Shadow Banking and Risk Sharing

Jie Ying *

April 15, 2017

Abstract

This paper models the shadow banking mechanism and discusses its functionality of risk sharing and its impact on financial instability. In equilibrium, shadow banking is more active when investors perceive higher expected returns from financial market. Shadow banking system shrinks when the market gets more volatile. Lower interest rates from traditional banks encourage shadow banking and the magnitude depends on investors’ aggregate risk preference. Overactive shadow banking activities can “cool down” itself. Shadow banking’s influence over the economy is twofold: it improves the overall welfare of heterogeneous agents by risk sharing, but it spreads the risk through the financing channel, which makes the savers more vulnerable to the negative shocks in the financial market.

*Department of Finance, Henry B. Tippie College of Business, University of Iowa. Email: jie-ying@uiowa.edu
Shadow Banking and Risk Sharing

Abstract

This paper models the shadow banking mechanism and discusses its functionality of risk sharing and its impact on financial instability. In equilibrium, shadow banking is more active when investors perceive higher expected returns from financial market. Shadow banking system shrinks when the market gets more volatile. Lower interest rates from traditional banks encourage shadow banking and the magnitude depends on investors’ aggregate risk preference. Overactive shadow banking activities can “cool down” itself. Shadow banking’s influence over the economy is twofold: it improves the overall welfare of heterogeneous agents by risk sharing, but it spreads the risk through the financing channel, which makes the savers more vulnerable to the negative shocks in the financial market.
1 Introduction

Financial intermediaries improve resource allocation and market completeness in the economy by providing extra financing channels among agents with different endowments, preferences, and productivities. History shows that many financial crises were attributed to the failure of financial intermediaries such as the 1930s Bank Runs crisis and the 2007-2009 sub-prime crisis. With the implementation of deposit insurance and discount window, traditional banks now can provide safe claims to households, which efficiently prevent bank runs. However, the “safety” of traditional banks comes with costs. The capital requirements and other restrictions make traditional banks less appealing to investors than the other form of banking: shadow banking.

Shadow banking refers to a series of securitization and secured funding techniques such as money market mutual funds (MMMFs), collateralized debt obligations (CDOs) and repurchase agreements (repos) (Pozsar et al. (2010)). It provides safe claims to investors through collateralizing the deposits with liquid assets or securitized illiquid assets. Once borrowers fail to repay the loan and contracted interest, lenders are entitled to liquidate borrowers’ asset for repayment. On one hand, shadow banking is more efficient in terms of credit and liquidity transformation because of its floating, customizable interest rates, and less restricted terms. On the other hand, compared to traditional banking, shadow banking is more fragile under unanticipated negative shocks. As argued by Gennaioli et al. (2013) and Martin et al. (2014), the collapse of shadow banking played a critical role in the formation of the 2007-2009 financial crisis.

In this paper, I propose a new model in which shadow banking provides addi-
tional risk sharing between depositors and borrowers through collateralized lending. In my model, following the seminal work of Diamond and Dybvig (1983), each agent faces an idiosyncratic preference shock. I extend the static three-period model into a dynamic equilibrium model with overlapping generations as in Qi (1994). The traditional banking provides intragenerational risk sharing by offering a predetermined interest rate. Once preferences are revealed, aggressive agents can lever up their security investments by borrowing from the new generation whose preferences are still uncertain. The lending contract is collateralized with aggressive agents’ financial assets. This intergenerational funding channel is defined as shadow banking because (1) it connects the borrowers who demand funding and depositors whose saving demand is not satisfied by traditional banking, and (2) the interest rate is endogenized and unregulated. Since borrowing through traditional banking usually requires physical assets as collateral, aggressive agents who invest in financial assets are unable to lever up their position through traditional banking.

The model solution shows two important features of shadow banking: procyclicality and path-dependence. When the economy is prosperous, the high expected return in financial market encourages levered investment and the lower interest rate in traditional banking drives the savers to transfer deposits from traditional banking account to shadow banking account, which both increases shadow banking volume. Another phenomenon associated with a booming economy is high market participation. If more people turn to invest the saving in financial market instead of consuming it right away, this preference shock also drives up the volume

---

1 One “generation” in this paper can be very short - overnight when agents make their deposits and during the day when they withdraw and consume, or invest and consume later.
of shadow banking activity. When the economy hits the turning point, the high volatility in the financial market scares the investors away and reduces the volume of shadow banking activities because of the decreasing demand of borrowing. The path-dependence of shadow banking is reflected in the impact of shadow banking activities of last generation on the shadow banking activities of present generation. Overactive shadow banking in previous generation “cools down” the shadow banking activities in current generation, which results from increased collateral and decreased interest rate.

