

# Shadow Banking, Macroprudential Regulation and Financial Stability\*

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## Abstract

This paper studies the implications of the presence of an unregulated shadow banking sector for economic activity, financial stability, and welfare. To explore this topic, I consider a Dynamic Stochastic General Equilibrium (DSGE) model with housing and collateral constraints for borrowers, 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, on the one hand, shadow banking leads to a higher amount of credit in the economy, which in turn implies higher consumption by borrowers, although at the expense of risks to financial stability. On the other hand, an unregulated banking sector can lead to unintended effects of macroprudential policy. Stricter regulation in the traditional banking sector 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 both costs and benefits 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 of 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, (ii) this function is performed frequently by several players interacting with each other, usually via the financial market, and, (iii) shadow banking entities are neither subject to banking regulation or oversight, nor do they have access to deposit guarantee schemes or central bank money.<sup>1</sup> Thus, shadow institutions are not subject to the same prudential regulations as traditional banks. In the shadow banking system, credit intermediation takes place in an environment where prudential 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.<sup>2</sup>

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

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<sup>1</sup>See Association of German Banks (2014).

<sup>2</sup>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.

surpassed the banking sector for a brief time after 2000.<sup>3</sup> 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.<sup>4</sup> 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

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<sup>3</sup>See the Financial Crisis Inquiry Commission (2011).

<sup>4</sup>See Elliott et al. (2015).

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.<sup>5</sup>

In this paper, I touch upon these issues, providing an analytical framework to disentangle the mechanisms behind the implications of a shadow banking sector for financial stability 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 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 endogenize 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

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<sup>5</sup>See Financial Stability Board (2011).

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 for achieving its macroprudential goal of bringing a more stable financial system.

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 et al. (2012), Rubio and Carrasco-Gallego (2014), or Angelini et al. (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, De Fiore and Uhlig, 2011; Chang et al., 2017). The paper is also related to the literature that tries to explain the implications of shadow banking. For instance, Verona et al. (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 Shempp (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 et al. (2017) use a macroeconomic model to study the effects of government securitized asset purchases on the shadow banking sector. 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. 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.

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 on 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.<sup>6</sup>

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 totalling \$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 at 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.

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<sup>6</sup>The FSB defines shadow banking as "credit intermediation involving entities and activities (fully or partly) outside of the regular banking system".

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.

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. (2016) 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. Within this framework, the implications of shadow banking for financial stability and welfare can be studied. 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. 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.<sup>7</sup> 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:

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

where  $c_t$ ,  $h_t$  and  $l_t$  represent consumption at time  $t$ , the housing stock and working hours, respectively.

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<sup>7</sup>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 et al. (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.



$1/(\eta - 1)$  is the labor supply elasticity,  $\eta > 0$ .  $j > 0$  constitutes the relative weight of housing in the utility function. Subject to the flow of funds:

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

Assuming that  $h_t$  is collateralizable, we denote  $m_F$  as the loan-to-value for the regulated banking sector and  $\alpha$  the share of collateral which is pledged to this sector.  $m_L$  is the private lender (shadow banking) LTV for housing.<sup>8</sup>  $b_t^F$ ,  $b_t^L$ ,  $R_t^F$  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:

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

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

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;<sup>9</sup> The first-order conditions are as follows:

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

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

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

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

where  $\lambda_t^F$  and  $\lambda_t^L$  are the Lagrange multipliers of the bank and the private lender borrowing constraint,

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<sup>8</sup>Although conditions tend to be more lax in the case of shadow banking, this sector mostly offers collateralized lending.

<sup>9</sup>In a similar manner, Rubio (2011) also introduces an exogenous dichotomy in borrowing: fixed versus variable-rate mortgages.

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:

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

where  $\beta \in (0, 1)$  is their discount factor, which is assumed to be greater than  $\gamma$ , the discount factor for borrowers.<sup>10</sup>

Subject to the budget constraint:

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

where  $d_t$  denotes bank deposits,  $R_t^D$  is the gross return from deposits.

