportion of shadow banking ends up not being welfare enhancing anymore. The lower-left panel of the figure helps understand these results. For lenders, who are not collateral constrained, shadow banking is unambiguously welfare decreasing. When the proportion of the unregulated sector increases, private lenders need to save more to give loans to borrowers and this decreases their consumption and therefore their welfare. However, for borrowers, even though shadow banking represents more availability of credit and consumption, it implies higher credit volatility. These agents have a collateral constraint that does not allow to smooth consumption through a regular Euler equation. Higher volatility of borrowing directly implies higher volatility of consumption, through the collateral constraint. Therefore, even though they benefit from the credit flow increase, these benefits start to decrease when credit variability becomes a burden. For the sake of completeness, I also present welfare values for banks. Banks are also collateral constrained individuals and therefore are also affected by credit variability. Although a higher proportion of shadow banking increases their dividends, as we have seen in impulse responses, as for borrowers, an increase in the volatility of credit markets also affects them negatively.

From the graph, we can infer that the proportion of shadow banking that maximizes households' welfare is around 30%. Beyond this threshold, welfare gains start to decrease and even become negative for larger values of this proportion.[25]

Now, the natural follow-up question would be to assess what are the regulating factors that affect the proportion of shadow banking. To do that, the assumption of the exogeneity of this share has to be dropped. The next section presents the full model in which the proportion of shadow banking is an endogenous choice.

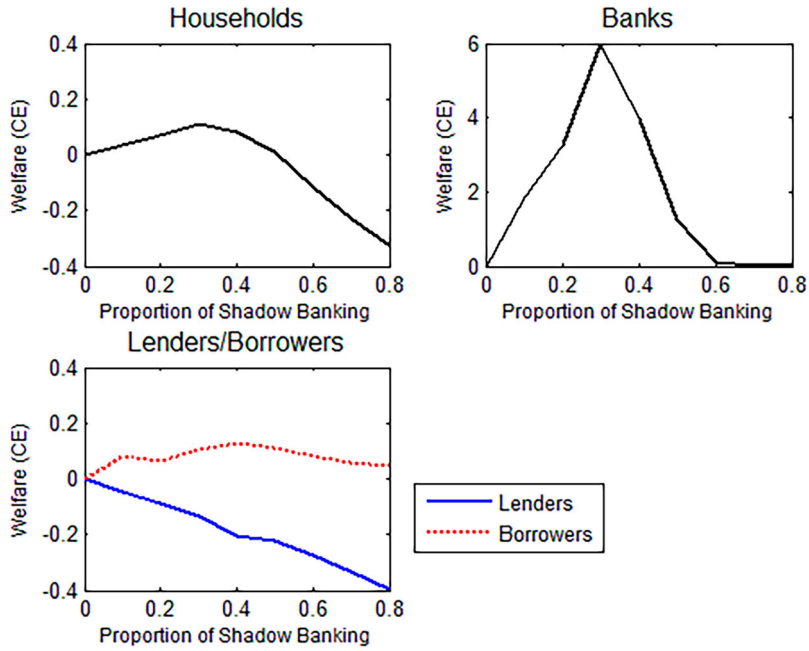

Figure 4. Welfare values (Consumption Equivalents) implied for different proportions of shadow banking.

5. The full model: allowing for endogenous α

In the full model, I allow for an endogenous choice of α, the proportion of shadow banking. This is a more realistic assumption. I also assume different liquidation technologies across lenders. The official sector typically has a better monitoring technology and better ability to recover loans than shadow bankers and therefore efficiency is lost when resources are shifted to the shadow banking sector. This is taken into account in this extended version of the model. In this way, I can account for the influence of regulation on the share of shadow banking in the economy. Then, the problem of the borrowers becomes the following:

$$\max_{b_t^H, b_t^F, h_t, l_t, \alpha_t} E_0 \sum_{t=0}^{\infty} \gamma^t \left(\ln c_t + j_t \ln h_t - \frac{(l_t)^\eta}{\eta} \right)$$

subject to the flow of funds:

$$c_t + q_t (h_t - h_{t-1}) + R_{t-1}^L b_{t-1}^L + R_{t-1}^F b_{t-1}^F = b_t^L + b_t^F + w_t l_t \tag{30}$$

