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Conference Paper

The Role of Shadow Banking in the Monetary Transmission Mechanism and the Business Cycle

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2016: Demographischer Wandel - Session: Transmission of Monetary Policy, No. G14-V3

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The Role of Shadow Banking in the Monetary Transmission Mechanism and the Business Cycle*

February 2016

Abstract

This paper investigates the heterogeneous impact of monetary policy shocks on financial intermediaries. I distinguish between traditional banks and shadow banks based on their ability to raise debt and equity funding. The functional form for both intermediaries imposes no constraints ex ante, but a Bayesian estimation of key parameters results in traditional banks having a comparative advantage at raising debt while shadow banks are better at raising equity. In line with empirical observations, shadow bank lending moves in the opposite direction to bank lending following monetary policy shocks, which mitigates aggregate credit responses. The recognition of a distinct shadow banking sector results in an amplified propagation of real shocks and a muted propagation of financial shocks. This identification can help in assessing effects of financial regulation on the economy. A historical shock decomposition highlights the roles of traditional banks and shadow banks in the run-up to the 2008 financial crisis.

Keywords: Shadow Banking, Monetary Policy Transmission, Credit Channel, Portfolio Choice, Bayesian Methods, Search Frictions

JEL Classification: E32, E44, G11, G20

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1 Introduction

Loan issuance is traditionally understood as one of the core functions of the banking sector. However, the data show that the volume of financial intermediation via non-bank financial institutions (NBFI), i.e. the market based or shadow banking sector, has been rising in the last decades, even overtaking the traditional banking sector in several countries, see Financial Stability Board (2014). Reacting to this development, Woodford (2010) calls for "a framework for macroeconomic analysis in which intermediation plays a crucial role and [...] which also takes account of the fact that the U.S. financial sector is now largely market-based." Although the financial sector has been incorporated in recent models, it is still largely treated as a relatively homogeneous entity. However, empirical studies indicate that banks and shadow banks react to shocks in different ways.[1] Consider monetary policy: While banks reduce the amount of loans on their balance sheets following monetary policy tightening, shadow banks increase lending (Figure 1). This suggests that the share of credit intermediation via the shadow banking sector is an important determinant of the effectiveness of monetary policy on aggregate lending and the economy.

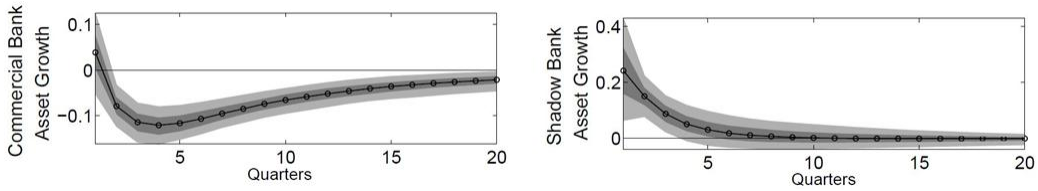

Figure 1: Impact of a 100bp increase in the monetary policy rate on bank and shadow bank lending (Source: Nelson, Pinter, Theodoridis, 2015)

The merits of distinguishing among different financial intermediaries are as follows. Imagine a regulator that wants to assess the effects of the implementation of different regulatory frameworks in a model that only recognizes one type of intermediary. As long as the regulation is specific to a certain type of intermediary (e.g. deposit insurance, Basel, asset purchasing programs, access to liquidity facilities at a central bank), the model may misrepresent the reaction of *aggregate* credit supply and macroeconomic variables to the implementation. Likewise, consider a central bank that is 'leaning against the wind'. If economic conditions warrant a change in the stance of monetary policy, ignoring the counter-intuitive reaction of a shadow banking sector (of considerable size) may lead to an inadequate adjustment in the policy rate.

In this paper I will answer the following questions: How does the monetary transmission channel via shadow banks work and how can it be modeled? How does the resulting credit intermediation of shadow banks affect the reaction of *aggregate* loan supply to monetary policy? In addition, if the inclusion of shadow banks changes the propagation of shocks, what has been its contribution to macroeconomic fluctuations in recent years?

To answer these questions I develop a structural model that distinguishes between banks and shadow banks based on their ability to raise funding. I use the monetary DSGE model with financial intermediaries by Gertler and Karadi (2011) (GK11 from here on) to describe intermediary behavior and extend it with a shadow banking sector. In addition to intermediaries being able to leverage, they are also able to raise equity and thereby substitute debt funding. I model equity fund raising by

[1] See e.g. Altunbas et al. (2009); Haan and Sterk (2011); Igan et al. (2013); Nelson et al. (2015).

both intermediaries as a search in the funding market for deposits, which are held by the household sector. Following Wasmer and Weil (2004), I model funding market frictions analogously to those on the labor market because of their comparable characteristics of "moral hazard, heterogeneity and specificity". In contrast to Wasmer and Weil, in my model the amount of deposits changes endogenously.

In GK11, an increase in the monetary policy rate leads to an increase in the external finance premium for borrowers, prompting a decrease in the value of their collateral, thereby decreasing the willingness of banks to lend. The resulting deleveraging results in a credit squeeze for the real sector, disinvestment and a fall in output. Simultaneously, increased interest rates discourage households from current consumption and instead encourage savings, which take the form of intermediary equity or debt. Shadow banks lend out these additional funds and thereby alleviate the credit squeeze, mitigating the fall in investments and any consequent recession. Although intermediaries are modeled almost symmetrically, an estimation using Bayesian methods illuminates their different fund raising abilities. The present paper lays out a simple way to extend financial models by adding a shadow banking sector, as well as the ability to model a (bank) equity channel. Since the non-bank financial sectors have different sizes in different jurisdictions, this model extension can help to better assess the impact of monetary policy shocks on aggregate lending and the economy.

Existing macroeconomic models of shadow banking include Meeks et al. (2014); Verona et al. (2013); and Goodhart et al. (2012). The first is mainly concerned with financial stability and considers shadow banks as off balance sheet vehicles of commercial banks to unload risky loans. Verona et al. study adverse effects of excessively easy monetary policy and understand shadow banks as financial intermediaries specializing in less risky loans akin to bond issuance by investment banks. Goodhart et al. study different regulatory regimes to stop fire sales by shadow banks and take the opposite view to Verona et al., considering shadow banks to be less risk averse, but still funded by the regular banking sector, comparable to off balance sheet vehicles as in Meeks et al.

Models of endogenous equity issuance include Meh and Moran (2010) and Gertler et al. (2012). The former look at the role of bank equity in the propagation of a diverse number of shocks when banks are present. The latter allow outside equity to substitute for deposits in existing banks, but still assume an automatic creation of inside equity. In contrast, I endogenize the decision to create new banks based on the need for additional intermediaries and the value of funding operations for investors (households).

Search and matching in credit markets has been studied since Dell'Ariccia and Garibaldi (1998). den Haan et al. (2003) analyze the business cycle effects of long-term lending relationships with frictions. Wasmer and Weil (2004) study the effects of credit market frictions on labor market dynamics. What these models have in common is that the total amount of credit to be allocated is either fixed exogenously or is influenced endogenously but without any relation to credit creation by financial intermediaries. This paper explicitly focuses on this interaction.

In the next section, I will describe the model with two types of intermediaries and the incorporation of equity issuance. Section 3 contains the model analysis, including Bayesian estimation of newly introduced structural parameters and all shock parameters, impulse response functions to monetary policy shocks and a historical shock decomposition. Section 4 concludes.

2 The Model

The basic structure is the monetary DSGE model with financial intermediaries by GK11, to which I add endogenous equity formation. The traditional banking sector is mirrored by a second financial

intermediary, called the non-bank financial or shadow banking sector, which also issues loans to firms. Irrespective of whether shadow banks lend to the real sector directly, or whether they buy securitized credit claims of previously originated loans, shadow banks become the effective intermediary, and banks' balance sheets are freed up.