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

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

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

$$\frac{q_t}{c_t'} = \frac{j}{h_t'} + \beta E_t \left( \frac{q_{t+1}}{c_{t+1}'} \right) \quad (11)$$

$$w_t' = c_t' (l_t')^{\eta-1} \quad (12)$$

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

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<sup>10</sup>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  $\gamma$  is lower than the households' discount factor  $\beta$ , which in turn prices bonds.

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

Banks solve the following problem:

$$\max E_0 \sum_{t=0}^{\infty} \delta^t [\log Div_t],$$

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:<sup>11</sup>

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

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:

$$\frac{b_t^F - d_t}{b_t^F} \geq CRR. \quad (14)$$

Simple algebra shows that this relationship can be rewritten as:

$$d_t \leq (1 - CRR) b_t^F, \quad (15)$$

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:<sup>12</sup>

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<sup>11</sup>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.

<sup>12</sup>This constraint creates a relationship between capital requirements and the volatility of borrower consumption. Bank

$$d_t \leq \chi b_t^F, \quad (16)$$

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

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

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

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.

### 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:

$$\max \Pi_t = y_t - w_t l_t - w_t' l_t',$$

$$y_t = A_t l_t^\nu l_t'^{1-\nu}, \quad (19)$$

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

$$w_t = \frac{\nu y_t}{l_t}, \quad (20)$$

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capital constraints provide a substantial benefit of reducing the sensitivity of consumption to house prices and avoiding financial problems.

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

### 3.5 Equilibrium

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

$$h_t + h'_t = 1. \quad (22)$$

The goods market clearing condition is as follows:

$$y_t = c_t + c'_t + c''_t, \quad (23)$$

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 Pescatori (2007), I take this latter approach to be able to evaluate the welfare of the three types of agents separately.<sup>13</sup> The individual welfare for borrowers, lenders, and the financial intermediary, respectively, is as follows:

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

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

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<sup>13</sup>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.

$$W_t'' \equiv E_t \sum_{m=0}^{\infty} \delta^m [\log c_{t+m}''] . \quad (26)$$

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).<sup>14</sup> A 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:

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

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

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

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.<sup>15</sup>

## 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 financial stability, as well as a continuum of cases in which shadow banking increases in the economy. Finally, for the sake of completeness, I check how shadow banking affects welfare for the different agents in the model. The next subsection describes the parameter values used for calibration.

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<sup>14</sup>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.

<sup>15</sup>I follow Ascari and Ropele (2009) for the specification of consumption equivalent units.

## 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 than savers.<sup>16</sup> As in Iacovello (2015),  $\delta$  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.<sup>17</sup> 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:

<b>Table 1: Parameter Values</b>		
$\beta$	.99	Discount Factor for Savers
$\gamma$	.98	Discount Factor for Borrowers
$\delta$	.965	Discount Factor for Banks
$j$	.1	Weight of Housing in Utility Function
$\eta$	2	Parameter associated with labor elasticity
$\nu$	.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
$\rho$	.9	Shock persistence

## 4.2 Impulse Responses

In this subsection, I present impulse responses to a productivity shock. This shock is expansionary and makes borrowing increase. However, the question that arises is whether the size of the increase in borrowing depends on the proportion of shadow banking in the economy.

<sup>16</sup>Lawrance (1991) estimated discount factors for poor consumers at between 0.95 and 0.98 at quarterly frequency.

<sup>17</sup>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%.