And subject to the following borrowing constraints:

$$R_t^F b_t^F \leq m_F \alpha_t q_{t+1} h_t \tag{31}$$

$$R_t^L b_t^L \leq q_{t+1} (1 - \alpha_t) h_t \left(1 - (1 - m_L) \frac{q_{t+1} (1 - \alpha_t) h_t}{qh} \right) \tag{32}$$

The collateral constraint on private lenders displays decreasing returns to scale in their liquidation technology.[26] This reflects the fact that, on the one hand, shadow bankers are perceived as a riskier choice by borrowers and, on the other hand, it may result in being more difficult for private lenders to liquidate the collateral because they are not backed up by institutions and because they tend to offer loans to riskier borrowers and they may have more difficulties in recovering their collateral.[27] Borrowers choose labor and assets; how much to borrow from

banks and private lenders; how to allocate shares α_t of assets between the regulated and the unregulated sectors. The first-order conditions are as follows:

$$\frac{1}{c_t} = E_t\left(\frac{\gamma R_t^F}{c_{t+1}}\right) + \lambda_t^F R_t^F \tag{33}$$

$$\frac{1}{c_t} = E_t\left(\frac{\gamma R_t^L}{c_{t+1}}\right) + \lambda_t^L R_t^L \tag{34}$$

$$\frac{j_t}{h_t} = E_t\left(\frac{1}{c_t}q_t - \frac{\gamma\, q_{t+1}}{c_{t+1}}\right) + \lambda_t^F m_F \alpha_t q_{t+1} + \lambda_t^L\left(1-\alpha_t\right) q_{t+1}\left(1 - \frac{2\left(1-m_L\right)\left(1-\alpha_t\right) q_{t+1} h_t}{qh}\right) \tag{35}$$

$$\lambda_t^F m_F = \lambda_t^L E_t\left(1 - \frac{2\left(1-m_L\right)\left(1-\alpha_t\right) q_{t+1} h_t}{qh}\right) \tag{36}$$

$$w_t = \left(l_t\right)^{\eta-1} c_t \tag{37}$$

The first-order conditions are the consumption Euler Equations (34) and (33), asset demand (35), choice of α_t (36), and labor supply (37).

From Equations (33), (34) and (36), we can solve for α_t:

$$\alpha_t = 1 - \frac{1 - \left(\lambda_t^F/\lambda_t^L\right) m_F}{1-m_L}\frac{qh}{2q_{t+1}h_t}$$

If we find the value of α_t in the steady state, we obtain:

$$\alpha = 1 - \frac{1-m_F}{2\left(1-m_L\right)} \tag{38}$$

Therefore, in the steady state, the share of collateral devoted to formal banking will be positively related to the average bank loan-to-value ratio (m_F) and inversely related to average private lender loan-to-value ratio (m_L). We see that the proportion of shadow banking in the economy directly depends on LTV regulation.[28]

6. Shadow banking and regulation

6.1. LTV regulation

LTV limits are a borrower-based macroprudential measure that has been widely considered as part of the macroprudential toolkit that authorities have to ensure financial stability. While the Basel accords apply internationally, individual countries can also play with other instruments in their search for financial stability.

Throughout the paper, I have assumed that the LTV which is applied in shadow banks is higher than the one for the traditional banking sector, reflecting the fact that the shadow banking sector has looser standards than the formal one. However, if the LTV for shadow banks could be lowered to the level of the formal banking LTV, this would have effects for credit variability.

Figure 5 shows impulse responses to a technology shock for three alternative values of the shadow banking LTV. Changing the LTV for shadow banks has dynamic effects. We see that cutting this LTV, that is making regulation stricter, has distributional effects between the shadow and the formal lending, in the sense that the sharpest increase in shadow lending happens when the LTV in this sector is the lowest.

In turn, Table 3 displays the standard deviation of borrowing for the same values of the shadow banking LTV considered above. We can see that cutting the LTV applied in shadow banks has beneficial effects for credit volatility.