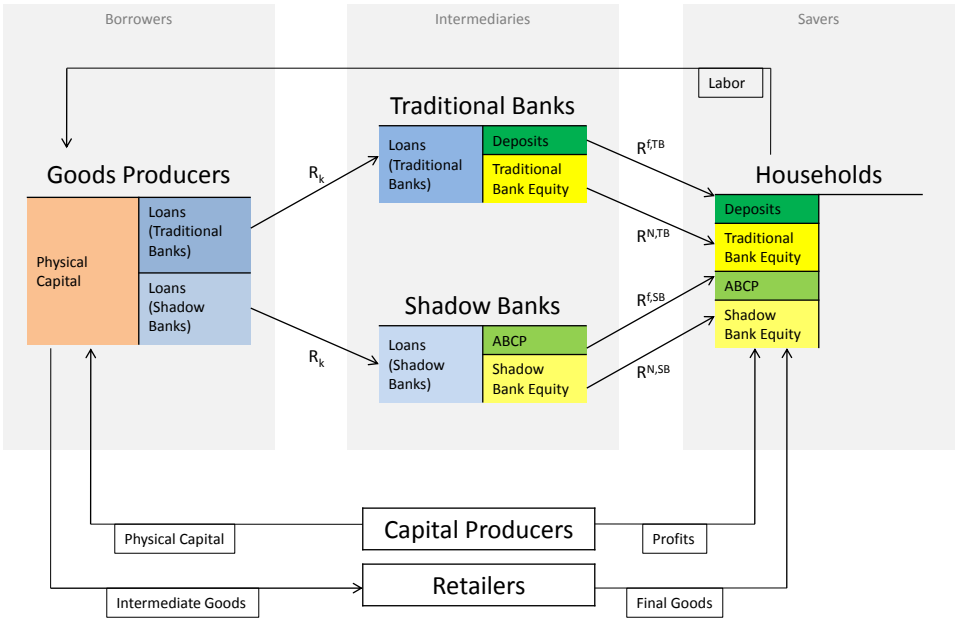

Figure 2: Model Economy

In this model the economy is populated by six types of agents: households, traditional banks, shadow banks, non-financial goods producers who demand loans, capital producers, and monopolistically competitive retailers. Intermediaries finance loans by issuing non-contingent debt, which takes the form of deposits at traditional banks and asset-backed commercial paper (ABCP) at shadow banks, and state-contingent equity to households. A central bank conducting monetary policy is the source of monetary disturbances and completes the model.[2]

2.1 Financial Intermediaries

There are two types of financial intermediaries, traditional banks and shadow banks. Since their structure is almost identical, I will generally refer to both of them by the exponent j, specifying $j \in \{\text{Traditional Banks} = \text{TB}, \text{Shadow Banks} = \text{SB}\}$ when necessary. As in other models of the financial accelerator, intermediaries (both types) have a finite lifetime so that their lending operations will never become fully self-financed. The life cycle of a financial institution starts when a household member decides to enter as a potential intermediary looking for equity funding. If the potential intermediary finds funding, they are able to start their business and leverage their operations using debt financing.[3] Intermediaries accumulate retained earnings until they die with a probability θ^j

[2]For the timing, see Figure 5 in Appendix A.1.

[3]Intermediary leverage is independent of individual characteristics as shown in GK11.

every period. They exit the intermediary market and pay out accumulated profits to the household that they came from.

Debt and equity financing are modeled using two different types of frictions. Debt financing via the moral hazard problem as in GK11 and Gertler and Kiyotaki (2010) guarantees that as long as the intermediary does not exceed a maximum amount of leverage per intermediary value, households are indifferent towards the absolute amount of debt that they hold with each intermediary or in total. Without explicitly modeling it, this can be understood as deposit insurance for traditional banks and secured debt for shadow banks. This indifference is reflected in the risk free interest rate that intermediaries pay.

Equity financing is risky. Since equity investors participate in the state-contingent returns of the intermediary, households are only willing to hold equity claims that have an underlying returns profile that fits into the individual household's portfolio. Although this is not modeled explicitly, this heterogeneity on the micro level is captured via the search and matching mechanism: only a fraction of households agree to the terms of the potential intermediaries that they meet on the equity funding market. An equity dividend that is higher than the interest rate on debt signals this riskiness.

2.1.1 Existing Intermediaries

Existing intermediaries' balance sheets are given by[4]

$$Q_t^j S_t^j = D_{t+1}^j + N_t^j. \tag{1}$$

Intermediaries fund their loan portfolio S_t^j priced at Q_t through their net worth N_t^j and debt obtained from households D_{t+1}^j. Because they pay interest on their debt of R_{t+1}^j and earn a return R_{kt+1} on their loans, an individual bank's net worth evolves according to

$$\begin{aligned} N_{t+1}^j &= R_{kt+1} Q_t S_t^j - R_{t+1}^j D_{t+1}^j \\ &= (R_{kt+1} - R_{t+1}^j) Q_t S_t^j + R_{t+1}^j N_t^j. \end{aligned}$$

Intermediaries want to maximize their expected terminal net wealth before they exit the industry with a probability θ^j per period and pay out all the accumulated profits to the household that they came from. Expected terminal net wealth is given by

$$\begin{aligned} V_t^j &= E_t \sum_{i=0}^{\infty} (1-\theta^j)(\theta^j)^i \beta^{i+1} \Lambda_{t,t+1+i} N_{t+1+i}^j \\ &= \nu_t^j Q_t S_t^j + \eta_t^j N_t^j \end{aligned}$$

where the second line is the equivalent recursive formulation. The marginal expected discounted value of net worth is η_t^j and ν_t^j is the marginal expected discounted value of expanding assets

$$\nu_t^j = E_t[(1-\theta^j)\beta \Lambda_{t,t+1}(R_{kt+1} - R_{t+1}^j) + \beta \Lambda_{t,t+1} \theta^j x_{t,t+1}^j \nu_{t+1}^j] \tag{2}$$

$$\eta_t = E_t[(1-\theta^j)\beta \Lambda_{t,t+1} R_{t+1}^j + \beta \Lambda_{t,t+1} z_{t,t+1}^j \theta^j \eta_{t+1}^j] \tag{3}$$

[4]For simplicity, I will abstract from equations of the individual agents and instead show their aggregate form directly, distinguishing between individual and aggregate forms as necessary. For more detail, GK11 show individual agents' equations.

and the growth rate in net worth $z^j_{t,t+1}$ and the growth rate in assets is $x^j_{t,t+1}$ defined below.

It is profitable to increase the loan portfolio as long as the interest rate differential is positive. To motivate an endogenous constraint on intermediaries' ability to leverage, a moral hazard problem is introduced: the intermediary can divert a fraction of the loan portfolio λ^j_t that the creditors are not able to recover. As a consequence, the intermediary goes bankrupt. Therefore, households will keep their debt claims[5] at individual intermediaries only as long as the franchise value of the intermediary, V^j_t, is higher than or equal to the divertible amount, which guarantees the intermediary's interest in not diverting assets and declaring bankruptcy:

$$V^j_t \geq \lambda^j_t Q_t S^j_t.$$

The divertible fraction λ^j_t is a time dependent AR(1) process with persistence ρ_{λ^j}, which is included to analyze the role of trust in intermediaries and a corresponding ability to leverage. I will assume that the constraint always binds, and after substituting and rearranging, the size of an intermediary's loan portfolio then depends on the size of their net wealth according to

$$Q_t S^j_t = \frac{\eta^j_t}{\lambda^j_t - \nu^j_t} N^j_t \tag{4}$$

and the leverage ratio can be defined as

$$\phi^j_t \equiv \frac{\eta^j_t}{\lambda^j_t - \nu^j_t}. \tag{5}$$

The growth rate in net worth $z^j_{t,t+1}$ and the growth rate in assets $x^j_{t,t+1}$ are defined as

$$\begin{aligned} z^j_{t,t+1} &= \frac{N^j_{t+1}}{N^j_t} \\ &= \frac{(R^j_{kt+1} - R^{f,j}_{t+1}) Q_t S^j_t + R^j_{t+1} N^j_t}{N^j_t} \\ &= (R_{kt+1} - R^j_{t+1}) \phi^j_t + R^j_{t+1} \qquad (6) \\ x^j_{t,t+1} &= \frac{Q_{t+1} S^j_{t+1}}{Q_t S^j_t} \\ &= \frac{\phi^j_{t+1} N^j_{t+1}}{\phi^j_t N^j_t} \\ &= \frac{\phi^j_{t+1}}{\phi^j_t} z^j_{t,t+1}. \qquad (7) \end{aligned}$$

2.1.2 New Intermediaries

A constant share $1 - \theta^j$ of intermediaries dies every period and distributes its retained earnings to their investors. New intermediaries enter in their place. To become a new intermediary, potential

[5] Deposits at traditional banks and ABCP at shadow banks.