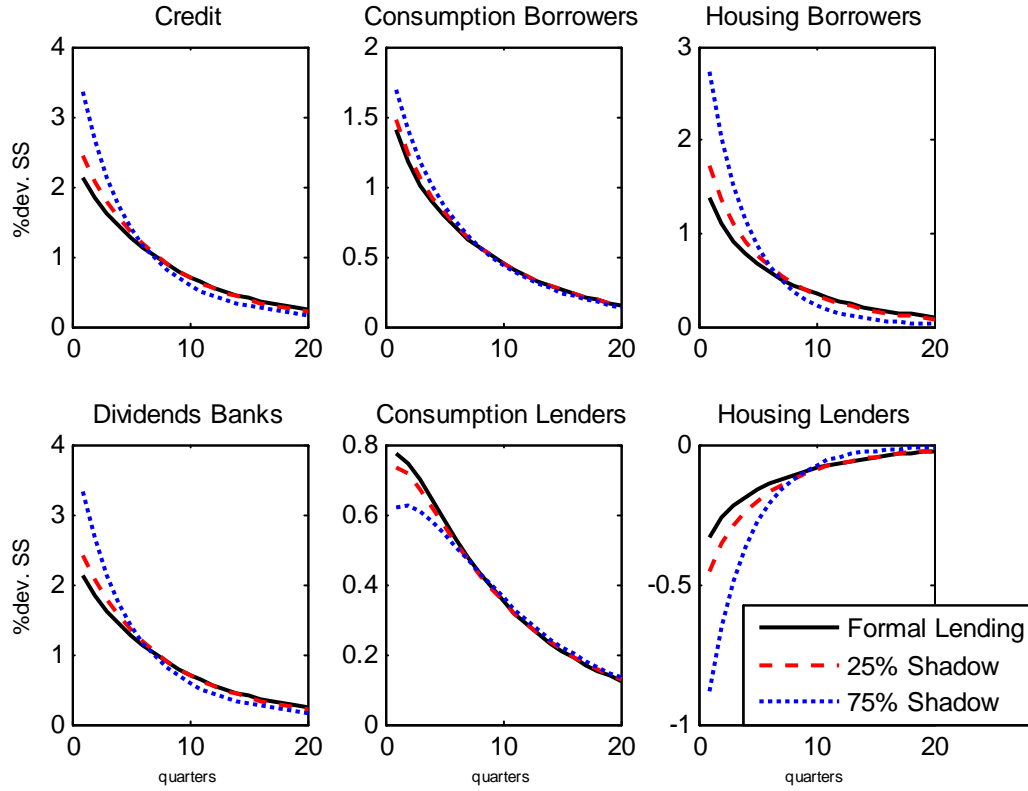


Figure 1: Impulse Responses to a Technology Shock

Figure 1 presents these impulse responses to a technology shock. 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 in the economy 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. 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. 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.



### 4.3 Financial Stability

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 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.

<b>Table 2: Financial Stability and Shadow Banking</b>	
	$\sigma(b)$
<b>Formal Lending</b>	4.5122
<b>Shadow Banking (25%)</b>	4.8899
<b>Shadow Banking (75%)</b>	5.7433

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 poses risks to financial stability, understood as a larger volatility in financial markets. Figure 2 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 financial volatility. Thus, the model displays a trade-