Equation (38) shows that the steady state level of α, the proportion of shadow banking in the economy, is directly related to the LTV in this sector. That is, the stricter the regulation in the shadow banking sector, the less important this sector becomes. This also reflects leakages in LTV regulation. Figure 6 displays how the steady-state share of shadow banking changes with regulation on the LTV. As we have seen, the proportion of shadow

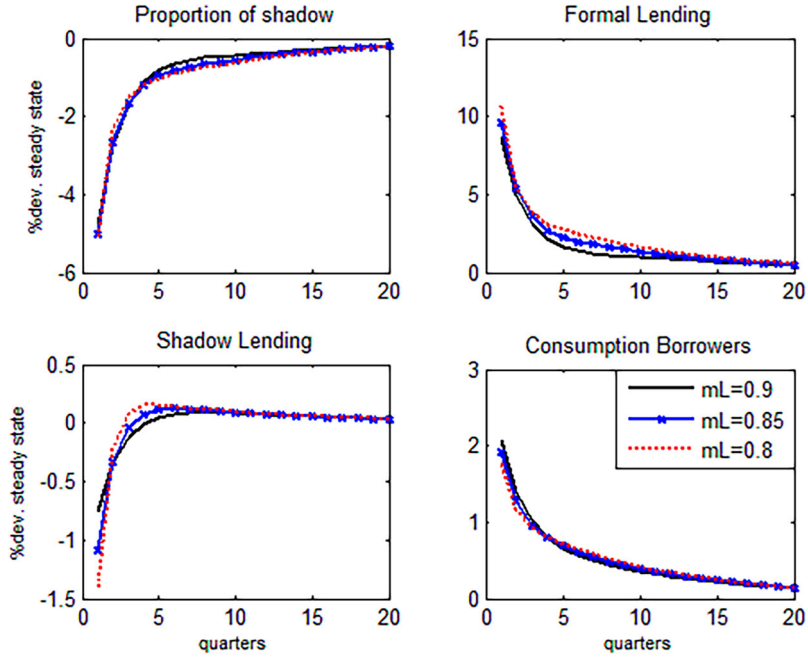

Figure 5. Impulse responses of a technology shock for alternative LTV.

Table 3. LTV and credit variability.

mL	0.9	0.85	0.8
$\sigma(b)$	5.8027	5.5578	5.1234

banking is directly related to LTV regulation because it is a borrower's decision. Borrowers are particularly concerned about this regulation because it directly affects their collateral constraint. LTV regulation is typically a national decision. For instance, at the EU level, LTV together with other borrower-based measures depends on national macroprudential authorities. However, the perimeter to which this regulation can be applied is usually confined to the domestic banking sector.

In Figure 6, the black solid line corresponds to the change in the proportion of shadow banking when the LTV regulation in the formal banking system changes. The red dotted line represents the change in the proportion of shadow banking when the shadow banking LTV changes. This graph already gives us an idea on how regulation in the banking system affects the share of shadow banking, particularly if it is not accompanied by a change in regulation in the unregulated sector in the same direction. These effects on the share would represent leakages from regulation. We see that when banking regulation in the formal sector becomes looser, that is, m_F increases for a given m_L, credit will flow to this sector in a linear way and the proportion of shadow banking decreases. By the same token, stricter LTV regulation on the banking system would make credit go to the non-regulated sector. Conversely, if the shadow banking sector were regulated and this regulation was made stricter, for instance, cutting the LTV in shadow banking, the proportion of credit in this latter sector would decrease. Nevertheless, notice that this decrease is non linear, reflecting the decreasing marginal ability of private lenders to extract value from borrowers' assets. Thus, financial regulation does leak to the less regulated sector, representing the unintended spillovers that regulation may have.

6.1.1. Policy implications

In the previous section, with an exogenous proportion of shadow banking, we saw that households' welfare is maximized when the shadow banking share is around 30%. From graph Figure 6 we see that in order to