intermediaries have to receive equity funding from households. They do this by posting advertisements for their operations at a cost κ^j. Individual savers and individual potential intermediaries searching for equity funding randomly meet and evaluate the potential for a match in isolation. On the micro level, potential intermediaries differ with regard to their management style, loan applicants, investment policies, etc. Individual savers differ with regard to their preferences, their idiosyncratic risks and investment portfolios. I abstract from these differences on the macro level, where this behavior is approximated via search and matching[6] in the market for equity funding. In aggregate, potential intermediaries will find a suitable investor with a probability q_t^j. The value of participation is

$$B_t^{j,S} = -\kappa^j + \beta\Lambda_{t,t+1}\left\{q_t^j B_{t+1}^{j,M} + (1-q_t^j)B_{t+1}^{j,S}\right\}.$$

The value a potential intermediary has from establishing operations is

$$B_t^{j,M} = \phi_{t-1}^j R_{kt} - (\phi_{t-1}^j - 1)R_t^j - R_t^{j,N} + \beta\Lambda_{t,t+1}\left\{\theta^j B_{t+1}^{j,M} + (1-\theta^j)B_{t+1}^{j,S}\right\}.$$

Intermediaries stand to gain the borrowing rate times their leverage net of interest rates on deposits/ABCP and equity dividend payouts. There is generally future expected discounted value from continuing operations in the subsequent period with a probability θ^j. Potential intermediaries can assume leveraged operations since leverage is independent of firm-specific factors as shown in GK11. Assuming potential financiers will enter the market for equity funding until the expected value from participating in the search market $B^{j,S}$ is zero, a Euler condition for advertisements results:

$$\frac{\kappa^j}{q_t^j} = \beta\Lambda_{t,t+1}\left\{\phi_t^j R_{kt+1} - (\phi_t^j - 1)R_{t+1}^j - R_{t+1}^{j,N} + \theta^j \frac{\kappa^j}{q_{t+1}^j}\right\}.$$

New advertisements will be posted until the marginal cost of establishing a match equals the marginal benefit of having established intermediary operations, which is the combination of the interest rate differential and avoided future search costs.

2.1.3 The Equity Matching Market

To compute the probability of matching a potential intermediary with a household I assume a funding market matching function $m(v_t^j, D_{t+1}^{TB})$ that is increasing in its arguments, the number of advertisements v_t^j and the number of deposits D_{t+1}^{TB}. Equity investments can only be made with bank deposits, which therefore enter the matching process of both traditional banks and shadow banks.[7]

Assuming a constant returns to scale matching function, the probability that a potential intermediary will find suitable funding is then

$$q^j = m(1, (\Theta_t^j)^{-1}) = \frac{m(v_t^j, D_{t+1}^{TB})}{v_t^j} = s^j (v^j)^{-\xi^j} (D^{TB})^{\xi^j} \tag{8}$$

with matching elasticity ξ^j and matching efficiency s^j.

[6] This is common practice in the labor literature, see e.g. Petrongolo and Pissarides (2001).

[7] See Pozsar (2014) who writes that "banks and demand deposits are special [...] because of their unique role in forming the backbone of the payments system and facilitating the payments of all entities lower in the system-hierarchy."

The probability that a household will find equity in type j intermediary is

$$f^j = m(\Theta_t^j, 1) = \frac{m(v_t^j, D_{t+1}^{TB})}{D_{t+1}^{TB}} = s^j (v^j)^{1-\xi^j} (D^{TB})^{\xi^j - 1}. \tag{9}$$

2.1.4 Equity Dividend Bargaining

Because of the existence of search frictions, intermediaries enjoy a rent on established matches. I assume that the dividend intermediaries pay on equity raised is determined via Nash bargaining over these surpluses. ω^j signifies the relative bargaining power of households. Dividends $R_{t+1}^{j,N}$ are negotiated that maximize a convex combination of the surpluses,

$$R_{t+1}^{j,N} = argmax \quad \omega^j lnV_t^{HH} + (1-\omega^j) lnV_t^j.$$

The resulting interest rate that traditional banks and shadow banks pay for equity raised is, respectively (see Appendix A.2 for details)

$$R_{t+1}^{TB,N} = (1-\omega^{TB}) R_{t+1}^{f,TB} + \omega^{TB} \left\{ R_{t+1}^{f,TB} + \phi_t^{TB} (R_{kt+1} - R_{t+1}^{f,TB}) + \kappa^{TB} \frac{f_{t+1}^{TB}}{q_{t+1}^{TB}} \right\}$$
$$R_{t+1}^{SB,N} = (1-\omega^{SB}) R_{t+1}^{f,TB} + \omega^{SB} \left\{ R_{t+1}^{f,SB} + \phi_t^{SB} (R_{kt+1} - R_{t+1}^{f,SB}) + \kappa^{SB} \frac{f_{t+1}^{SB}}{q_{t+1}^{SB}} \right\}$$

If household bargaining power is low, intermediaries can get away with paying only the interest rate $R_{t+1}^{f,j}$ that banks pay on their deposits. With increasing bargaining power, intermediaries need to share expected profits with investing households.

2.2 Households

A continuum of households of measure one exists that consume, save in a portfolio of assets and supply labor. They maximize discounted lifetime utility

$$\max_{C_t, L_t, D_{t+1}^j, N_{t+1}^j} E_t \sum_{i=0}^{\infty} \beta^i [ln(C_{t+i} - hC_{t+i-1}) - \frac{\chi}{1+\varphi} L_{t+i}^{1+\varphi}]$$

subject to the sequence of period budget constraints

$$C_t + D_{t+1}^{TB,e} + N_{t+1}^{TB} + D_{t+1}^{SB} + N_{t+1}^{SB} = W_t L_t + \Pi_t + R_t^{f,TB} D_{t+1}^{TB,e} + R_t^{N,TB} N_{t+1}^{TB} + R_t^{f,SB} D_{t+1}^{SB} + R_t^{N,SB} N_{t+1}^{SB}.$$

Each unit of labor L_t earns the real wage W_t. Π_t are profits from ownership of capital producers, retailers and financial intermediaries, both traditional banks and shadow banks. β is the discount factor, h is the habit parameter, χ is the relative utility weight of labor and φ is the inverse Frisch elasticity of labor supply. The asset portfolio consists of debt and equity in traditional banks and shadow banks. On the micro level, when a household wants to invest into equity, it enters the equity matching market and randomly meets a potential intermediary. If the equity investment is a good fit regarding individual portfolio characteristics, they will invest and form a match. On the macro level, this behavior is approximated by a search and matching mechanism: we only observe a fraction f_t^j of searching households to establish a match. The amount of *effective* deposits that remain in the portfolio after investment into both forms of equity are then $D_{t+1}^{TB,e} = D_{t+1}^{TB}(1 - f_t^{TB} - f_t^{SB})$.

Since only a fraction of intermediaries ceases operations every period, a law of motion for equity by traditional banks and shadow banks emerges each

$$N_{t+1}^{j} = \theta^{j} N_{t}^{j} z_{t}^{j} \zeta_{t}^{j} + f_{t}^{j} D_{t+1}^{TB}. \tag{10}$$

With ϱ_t denoting marginal utility of consumption and μ_t^j denoting the additional value of being invested in type j equity, the first order conditions are given by

$$\text{Consumption } C_t: \quad \varrho_t = \frac{1}{C_t - hC_{t-1}} - \frac{\beta h}{C_{t+1} - hC_t} \tag{11}$$

$$\text{Labor } L_t: \quad \chi L_t^{\varphi} = \varrho_t W_t \tag{12}$$

$$\text{Deposits } D_{t+1}^{TB}: \quad \varrho_t = (1 - f_t^{TB} - f_t^{SB}) E_t \beta R_{t+1}^{TB} \varrho_{t+1} + f_t^{TB}(\mu_t^{TB} + \varrho_t) + f_t^{SB}(\mu_t^{SB} + \varrho_t) \tag{13}$$

$$\text{Equity } N_{t+1}^{j}: \quad \mu_t^j + \varrho_t = E_t \beta \left\{ \varrho_{t+1} R_{t+1}^{j,N} + \mu_{t+1}^j \theta^j z_{t+1}^j \zeta_{t+1}^j \right\} \tag{14}$$

$$\text{ABCP } D_{t+1}^{SB}: \quad E_t \beta R_{t+1}^{f,SB} \frac{\varrho_{t+1}}{\varrho_t} = 1 \tag{15}$$

with the marginal rate of substitution between consumption today and tomorrow given by

$$\Lambda_{t,t+1} = \frac{\varrho_{t+1}}{\varrho_t}. \tag{16}$$

The first order conditions for consumption and labor are standard.