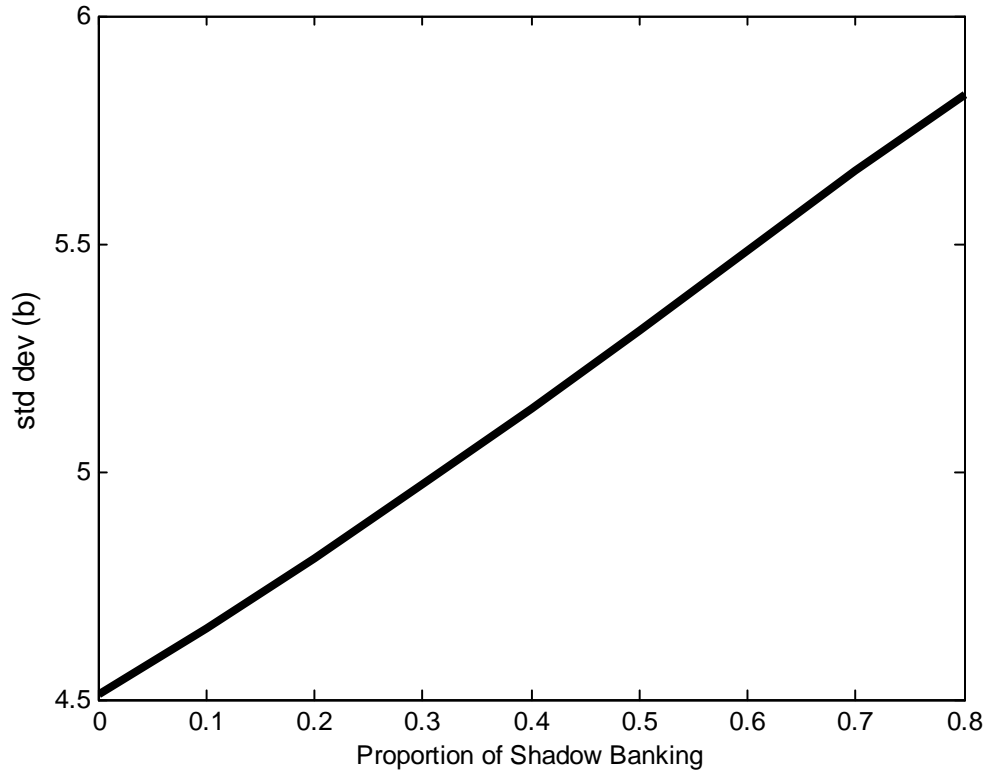


Figure 2: Shadow Banking and Financial Stability

off of 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 financial instability.

#### 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 3 presents welfare values, in consumption equivalents for the different agents of the model, for an increasing proportion of shadow banking in the economy. 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

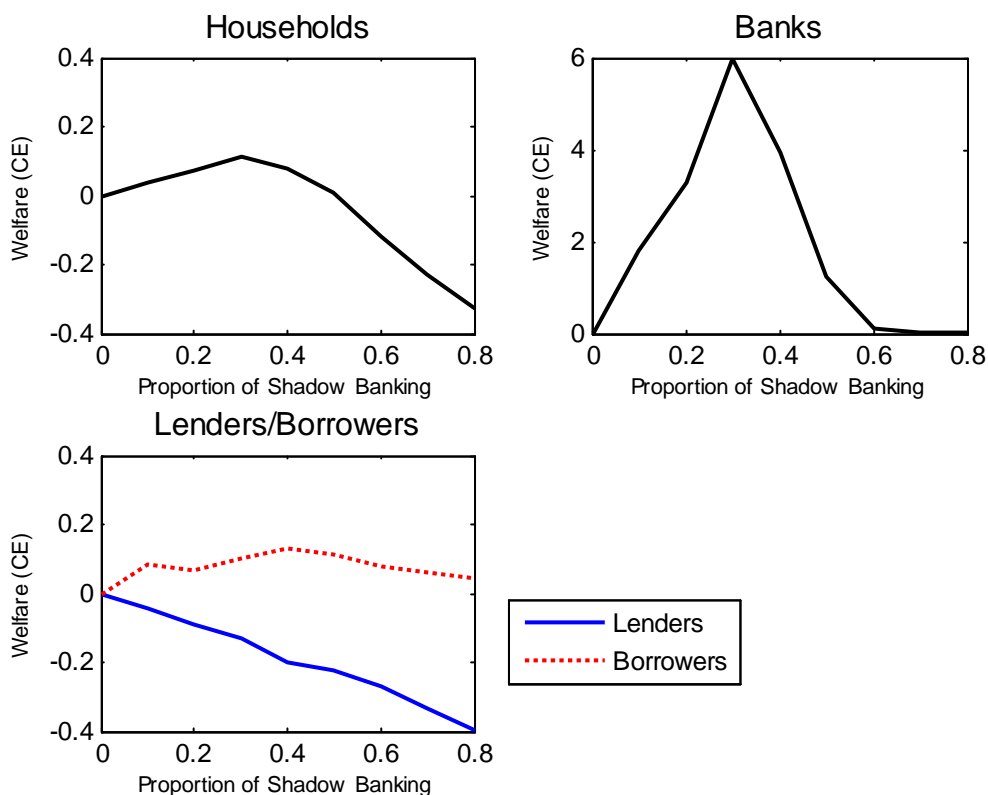


Figure 3: Welfare values (Consumption Equivalents) implied for different proportions of shadow banking