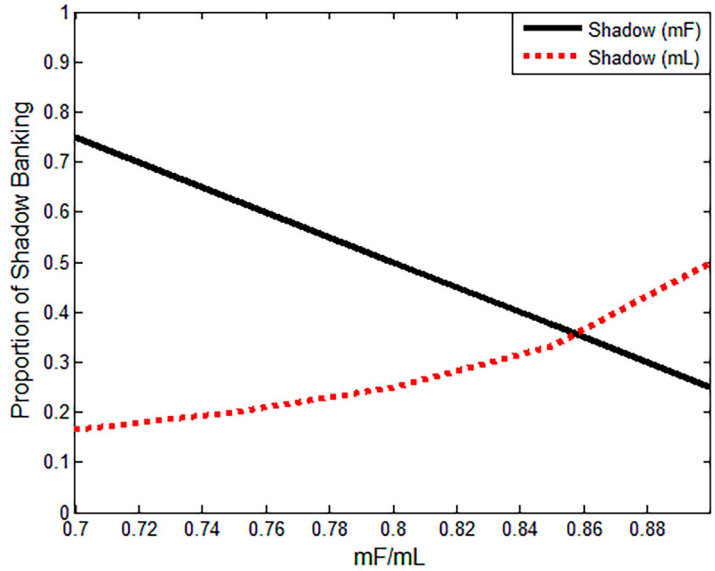

Figure 6. Proportion of shadow banking with LTV regulation.

endogenously achieve this proportion there are two options: either cut the private lending LTV, not allowing LTVs to go beyond 80%, or to make the LTV regulation on the formal banking sector looser, with LTV closer to 90% to attract more borrowers. In the search for credit stability, deregulating the formal banking sector to decrease the proportion of shadow banking would play against its final goal. The second option, which is consistent with the pursuit of the macroprudential objectives, but difficult to implement in practice would be to try to impose some limits on shadow banking LTVs. The ESRB has repeatedly reported its concerns on the issue. The policy discussion focuses on whether the regulatory perimeter on LTVs and other national borrower-based measures should be extended. In light of these results, it seems appropriate to make an effort in supervising those unregulated entities and trying to enforce some limits in LTVs, so that the share of shadow banking does not reach values that can decrease welfare.

6.2. Basel regulation

The regulatory perimeter of Basel III is also an issue of concern because of its implications on financial stability. Capital regulation on banks may also affect the proportion of shadow banking in the economy and therefore the effects that this policy may have on financial stability. However, this regulation on capital requirements, unlike the LTV regulation, does not affect the steady-state value of this share. The allocation of funds to shadow banking is a borrower's decision and their credit demand is directly influenced by the collateral constraint, which becomes more or less tight with the LTV. Thus, the LTV directly affects this choice. Nevertheless, this does not mean that regulations on bank capital do not affect this decision at all, but they do it in an indirect way, since they determine the total amount of credit that is available in the economy. Then, although it is not affecting the size of shadow banking in the steady state, it does affect it dynamically.

As we know, capital regulation on banks is settled internationally by Basel accords. Nonetheless, Basel regulation on capital just applies to traditional banks, shadow banking escapes this regulation.

Figure 7 illustrates precisely this point. The graph shows impulse responses to a technology shock when the model is calibrated to two alternative scenarios; the first one corresponds to capital requirements imposed by Basel I and II, that is 8%, while the second one would illustrate a stricter regulation, like the one in Basel III, that is 10.5%. We can observe that the dynamic properties of the model change with CRR regulation, as expected. A technology shock, which is an expansionary shock for the economy, decreases the proportion of shadow lending. However, given the same size of the shock, when the Basel regulation becomes stricter, this decrease is not as