Equation (13) reduces to the commonly known Euler condition in the case that equity investments do not exist or have no additional value[8], i.e. the household will increase savings until the marginal utility of consumption today equals the discounted expected marginal utility of consumption tomorrow. However, since the household's investment in equity is constrained, i.e. $f_t^j < 1$, being invested in equity is valuable, i.e. $\mu_t^j > 0$. The household will therefore increase savings until the marginal utility of consumption today equals the *probability* of consuming tomorrow $(1 - f_t^{TB} - f_t^{SB})$ times its value (the discounted expected marginal utility of consumption tomorrow) plus the *probability* of investing in one type of equity f_t^j times that value. The value of investing in equity type j is given by Equation (14), which shows that the marginal utility of investing in equity $\mu_t^j + \varrho_t$ is tomorrow's discounted dividend weighted by marginal utility of consumption, as well as the future value of staying matched. Since ABCP cannot be used for the purchase of equities, their holdings do not carry the potential for being invested in equity.[9]

2.3 Goods Producers

Perfectly competitive goods producers manufacture intermediate goods and sell them to the retailer at the relative intermediate output price P_{mt}. Goods producers need to finance their capital expenditures via loans from intermediaries, which they may borrow without frictions, i.e. intermediaries can enforce all of their claims. However, since banks are constrained in the amount of deposits they can issue and shadow banks are constrained in the amount of funds they can raise, lending by intermediaries is capital constrained, which affects the supply of funds to firms and therefore the

[8] Iff $\mu_t^{TB} = \mu_t^{SB} = 0$, Equation (13) holds for all f_t^j.

[9] Interest rates on bank deposits have been below those on ABCP pre-2008, which the model explains by the additional utility from being able to use deposits for transactions.

required interest rate for borrowing, R_{kt+1}. Except for the addition of another source of funding, capital producers are identical to those in GK11.

The firm maximizes its profits by choosing capital K_{t+1} and labor L_t optimally each period.

$$\max_{K_{t+1},L_t} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+1} \left[P_{mt}Y_t + (Q_t - \delta)\xi_t K_t - W_t L_t - R_{kt} K_t Q_{t-1}\right]$$

with production output given by

$$Y_t = A_t(\xi_t K_t)^{\alpha} L_t^{1-\alpha} \tag{17}$$

where α is the capital share, Q_t is the real price of capital, δ is the depreciation rate and W_t are wages.

The first-order conditions are

$$R_{kt+1}Q_t = P_{mt+1}\alpha \frac{Y_{t+1}}{K_{t+1}} + (Q_{t+1} - \delta) \tag{18}$$

$$P_{mt}(1-\alpha)\frac{Y_t}{L_t} = W_t. \tag{19}$$

Firms do not earn any profits and pay out ex post returns to capital as interest payments, resulting in no profits state by state. They pay out all their profits to their creditors, who are a combination of banks and shadow banks according to

$$K_{t+1} = S_t + S_t^{SB}. \tag{20}$$

2.4 Capital Producers

Following GK11, capital producers buy leftover capital from goods producers which they refurbish, for which the price is unity. Units of new capital are made using input of final output and are then sold to goods producers at Q_t, which capital producers set by solving

$$\max_{I_{nt}} E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \Lambda_{t,\tau} \left\{ (Q_\tau - 1) I_{n\tau} - f\left(\frac{I_{n\tau} + I_{SS}}{I_{n\tau-1} + I_{SS}}\right)(I_{n\tau} + I_{SS}) \right\}$$

with

$$I_{nt} \equiv I_t \iota_t - \delta \xi_t K_t. \tag{21}$$

Following the literature on the importance of marginal efficiency of investment (Justiniano et al., 2010), investment specific shocks ι_t affect the transformation of gross investment into net investment. The functional form of $f(.)$ obeys $f(1) = f'(1) = 0$ and $f''(1) > 0$. $f(.)$ determines capital adjustment costs with the steady state value for investments given by I_{SS}. The capital producer thus creates profits outside of the steady state. Households receive profits from sales of new capital at price Q_t, which is given by the first-order condition

$$Q_t = 1 + f(.) + \frac{I_{nt} + I_{SS}}{I_{nt-1} + I_{SS}} f'(.) - E_t \beta \Lambda_{t,t+1} \left(\frac{I_{nt+1} + I_{SS}}{I_{nt} + I_{SS}}\right)^2 f'(.). \tag{22}$$

2.5 Retailers

Retailers buy intermediate goods from goods producers at the relative intermediate output price P_{mt}. Final output is the CES composite of a continuum of output by each retailer f with the elasticity of substitution ϵ, given by

$$Y_t = \left[\int_0^1 Y_{ft}^{\frac{\epsilon-1}{\epsilon}} df \right]^{\frac{\epsilon}{\epsilon-1}}.$$

Because users of final output minimize costs, we get

$$Y_{ft} = \left(\frac{P_{jt}}{P_t} \right)^{-\epsilon} Y_t$$

$$P_t = \left[\int_0^1 P_{ft}^{1-\epsilon} df \right]^{\frac{1}{1-\epsilon}}.$$

Each retailer can reset prices with probability $1-\gamma$ each period. Retailers will otherwise index their prices to lagged inflation. The retailers then choose their reset price P_t^* optimally to solve

$$\max_{P_t^*} E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t,t+1} \left[\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - P_{mt+i} \right] Y_{ft+i}.$$

The first-order condition is given by

$$E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t,t+1} \left[\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - \frac{\epsilon}{\epsilon-1} P_{mt+i} \right] Y_{ft+i} = 0. \tag{23}$$

The evolution of the price level is given by

$$P_t = [(1-\gamma)(P_t^*)^{1-\epsilon} + \gamma(\Pi_{t-1}^{\gamma_p} P_{t-1})^{1-\epsilon}]^{1/(1-\epsilon)}. \tag{24}$$

2.6 Resources and Policy

The aggregate resource constraint is given by

$$Y_t = C_t + \kappa^{TB} v_t^{TB} + \kappa^{SB} v_t^{SB} + I_t + f\left(\frac{I_{nt} + I_{SS}}{I_{nt-1} + I_{SS}} \right) (I_{nt} + I_{SS}). \tag{25}$$

Capital evolves according to

$$K_{t+1} = \xi_t K_t + I_{nt}. \tag{26}$$

Monetary policy is characterized by a Taylor rule. The nominal interest rate is given by i_t, with a steady state interest rate of i_{SS}, the natural rate of output given by Y_t^*, an interest rate smoothing parameter ρ, the inflation coefficient κ_π and the output gap coefficient κ_y:

$$i_t = (1-\rho)\left[i_{SS} + \kappa_\pi \pi_t + \kappa_y (logY_t - logY_t^*) \right] + \rho i_{t-1} + \epsilon_t. \tag{27}$$

The exogeneous shock to monetary policy enters the nominal interest rate as ϵ_t. The nominal interest rate has an effect on the economy through the Fisher relation

$$1 + i_t = R_{t+1} E_t (1 + \pi_{t+1}). \tag{28}$$

To close the model, I assume that the deposit rate paid by traditional banks on household deposits is equal to the real risk-free interest rate

$$R_{t+1}^{f,TB} = R_{t+1}. \tag{29}$$

3 Model Analysis

In this section, I will first pin down the model parameterization using calibration and Bayesian estimation. Next, I analyze how monetary policy shocks propagate through the economy, both with and without shadow banks. I then conduct a historical shock decomposition. The differing reactions of both channels are explained and their practical relevance is examined. The model is solved via first order perturbation around the deterministic steady state.

3.1 Parameterization

Most of the structural parameters are fixed and taken from GK11. Shadow banking parameters that have corresponding traditional bank parameters from GK11 are duplicated. The new parameters that follow the introduction of equity funding markets are the household bargaining power ω^j, search costs κ^j, matching efficiency s^j and matching elasticity ξ^j. Table 1 shows the fixed structural parameter values and their source. Household bargaining power is targets the spread between dividends and the risk free rate pre-crisis. The search costs are set so that the rate at which intermediaries find equity funding is between zero and one. A robustness check shows that neither the steady state nor the dynamics of the model change much in the values.