respect to financial stability 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 financial 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 financial stability risks become 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 financial stability. Although a higher proportion of shadow banking increases their dividends, as we have seen in impulse responses, as for borrowers, an increase in the instability in financial 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.<sup>18</sup>

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.

## 5 The Full Model: Allowing for endogenous $\alpha$

In the full model, I allow for an endogenous choice of  $\alpha$ , 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:

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

subject to the flow of funds:

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

And subject to the following borrowing constraints:

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

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

The collateral constraint on private lenders displays decreasing returns to scale in their liquidation

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<sup>18</sup>Quantitative results have to be taken with caution because they depend on the specific modeling strategy and on calibration.

technology.<sup>19</sup> 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.<sup>20</sup> Borrowers choose labor and assets; how much to borrow from banks and private lenders; how to allocate shares  $\alpha_t$  of assets between the regulated and the unregulated sectors. The first-order conditions are as follows:

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

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

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

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

$$w_t = (l_t)^{\eta-1} c_t \quad (37)$$

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

From equations (33), (34), and (36), we can solve for  $\alpha_t$ :

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

If we find the value of  $\alpha_t$  in the steady state, we obtain:

$$\alpha = 1 - \frac{1 - m_F}{2(1 - m_L)} \quad (38)$$

Therefore, in the steady state, the share of collateral devoted to formal banking will be positively related

<sup>19</sup>Convex costs in liquidation ensure that there is an internal solution in the choice of  $\alpha_t$ .

<sup>20</sup>Find a similar specification in Iacoviello and Minetti (2006) with domestic and foreign lenders.

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.

## 6 Shadow Banking and Regulation

### 6.1 LTV Regulation

Figure 4 displays how the steady-state share of shadow banking changes with regulation on the LTV. As we have seen, the proportion of shadow 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 4, 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.