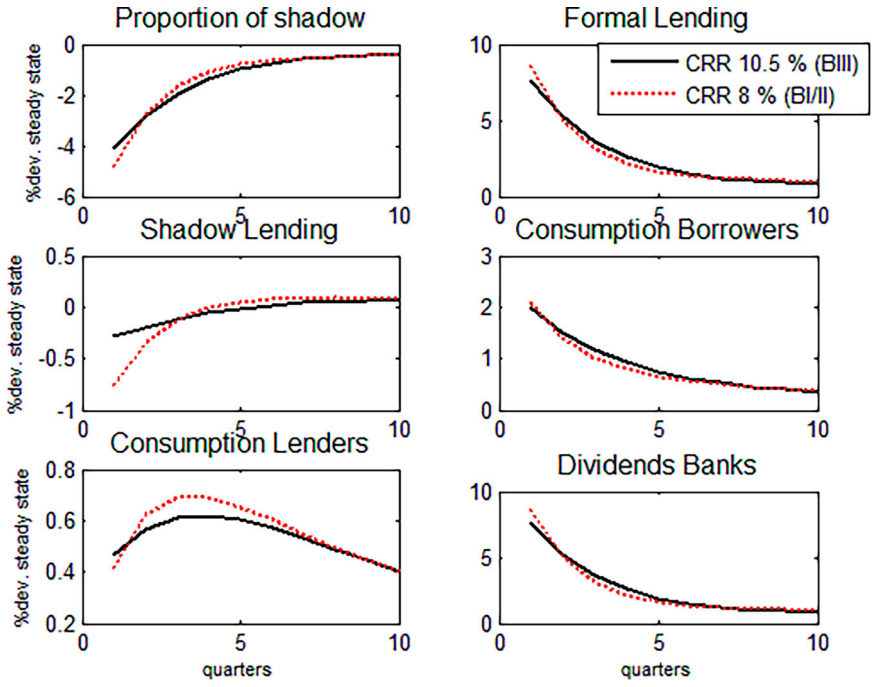

Figure 7. Impulse responses to a technology shock. Basel III versus Basel I/II Regulation.

Table 4. Basel regulation and financial stability.

	Basel I/II Formal Banking	Basel III Formal Banking	Basel III All Banks
$\sigma(b)$	5.8629	5.8027	4.5122

sharp. Borrowers consumption is about the same in both cases, because regardless of where the funding comes from, they consume a similar amount. Lenders can consume more in the situation in which there is less shadow banking because they do not need to save as much funding for borrowers.

In terms of financial stability, CRR regulation also has implications. Table 4 displays the standard deviation of borrowing, as a proxy for financial stability, under Basel I/II and Basel III regulation. We see that introducing a stricter regulation, as in Basel III, is beneficial for financial stability because it reduces the volatility of credit. However, in the hypothetical case in which not only the formal banking sector could be regulated but also the shadow one, the beneficial effects on financial stability could be even stronger. This result has an important policy message: if the shadow banking sector could be regulated, macroprudential policies would be more effective in the pursuit of financial stability. Therefore, the concerns that the presence of shadow banking may unintentionally 'undo' the beneficial effects that banking regulation may have on financial stability are well justified.

6.2.1. Policy implications

The above results show that the macroprudential purpose of Basel III is maximized when all banks are regulated. Nevertheless, we must remember that the presence of a shadow banking sector has both advantages and disadvantages. Getting rid of the shadow banking in full would be positive for financial stability but would definitely destroy the investment opportunities that an unregulated sector brings to the economy. Both sectors coexisting make credit flow more easily, especially to those individuals with difficulties in accessing the formal credit market.

Table 5. Basel III and financial stability.

mL	0.9	0.8
$\sigma(b)$	5.4983	4.9826
Household welf gain (CE)	–	0.0095
Total welf gain (CE)	–	0.0023

The Basel committee should take into account both benefits and costs of shadow banking when considering the extension of their regulatory perimeter. According to the findings in Figure 4, regulating all banks in the economy would not the optimal thing to do. There are benefits from having a shadow banking sector that should not be overlooked. Therefore, the Basel committee, without necessarily aiming at regulating all financial activities in the economy, should make sure that the proportion of non-regulated banks is within the range of welfare-enhancing values (i.e. within values around 30%, according to the model).

7. Policy recommendations: interactions between basel III and the LTV

Having shown that the presence of shadow banks in the economy has implications for both capital requirements and the LTV regulation, we can assess some policy recommendations for the current state of the Basel accords. Basel III regulation implies a CRR of 10.5% plus a countercyclical buffer. However, we know that, by definition, these measures cannot be applied to shadow banks. Nevertheless, given that the macroprudential toolkit is larger than just Basel III regulation, we can propose to complement Basel III with some LTV limit enforcement for shadow banks.

Figure 8 shows the dynamics of the model for Basel III as compared to also cutting the shadow bank LTV towards the level of the formal sector LTV. For a realistic description of Basel III, I also include a countercyclical buffer in the form of a countercyclical Taylor-type rule for the CRR:

$$CRR = CRR_{SS}\left(\frac{b_t^F}{b_{SS}^F}\right)^{\phi} \tag{39}$$

Equation (39) reflects an approximation on how the countercyclical buffer in Basel III is set in reality. The CRR stays at a fixed level, 10.5% in he case of Basel III, unless there are deviations of credit from its steady state. If credit goes beyond its steady state value, then the CRR must increase. The Basel guidelines specify that Basel III adds a countercyclical buffer as a macroprudential tool to avoid excessive credit growth, so that the CRR increases when there are signs of that. Here, I proxy this situation by deviations of formal lending from its steady state. I include formal lending in the rule because I assume that this is the one that macroprudential authorities can observe.