All parameters describing the shock processes and matching elasticities ξ^j are estimated using Bayesian methods. Banks are defined as US-chartered depository institutions and credit unions. Shadow banks combine Finance Companies, Funding Corporations, Asset-backed Security Issuers and Money Market Mutual Funds. The macroeconomic time series underlying the data for observables are real GDP, real consumption and real investment (all from the Bureau of Economic Analysis). Data on banks and shadow banks are taken from the Flows of Funds. For both sectors, we include time series on financial assets as well as the amount of fixed income liabilities convertible to currency on demand (Appendix 4). Since the model is expressed in log-deviations from steady state for estimation purposes, I take the log difference from the HP filtered trend (smoothing parameter is set to 1600). The data have a quarterly frequency and range from 1985:Q1 to 2008:Q4. Although earlier data are available, the shadow banking sector was a much smaller component of aggregate credit before 1985. I drop data after 2008 because the financial crisis and its aftermath had significant effects on the regulation and perception of the shadow banking sector. This is likely to have caused structural breaks and would change the parameters underlying the financial sector.

The priors for matching elasticities ξ^j are relatively uninformative Beta distributions centered around 0.5 and allowing for values in the open interval between 0 and 1. Following Christiano et al. (2010), the priors for all persistence parameters are Beta distributions with a mean of 0.5 and a

Symbol	Value	Description	Source
Households			
β	0.99	Discount rate	GK (2011)
h	0	Habit	off
χ	3.409	Relative utility weight of labor	GK (2011)
φ	0.276	Inverse Frisch elasticity of labor supply	GK (2011)
Financial Sectors			
λ^j	0.381	Fraction of bank assets that can be diverted	GK (2011)
θ^j	0.972	Survival rate of a banker	GK (2011)
ω^j	0.3	HH bargaining power	pre-crisis spreads
κ^j	0.01	Search cost	$q_t^j \in (0,1)$
Goods Producers			
α	0.33	Effective capital share	GK (2011)
δ	0.025	Depreciation rate	GK (2011)
Retail Firms			
ϵ	4.167	Elasticity of substitution	GK (2011)
γ	0.779	Probability of keeping prices fixed	GK (2011)
γ_p	0.241	Price indexation	GK (2011)
Government			
κ_π	1.5	Inflation coefficient of Taylor rule	GK (2011)
κ_y	0.125	Output gap coefficient of Taylor rule	GK (2011)
ρ_i	0.8	Smoothing parameter of the Taylor rule	GK (2011)

Table 1: Calibrated parameter values

standard deviation of 0.2. The priors for the white noise processes on the innovations are Inverse Gamma distributions with means taken from GK11 and standard deviations of 0.05. The shock processes are a priori independent. I run 10 Monte Carlo Markov Chains with 20.000 draws each over the full sample period. Convergence is reached after about 10.000 draws (see Figure 15 in Appendix A.4) and I therefore drop the first 50% of estimated values. Table 2 shows the results.

The posteriors of the shock processes are informative (see Appendix A.4). Persistence is relatively high for all shock processes with the exception of capital quality and bank net wealth shocks. Traditional bank matching elasticity ξ^{TB} is slightly higher than 0.5, while shadow bank matching elasticity ξ^{SB} is slightly lower than 0.5. This means that advertisements for equity investments are a relatively higher input factor in shadow banks than in traditional banks, or alternatively that shadow banks are better able to influence the amount of equity issuance. This can be explained by the superior experience of shadow banks on capital markets as the definition 'market-based financial intermediaries' suggests. Traditional banks are more dependent on deposit issuance, which is highly regulated and resistant to some market activity because of federal insurance.

3.2 Response to a monetary policy shock

Figure 3 shows impulse response functions for key variables after unexpected monetary policy tightening for the case with i) only traditional banks, and ii) traditional banks and shadow banks.

First, consider the case with no shadow banks present in the economy (red, dashed line). After an unexpected monetary tightening of about 30 basis points, interest rates on bank deposits increase to encourage depositors to keep their savings with banks instead of shifting them into other assets.

		Prior			Posterior	
Symbol	Name	Type	Mean	Std. Dev.	Mean	Std. Dev.
Structural						
ξ^{TB}	Matching elasticity	Beta	0.5	0.2	0.62	0.19
ξ^{SB}	Matching elasticity	Beta	0.5	0.2	0.40	0.06
Persistences						
ρ_A	TFP	Beta	0.5	0.2	0.87	0.07
ρ_i	Monetary Policy	Beta	0.5	0.2	0.48	0.21
ρ_ξ	Capital Quality	Beta	0.5	0.2	0.06	0.03
ρ_{IS}	Investment Efficiency	Beta	0.5	0.2	0.71	0.06
ρ_{Ne_TB}	Bank Net Wealth	Beta	0.5	0.2	0.13	0.07
ρ_{Ne_TB}	Bank Net Wealth	Beta	0.5	0.2	0.15	0.07
$\rho_{\lambda_{TB}}$	Traditional Bank divertible share	Beta	0.5	0.2	0.67	0.09
$\rho_{\lambda_{SB}}$	Shadow Bank divertible share	Beta	0.5	0.2	0.86	0.04
Std dev.						
e_A	TFP	Inverse Gamma	0.010	0.05	0.01	0.002
e_i	Monetary Policy	Inverse Gamma	0.010	0.05	0.003	0.001
e_ξ	Capital Quality	Inverse Gamma	0.010	0.05	0.01	0.001
e_{IS}	Investment Efficiency	Inverse Gamma	0.010	0.05	0.017	0.001
e_{Ne_TB}	Traditional Bank Net Wealth	Inverse Gamma	0.010	0.05	0.06	0.004
e_{Ne_SB}	Shadow Bank Net Wealth	Inverse Gamma	0.010	0.05	0.07	0.005
$e_{\lambda_{TB}}$	Bank divertible share	Inverse Gamma	0.010	0.05	0.04	0.003
$e_{\lambda_{SB}}$	Shadow Bank divertible share	Inverse Gamma	0.010	0.05	0.07	0.005

Table 2: Priors and posteriors of estimated parameters

This reduces consumption and output, decreasing the demand for physical capital and its price. In addition, an increase in interest rates reduces the net present value of firms' future operations and therefore their net worth. The resulting increase in the external finance premium translates into higher borrowing rates for firms, which expels the least credit worthy borrowers. This reduces investments and therefore capital overall, as well as the price of capital given its lower demand. The unanticipated decrease in capital prices weakens the ability of borrowers to repay their loans, which further dampens investment. A negative financial accelerator as in Bernanke et al. (1996) results.

With shadow banks present (blue, solid line) the initial reaction is the same. Risk free rates and borrowing rates rise and with them dividends of intermediary equity as lending for the remaining intermediaries becomes more profitable. This increases the amount of new equity issuance, especially by shadow banks as their issuance is relatively more dependent on advertisements than that of traditional banks ($\xi^{SB} > \xi^{TB}$). Households will therefore invest more into equity holdings and less into deposits. This increases in equity insulates shadow banks' source of funding and their ability to lend. Since many previously creditworthy borrowers were pushed out of the market, shadow bank loans now replace some of the lost credit. This has a dampening effect on the fall in investment, which reduces peak capital decumulation by about 75% compared to no shadow banks present. The effect is a less pronounced recession.

The behavior of shadow bank lending following a monetary policy tightening is qualitatively consistent with empirical studies of the shadow banking system (see Figure 1 and Altunbas et al. (2009); Haan and Sterk (2011); Igan et al. (2013)). Igan et al show that some shadow banks increase lending after monetary policy tightening, while banks reduce lending. Den Haan and Sterk show that both mortgages and consumption credit increase following an increase in the monetary policy rate. Finally, Altunbas et al show that European banks with more securitization activities