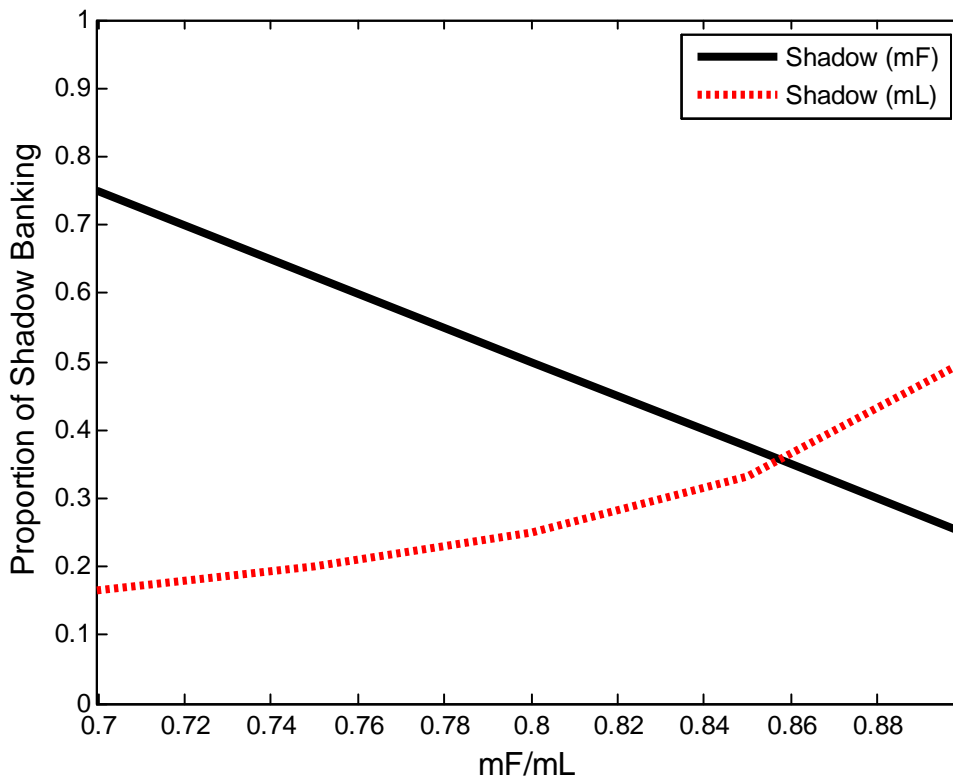


Figure 4: Proportion of Shadow Banking with LTV Regulation

### 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 this graph, we see that in order to 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 financial 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 financial stability, 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 endanger financial stability and decrease welfare.

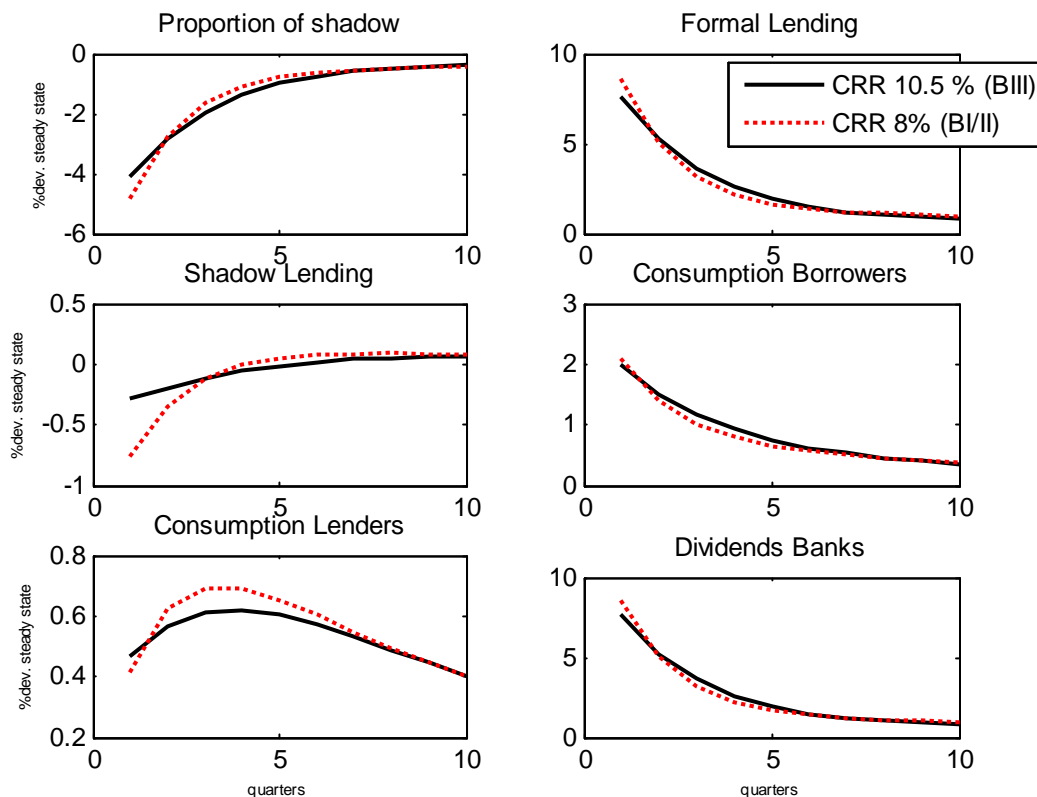


Figure 5: Impulse Responses to a Technology Shock. Basel III versus Basel I/II Regulation

## 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 5 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 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.

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

In terms of financial stability, CRR regulation also has implications. Table 3 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.

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 3, regulating all banks in the economy would not be 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 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 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 endogenize 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.

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