In Figure 8 we can see that, even though Basel III only applies to the formal banking sector, if it would be possible to enforce some limits in the shadow banking LTV, this would complement the macroprudential effects of Basel III.[29] That is, a borrower-based measure applied on the shadow banking system would create positive spillovers on financial stability that would compensate the negative ones created by the fact that Basel III banking regulation can only be applied to traditional banks.

Table 5 confirms these results. We see that when Basel III is complemented by a cut in the shadow banking LTV, the effects on financial stability are much larger, compensating the fact that banking regulation cannot be applied to the whole banking system. In Table 5, I also include the welfare gain (in consumption equivalents) of making regulation on the LTV stricter for the shadow bank sector. In line with the financial stability results, which show that this regulation would decrease the variability of credit, I also find that there is an implied welfare gain both for households and the total economy.[30]

8. Concluding remarks

In this paper, I provide an analytical framework to disentangle the mechanisms behind the implications of a shadow banking sector for financial stability and regulation. In the aftermath of the financial crisis, this is a

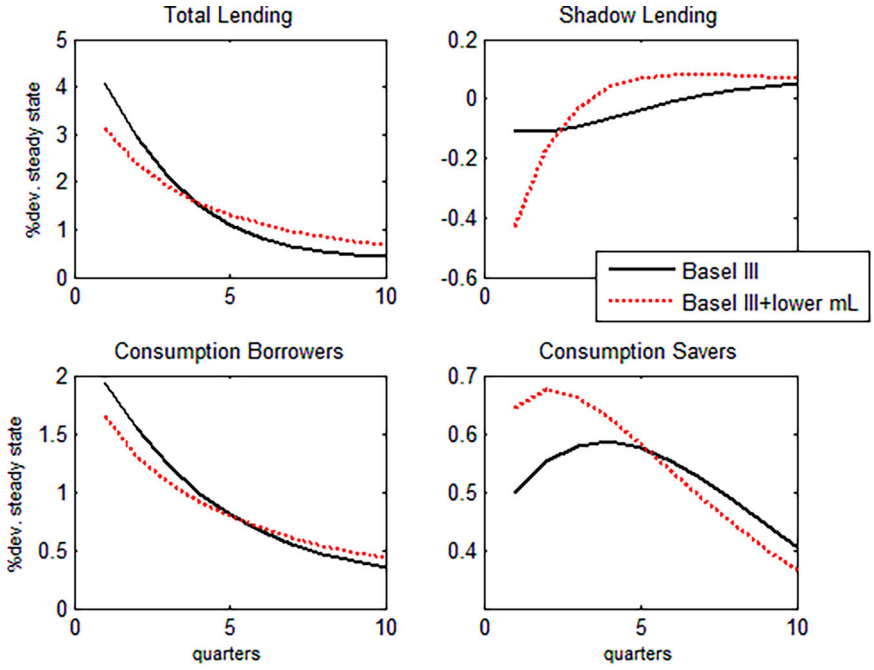

Figure 8. Impulse responses to a technology shock. Basel III (benchmark mL = 0.9) vs. Basel III (mL = 0.9).

much discussed topic. On the one hand, shadow banking is supposed to have beneficial effects for the economy, since it increases the overall availability of credit. However, on the other hand, it may pose risks to financial stability, a major concern these days.

To study this issue, I use a DSGE model with housing, and three types of agents; borrowers, savers and banks. Borrowers can decide whether to borrow from savers (private lenders), who represent the shadow banking system, or from regulated banks. Borrowers face collateral constraints for all types of credit. Financial regulation comes in the form of both capital requirements and the loan-to-value ratio (LTV). However, private lenders are not subject to the same banking regulation as traditional banks.