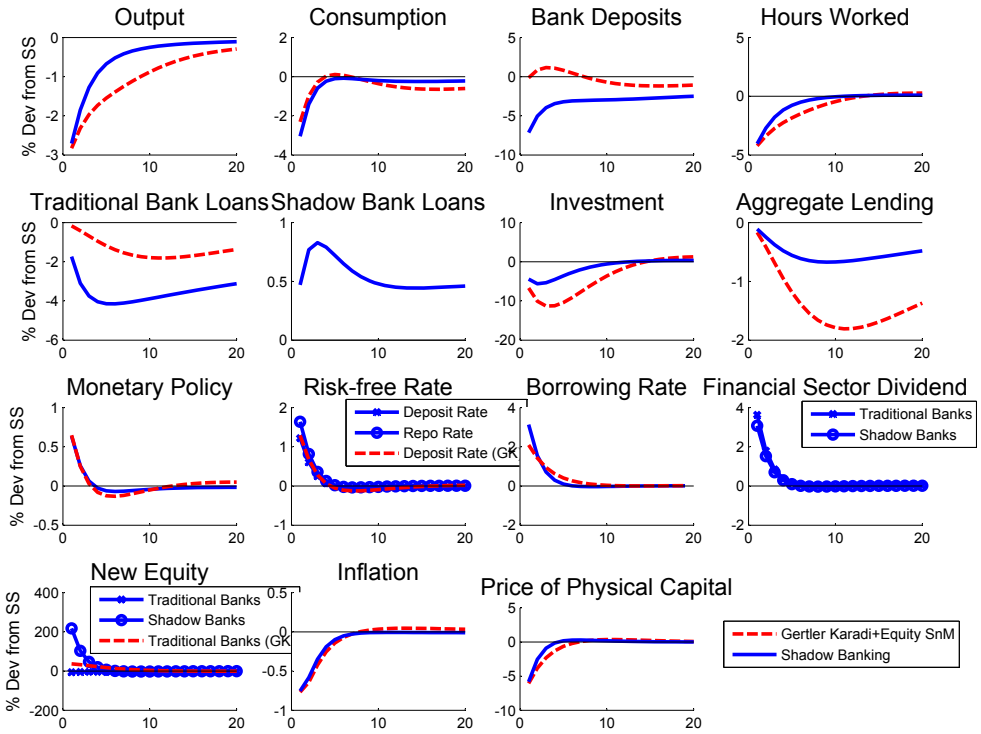

Figure 3: IRFs to Monetary Tightening

reduce their lending by less than non-securitizing banks after monetary tightening. European universal banks house both traditional banking and shadow banking activities within the same group structure. This finding is in line with understanding securitizing banks to be less affected by monetary shocks because their shadow banking operations are larger, which insulates aggregate group lending behavior by increasing shadow bank lending following monetary policy tightening.

3.3 The Role of Shadow Banks in the Business Cycle

Shadow banks change the way shocks propagate through the economy. Comparing variance decompositions of the economy with and without shadow banks shows that certain shocks are amplified while others are reduced, see Table 3. The contribution of technology shocks, both neutral and investment-specific, increases because shadow banks behave comparably to banks when real sector variables are affected. Shocks emanating from the banking sector are less pronounced, because the shadow banking sector offsets those developments, and vice versa. Monetary policy shocks are an in-between case, since they affect the real as well as the financial sectors simultaneously.

Given the changed nature of shock propagation, it follows that macroeconomic fluctuations may

Series \shock	TFP	Mon Pol	Inv	Cap Quality	Bank NW	SB NW	Bank leverage	SB leverage
Output	18% / 37%	2% / 2%	2% / 9%	13% / 14%	65% / 5%	- / 33%	1% / 0%	- / 0%
Hours	2% / 3%	5% / 6%	5% / 17%	8% / 12%	78% / 5%	- / 57%	3% / 0%	- / 1%
Investment	4% / 8%	2% / 1%	2% / 13%	5% / 7%	85% / 6%	- / 64%	2% / 0%	- / 1%
Consumption	17% / 29%	1% / 2%	1% / 4%	27% / 40%	53% / 5%	- / 19%	0% / 0%	- / 0%
Inflation	2% / 1%	10% / 7%	2% / 2%	8% / 3%	76% / 39%	- / 46%	2% / 0%	- / 1%

Table 3: Variance Decomposition without/with Shadow Banks

be attributed to different developments. To shed light on past business cycles, I perform a historical shock decomposition of the dynamics of key variables. Parameters are fixed at the posterior mean and the Kalman smoother is used to identify shock timelines that best explain the data. Figure 4 shows the log deviation of GDP, bank loans and shadow bank loans from the HP-filtered trend (data are Q1 1990 to Q4 2008).

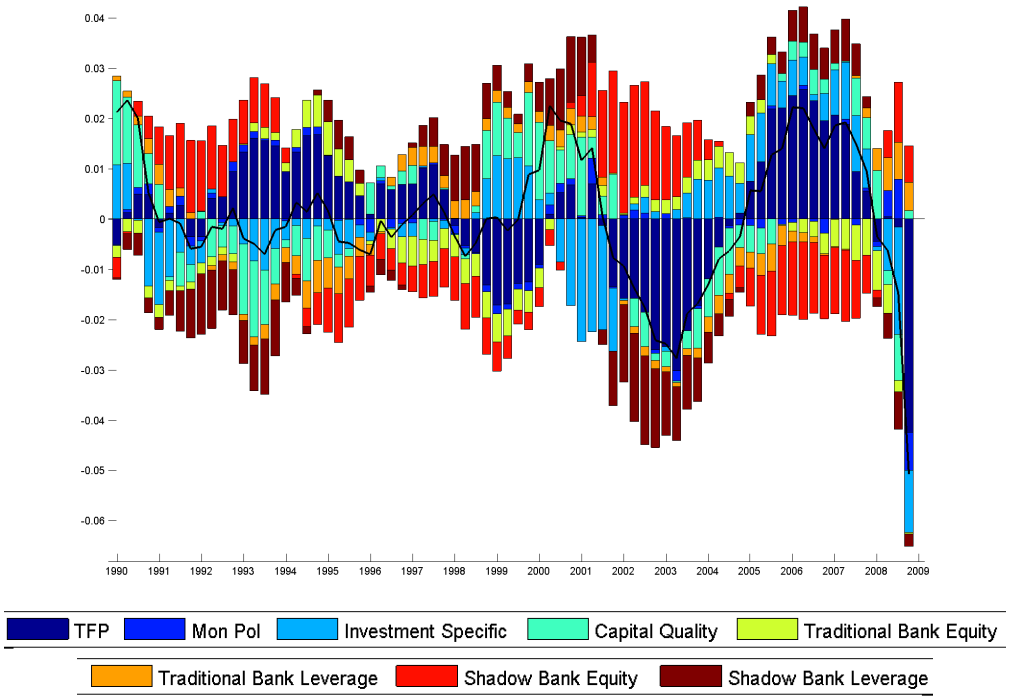

Figure 4: Historical Shock Decomposition

Focusing on the lead up to the financial crisis, the model interprets the contribution of shadow banks from a rise in their leverage, as their equity has been decreasing and confidence had increased. This reverses in 2008 when shadow banks' ability to leverage is negatively shocked.

In contrast to some voices (e.g. Taylor (2007)), the model does not interpret monetary policy to have been artificially low and thereby contributing to the housing boom. Monetary policy

influences GDP growth positively in the second and third quarter of 2008, which were the time when the Federal Reserve Bank of the U.S. cut the monetary policy rate repeatedly. Monetary policy hit the zero lower bound at the end of 2008 and the absence of aggressive further easing may – in the presence of conditions that elicit the Taylor rule to decrease rates further – be interpreted by the model as tightening.

Surprisingly, shadow bank equity receives positive shocks in the last three quarters of 2008. This may be attributed to the fact that equity in the model is measured by the difference in assets and liabilities. If shadow bank liabilities fell more quickly than their asset values, equity seems to have increased.

4 Conclusions

In this paper I have introduced non-bank financial intermediaries into a monetary financial DSGE model via the relatively parsimonious search and matching framework. Since shadow banks can find equity funding more easily than traditional banks, they are better able to stem the outflow of funds from monetary policy shocks via new equity issuance. The shadow bank equity channel therefore insulates against some of the negative consequences of the other transmission channels.

In addition, I have introduced a portfolio choice over different assets into the household maximization problem. The portfolio choice results in a rebalancing of household portfolios following shocks. Monetary policy shocks raise the attractiveness of shadow bank equity compared to traditional bank equity, allowing shadow banks to substitute debt for equity more readily than traditional banks.

Estimating the abilities of traditional banks and shadow banks to raise debt and equity results in impulse response functions suggested by empirical studies of the sector. Following monetary policy tightening, banks will decrease the amount of loans, while shadow banks will increase lending (Figure 1). As a consequence, shadow banks can significantly reduce the real effects of monetary policy shocks. At the same time, they amplify the reaction of key variables to real and financial shocks.

A historical shock decomposition shows that leveraging of the shadow banking sector was an important contributing factor to the run up to the financial crisis. Expansionary monetary policy does not seem to have played a major role, mainly because credit developments by banks and shadow banks are affected in opposite directions. Deleveraging of shadow banks was a key contributor to the sharp drop in GDP in 2008.

The modification of impulse response functions in the face of different financial intermediaries suggests an impact on the welfare effects of business cycles in the tradition of Lucas (2003). A further reduction of volatility emanating from monetary policy shocks may be achieved with a change in key shadow bank parameter values. The recognition of additional effects shadow banks introduce may impact results on both the optimal size of the financial sector as a whole, and the relative shares of its components.