Within this setting, I study first how the proportion of shadow banking affects the dynamics of the model and financial stability. Results show that shadow banks increase the availability of credit in the economy and this is beneficial for borrowers, because they can consume more of both consumption goods and housing. However this comes at the cost of more instability in the financial system. Therefore there is a trade-off between the beneficial effects of shadow banking and its costs. Welfare analysis conveys these results. Even though shadow banking is initially beneficial for households, after a certain threshold, welfare starts to decrease. Then, I extend the model to endogeneize the proportion of shadow banking and I find that this proportion, in the steady state, mainly depends on the private lender and bank LTVs. LTVs directly affect the borrower choice on whether to obtain loans in the shadow or regulated banking sector because of the presence of collateral constraints. When there is a decrease in the banking sector LTV, borrowers will prefer to borrow from private lenders instead, that is, credit will flow to the industry that is less regulated. On the other hand, results also show that if Basel regulation could also be applied to the shadow banking sector, it would be more effective in achieving its macroprudential goal of bringing a more stable financial system.

The policy implications that come from these results are the following: In terms of LTV regulation, it seems appropriate to make an effort in supervising those unregulated entities and trying to enforce some limits in LTVs, so that the share of shadow banking does not reach values that can endanger financial stability and decrease welfare. On the contrary, the Basel committee should take into account both benefits and costs of shadow banking when considering the extension of their regulatory perimeter. Thus, without necessarily aiming to regulate all

financial activities in the economy, the implementation of Basel III should make sure that the proportion of non-regulated banks is within the range of welfare-enhancing values. Furthermore, a borrower-based measure applied on the shadow banking system would create positive spillovers on financial stability that would compensate the negative ones created by the fact that Basel III banking regulation can only be applied to traditional banks.

Notes

1. Hodula, Melecky, and Machacek (2020) compile several definitions of shadow banking: 'financial intermediaries that conduct maturity, credit, and liquidity transformation without access to central bank liquidity or public sector guarantees' (Pozsar et al. 2013), 'all financial activities, except regular banking, which rely on a private or public backstop to operate' (Claessens et al. 2012), 'financing of bank- and nonbank financial institutions through noncore liabilities constitutes shadow banking, regardless of the entity that carries it out' (IMF 2014).
2. See Association of German Banks (2014).
3. The global financial crisis demonstrated many ways in which shadow banking can have an impact on the global financial system, both directly and through its interconnectedness with the regular banking system, prompting the move to overhaul the regulation of the shadow banking system. The International Monetary Fund suggested that the two policy priorities should be to reduce spillovers from the shadow banking system to the main banking system and to reduce procyclicality and systemic risk within the shadow banking system itself.
4. See the Financial Crisis Inquiry Commission (2011).
5. See Elliott, Kroeber, and Qiao (2015).
6. See Financial Stability Board (2011).
7. The FSB defines shadow banking as 'credit intermediation involving entities and activities (fully or partly) outside of the regular banking system'.
8. See Irani et al., Hodula et al. (2020) and Hodula and Libich (2023).
9. There are some other papers in the literature that also employ macro-founded models to assess the implications of bank capital tightening, which increases lending by unregulated shadow banks (Begenau and Landvoigt 2022; Gebauer and Mazelis 2023) as well as securitization activities (Lubello and Rouabah 2024). There are a few empirical papers that show how macroprudential leakage may work using observed data (Cizel et al. 2019; Hodula and Ngo 2024).
10. Note that, in the model, shadow bankers have direct claims on the borrowers rather than the shadow banks obtaining funds through the financial intermediaries; the financial intermediation is implicitly assumed. Gertler, Kiyotaki, and Prestipino (2016) model a shadow banking sector that borrows from banks and lends borrowed funds to households. For simplicity, I model this sector resembling a model of bond-holders (direct finance) vs. banks and focus on regulation as the main difference between them, since this is the focus of the research question.
11. Although conditions tend to be more lax in the case of shadow banking, this sector mostly offers collateralized lending.
12. In a similar manner, Rubio (2011) also introduces an exogenous dichotomy in borrowing: fixed versus variable-rate mortgages.
13. In a neighborhood of the steady state equilibrium, the multipliers associated with the entrepreneurs' collateral constraints will be positive, so long as the entrepreneurial discount factor γ is lower than the households' discount factor β, which in turn prices bonds.
14. I follow Iacoviello (2015) in which the deposit rate for banks Is the same as the rate for lenders because lenders are basically the savers depositing in the banks. However, because the analysis focuses on the borrowing side, which is the one affected by regulation, a different deposit structure would not change the answer to the research question.
15. In a model without banks and a capital constraint, there would not be any spread between the lending and the deposit rate. The capital constraint is introducing an extra distortion in the economy that affects agents' welfare.
16. This constraint creates a relationship between capital requirements and the volatility of borrower consumption. Bank capital constraints provide a substantial benefit of reducing the sensitivity of consumption to house prices and avoiding financial problems.
17. The setup for private lenders follows Iacoviello (2005) in which there is direct financial intermediation. Iacoviello (2015) adds an explicit financial intermediary, but it is set up as an extra agent that maximizes a utility function on consumption (which can be interpreted as a dividend maximization problem). Iacoviello (2015) extends Iacoviello (2005) keeping the basic direct intermediation setting but adding a financial intermediary so that capital requirements can be accounted. The financial system setup in the present study is based on those papers.
18. I used the software Dynare to obtain a solution for the equilibrium implied by a given policy by solving a second-order approximation to the constraints, then evaluating welfare under the policy using this approximate solution, as in Schmitt-Grohe and Uribe (2004). See Monacelli (2006) for an example of the Ramsey approach in a model with heterogeneous consumers.
19. The benchmark scenario corresponds to a case in which all the lending is made under a formal banking sector, which is subject to capital requirement regulation. In this case, lenders deposit funds into financial intermediaries but do not directly lend to borrowers.
20. I follow Ascari and Ropele (2009) for the specification of consumption equivalent units.