Another important question is whether central bank policy reacts optimally to real and financial shocks if it does not take the presence of shadow banks into account. Monetary policy as modeled by a Taylor rule may not anticipate dampened responses following the presence of shadow banks, and may therefore not react optimally. The recognition of shadow bank lending or a modified Taylor rule that includes data on money and credit as in Christiano et al. (2007) may generate further insights in another exploration.

In the model, shadow banks fund themselves through fund shares that are sold to households only. In reality, shadow banks are often debtors to banks. Additionally, before the 2008 financial crisis mostly US shadow banks contributed to the funding of mostly EU banks. These situations could be explored in both a national and international setting to understand the funding shocks more thoroughly. These analyses will also allow us to experiment with the appropriate re-regulation of the shadow banking sector.

The model generates several hypotheses that should be tested empirically in order to determine the strength of the model. The household portfolio choice among different savings and investment types is an important mechanism driving the model. Likewise, the reaction of different interest rates and dividends to the various shocks should be established empirically.

A Appendix

A.1 Figures

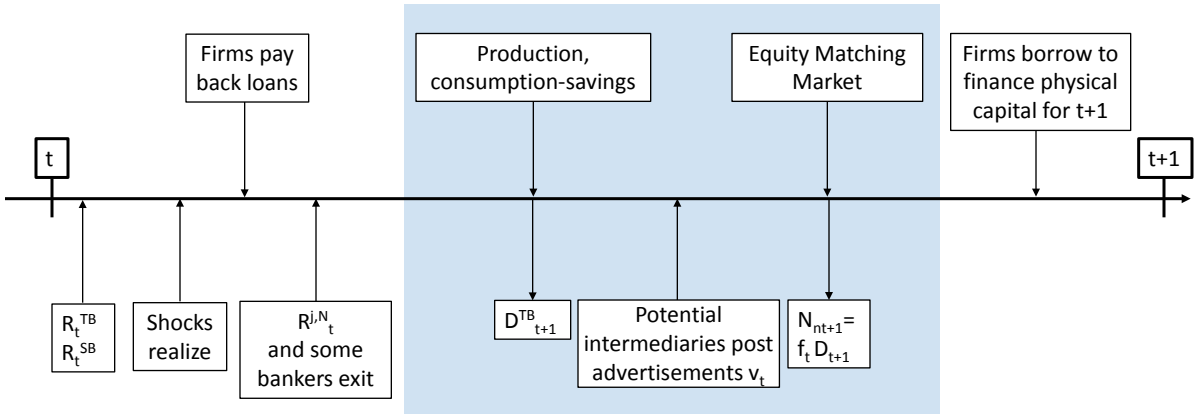

Figure 5: Timing of events

A.2 Interest Rate Bargaining

Surplus for a potential banker

$$R^N_{t+1} = argmax \quad \omega \ln H_t + (1-\omega) lnE_t.$$

For a household the value of buying an equity stake in a bank $V^{HH,e}$ versus savings at banks $V^{HH,u}$ is

$$V^{HH,e}_t = R^N_t + \beta\Lambda_{t,t+1}[(1-\chi)V^{HH,e}_{t+1} + \chi V^{HH,u}_{t+1}]$$
$$V^{HH,u}_t = R_t + \beta\Lambda_{t,t+1}[f_t V^{HH,e}_{t+1} + (1-f_t)V^{HH,u}_{t+1}],$$

which can be combined to

$$V^{HH}_t = R^N_t - R_t + \beta\Lambda_{t,t+1}(1-\chi-f_t)V^{HH}_{t+1}.$$

From the first-order condition for dividend bargaining I know that

$$\frac{\omega^{HH}}{V^{HH}_t} = \frac{(1-\omega^{HH})}{B^M_t}.$$

Solving this forward one period and inserting above, as well as inserting B^M_{t+1}, I get for the dividend banks have to pay on their equity shares

$$R^N_{t+1} = R_{t+1} + \omega^{HH}\left\{\phi_t(R_{kt+1} - R_{t+1}) + \kappa\frac{f_{t+1}}{q_{t+1}}\right\}.$$

A.3 Data Sources

Variables	Type	Source
Aggregate Output Y_t	Gross domestic product, USD, s.a.	BEA
Consumption C_t	Non-durable goods and services, USD, s.a.	BEA
Investment I_t	Gross private domestic fixed investment, USD, s.a.	BEA
Bank Loans S_t	Financial assets of U.S.-chartered depository institutions and credit unions, USD, not s.a.	U.S. FoF
Shadow Bank Loans S_t^{SB}	Financial assets of Money Market Mutual Funds,Funding corporations, finance companies, issuers of ABS, USD, not s.a.	U.S. FoF
Bank deposits D_t	Fixed income savings convertible to currency on demand of U.S.-chartered depository institutions and credit unions: checkable deposits, small time and savings deposits, large time deposits, open market paper, credit market instruments, USD, not s.a.	U.S. FoF
ABCP B_t^{SB}	Fixed income savings convertible to currency on demand of Money Market Mutual Funds, Funding corporations, finance companies, issuers of ABS: commercial paper, credit market instruments, USD, not s.a.	U.S. FoF

Table 4: Data sources and definitions

A.4 Bayesian Estimation

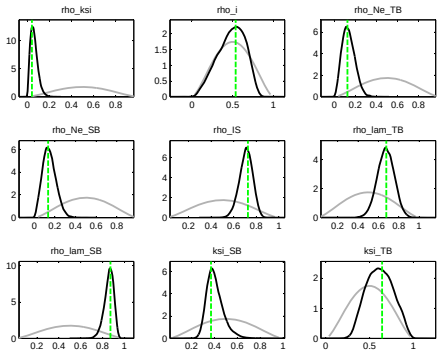

Figure 6: Univariate Diagnostics

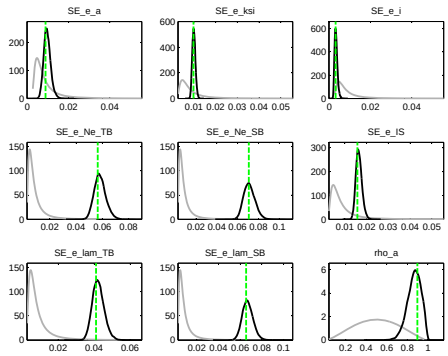

Figure 7: Univariate Diagnostics

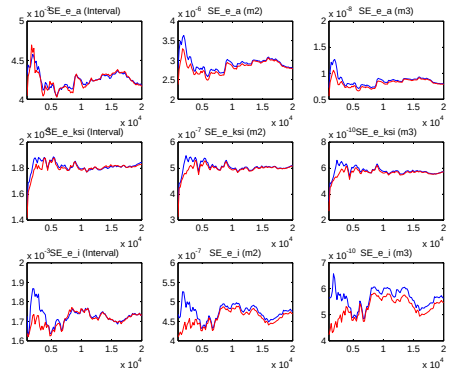

Figure 8: Univariate Diagnostics

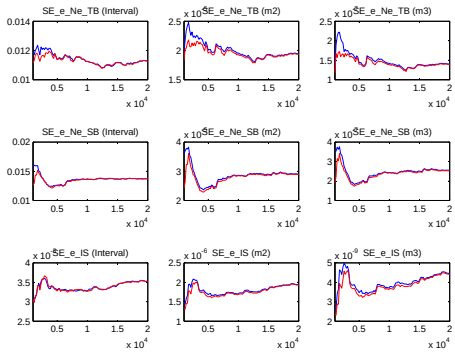

Figure 9: Univariate Diagnostics

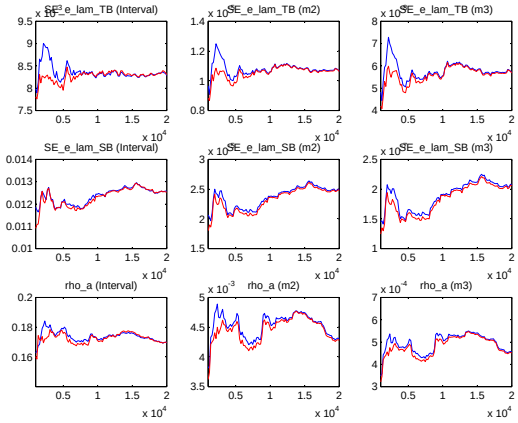

Figure 10: Univariate Diagnostics

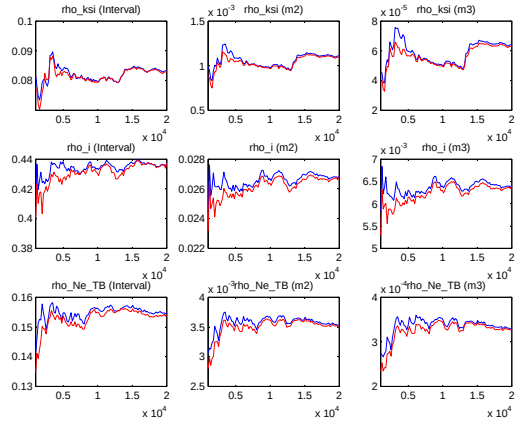

Figure 11: Univariate Diagnostics

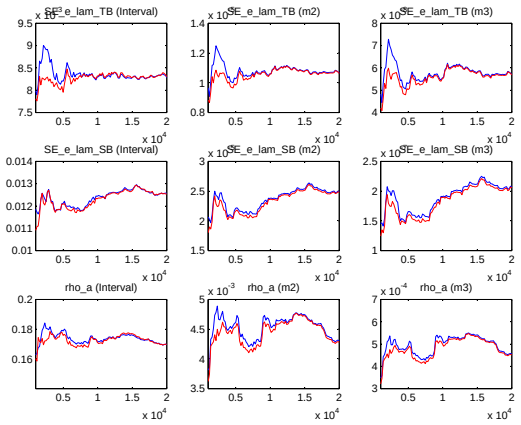

Figure 12: Univariate Diagnostics

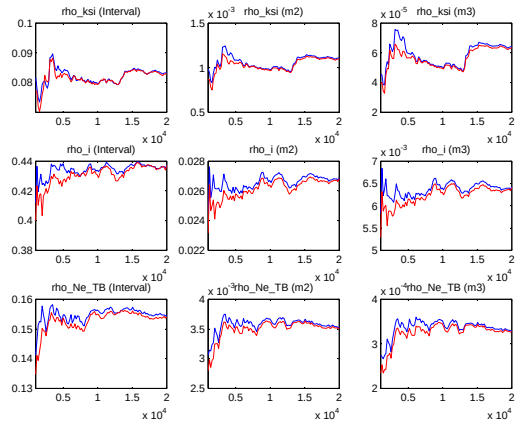

Figure 13: Univariate Diagnostics

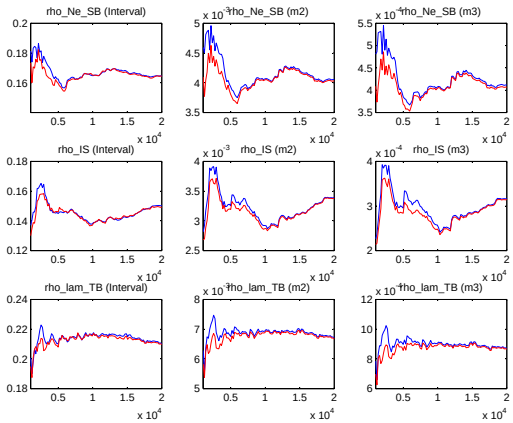

Figure 14: Univariate Diagnostics

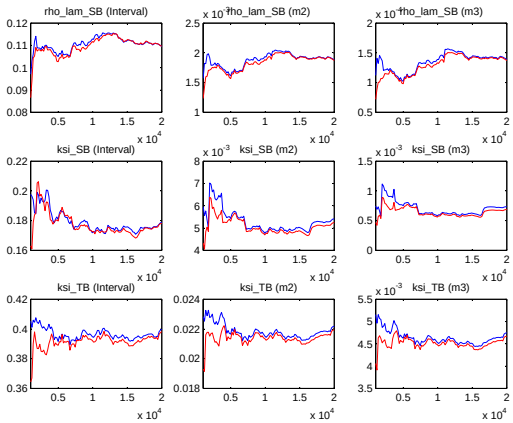

Figure 15: Univariate Diagnostics

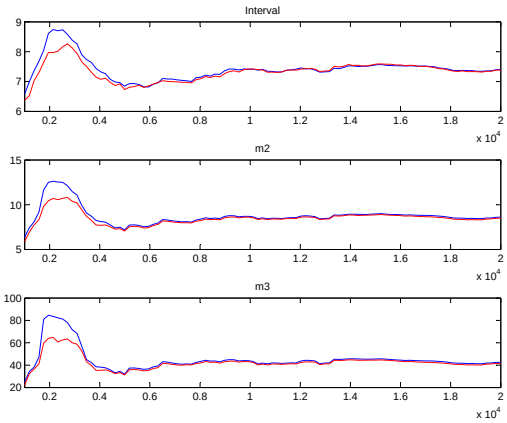

Figure 16: Multivariate Diagnostics

References

Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez
2009. Securitisation and the bank lending channel. *European Economic Review*, 53(8):996–1009.

Bernanke, B., M. Gertler, and S. Gilchrist
1996. The Financial Accelerator and the Flight to Quality. *The Review of Economics and Statistics*, 78(1):1–15.

Christiano, L., R. Motto, and M. Rostagno
2007. Two Reasons Why Money and Credit May be Useful in Monetary Policy. NBER Working Papers 13502, National Bureau of Economic Research, Inc.

Christiano, L., M. Rostagno, and R. Motto
2010. Financial factors in economic fluctuations. Working Paper Series 1192, European Central Bank.

Dell'Ariccia, G. and P. Garibaldi
1998. Bank Lending and Interest Rate Changes in a Dynamic Matching Model. IMF Working Papers 98/93, International Monetary Fund.

den Haan, W. J., G. Ramey, and J. Watson
2003. Liquidity flows and fragility of business enterprises. *Journal of Monetary Economics*, 50(6):1215–1241.

Financial Stability Board
2014. Global shadow banking monitoring report 2014. Technical report, Financial Stability Board.

Gertler, M. and P. Karadi
2011. A model of unconventional monetary policy. *Journal of Monetary Economics*, 58(1):17–34.

Gertler, M. and N. Kiyotaki
2010. Financial Intermediation and Credit Policy in Business Cycle Analysis. In *Handbook of Monetary Economics*, B. M. Friedman and M. Woodford, eds., volume 3 of *Handbook of Monetary Economics*, chapter 11, Pp. 547–599. Elsevier.

Gertler, M., N. Kiyotaki, and A. Queralto
2012. Financial crises, bank risk exposure and government financial policy. *Journal of Monetary Economics*, 59(S):S17–S34.

Goodhart, C. A., A. K. Kashyap, D. P. Tsomocos, and A. P. Vardoulakis
2012. Financial regulation in general equilibrium. Working Paper 17909, National Bureau of Economic Research.

Haan, W. J. D. and V. Sterk
2011. The Myth of Financial Innovation and the Great Moderation. *Economic Journal*, 121(553):707–739.

Igan, D., A. N. Kabundi, F. N.-D. Simone, and N. T. Tamirisa
2013. Monetary Policy and Balance Sheets. IMF Working Papers 13/158, International Monetary Fund.

Justiniano, A., G. E. Primiceri, and A. Tambalotti
2010. Investment shocks and business cycles. *Journal of Monetary Economics*, 57(2):132–145.

Lucas, Robert E., J.
2003. Macroeconomic priorities. *American Economic Review*, 93(1):1–14.

Meeks, R., B. Nelson, and P. Alessandri
2014. Shadow banks and macroeconomic instability. Bank of England working papers 487, Bank of England.

Meh, C. A. and K. Moran
2010. The role of bank capital in the propagation of shocks. *Journal of Economic Dynamics and Control*, 34(3):555–576.

Nelson, B., G. Pinter, and K. Theodoridis
2015. Do contractionary monetary policy shocks expand shadow banking? Bank of England working papers 521, Bank of England.

Petrongolo, B. and C. A. Pissarides
2001. Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, 39(2):390–431.

Pozsar, Z.
2014. Shadow banking: The money view. Ofr working paper, Office of Financial Research.

Taylor, J.
2007. Housing and Monetary Policy. Discussion Papers 07-003, Stanford Institute for Economic Policy Research.

Verona, F., M. M. F. Martins, and I. Drumond
2013. (Un)anticipated Monetary Policy in a DSGE Model with a Shadow Banking System. *International Journal of Central Banking*, 9(3):78–124.

Wasmer, E. and P. Weil
2004. The Macroeconomics of Labor and Credit Market Imperfections. *American Economic Review*, 94(4):944–963.

Woodford, M.
2010. Financial Intermediation and Macroeconomic Analysis. *Journal of Economic Perspectives*, 24(4):21–44.