21. Lawrence (1991) estimated discount factors for poor consumers at between 0.95 and 0.98 at quarterly frequency.
22. Microeconomic estimates usually suggest values in the range of 0 and 0.5 (for males). Domeij and Flodén (2006) show that in the presence of borrowing constraints these estimates could have a downward bias of 50%.
23. The measure adopted to proxy for financial stability, that is, credit variability, is widely used in the DSGE literature. I acknowledge that risks are not captured in the model, given the nature of the DSGE solving device, which is based on log-linearization.
24. Following Mendicino and Andrea (2007), Rubio (2011), and Brzoza-Brzezina, Kolasa, and Makarski (2013), I aggregate welfare taking into consideration the discount factor of each consumer. Then, household welfare is defined as: $W_t^{hh} \equiv (1-\gamma)W_t + (1-\beta)W_t^{'}$. In this way, all the groups receive the same level of utility from a constant consumption stream.
25. Quantitative results have to be taken with caution because they depend on the specific modeling strategy and on calibration.
26. Convex costs in liquidation ensure that there is an internal solution in the choice of α_t.
27. Find a similar specification in Iacoviello and Minetti (2006) with domestic and foreign lenders.
28. By fixing the LTV of the formal sector to 0.7, as in the benchmark calibration, a 30% proportion of shadow banking would imply an LTV on shadow banking or 0.78.
29. The model has two distortions; the nominal rigidity distortion (coming from sticky prices) and the collateral distortion (coming from the collateral constraint). Policies aim at easing the effects of the distortions. For instance, monetary policy would aim at price stability, which would reduce the nominal rigidity distortion. On the other hand, macroprudential policy (in the form of higher capital requirements or lower LTV) would aim at credit stability, which would soften the collateral distortion. This is why, more regulations on the financial side may be beneficial for the economy, because they reduce the collateral distortion.
30. Results calls for regulations on both types of banks simultaneously. This would work in the same way as tightening of monetary policy that can affect all sectors. However, the usage of monetary policy is relatively easy, while setting regulations, especially for the shadow banking sector, might be difficult and problematic since it composes of diverse and highly specialized institutions/individuals.

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No potential conflict of interest was reported by the author(s).

Data availability statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Notes on contributor

Margarita Rubio is an Associate Professor in Economics at the University of Nottingham. Previously, she held a full-time position at the Bank of Spain. She obtained her PhD in Economics in 2008 at Boston College (USA) with a dissertation entitled: 'Housing Markets, Business Cycles and Monetary Policy'. Margarita's research fields are Macroeconomics and Monetary Economics. Her research focuses on Dynamic Stochastic General Equilibrium Models with financial frictions. Her topics of interest include housing markets, housing finance, and its interrelation with business cycles and monetary policy, as well as macroprudential policies and its effects on the real economy, financial stability and welfare.

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