The results also show that shadow banking improves the welfare of both aggressive and conservative agents. As creditors both kinds of agents have the chance to receive higher interest returns by lending through shadow banking, and aggressive agents enjoy the profit from leverage. Shadow banking, however, adds instability to the economy by spreading capital market risk from aggressive agents to conservative agents. Once a negative shock is realized in the investment, aggressive agents default on the shadow banking debt. The liquidation value of the collateral can be even lower than the traditional banking yield, which makes creditors of the shadow banking system worse off.

There has been some emerging literature in shadow banking research. Most of the literature attempts to describe the shadow banking system, for example, Pozsar et al. (2010), Gorton et al. (2010), Gorton and Metrick (2012), and Acharya et al. (2013). The authors document the growth of shadow banking in the United States, describe the functions of all forms of shadow banking, and discuss the reason behind the growth of shadow banking. Gorton et al. (2010) argues that the growth of shadow banking is attributed to both supply and demand sides. Financial innovations allow intermediaries to create money-like instruments to overcome the
comparative advantage of traditional banks, and the increasing financial transactions require the development of securitization and collateralization. All the papers believe the collapse of shadow banking is central to the most recent financial crisis.

This paper contributes to the class of papers which focuses on modeling the mechanism behind shadow banking. In contrast with Gennaioli et al. (2013), Hanson et al. (2015), and Sunderam (2014), all of which model shadow banking with static equilibrium, my model captures the dynamic feature of the development of shadow banking activities. Inspired by Hanson et al. (2015), shadow banking in my model creates safe claims and stable interest incomes when adverse shock is moderate, however, once the negative shock is large enough the default option of shadow banking debts allows borrowers of shadow banking to share the loss with its lenders. Among the dynamic models of shadow banking, Moreira and Savov (2014) use a jump process of a latent crash variable to derive the liquidity crisis in an economy with shadow banking. My approach to model the market crash is simpler: investors’ dramatic loss during market crash is a consequence of deep leverage through shadow banking.

The model explored in this paper is also related to the literature that researches financial frictions. Benanke and Gertler (1989) and Bernanke et al. (1999) captures the amplification and propagation effect of friction assuming the convex adjustment cost. Bernanke et al. (1991) describes the process of credit crunch and its macroeconomic impact. The collateralization setting in my model is inspired by Kiyotaki and Moore (1997), who consider the collateral value of assets as the primary limit of external funding; and Shleifer and Vishny (1992) who argue that the liquidation value of collateral affects corporate debt capacity. Similar to Brunnermeier and Pedersen (2009) who show that the restriction of collateralized lending
is linked to the volatility of the collateral assets, the volatility of risky investment in my model determines investors’ expectations of a default in shadow banking and affect the shadow banking activities. Other research related to this paper includes Curdia and Woodford (2010), Adrian et al. (2012), and Brunnermeier et al. (2012).

Lastly, my paper adds to the literature on financial intermediaries. In recent years, the focus of research on financial crisis has shifted to financial intermediaries, such as Holmstrom and Tirole (1997), Gertler and Karadi (2011), Duffie and Strulovici (2012), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014), Adrian and Boyarchenko (2012), Muir (2016), and Rampini and Viswanathan (2017). They model financial intermediaries as a special agent between households and entrepreneurs, and intermediaries have their own risk preference and consumption optimization problem. Here I do not explicitly model shadow banking as a stand-alone agent. Instead, I distinguish traditional banking and shadow banking as two financing channels. This definition simplifies the analysis and helps separate the roles of traditional banking and shadow banking as two types of intermediaries. Similar to the financial intermediary literature, my model provides an explanation to the financial crisis.

The rest of the paper is organized as follows. In Section 2, I introduce the model setup. In Section 3, I formalize the model solution in equilibrium and discuss the numerical results. In Section 4, I show the results from simulation. Section 5 concludes.
2 Model

In the model, there is an infinite number of overlapping generations of agents in the economy. Each generation lives three periods (T=0, 1, 2). There is a continuum of agents in every generation. When agents are born in period 0 with endowment of 1 unit, they are uncertain about their preference: aggressive or conservative. Each agent learns its privately observed preference in period 1 when they establish their utility function:

\[
U(C_1, C_2) = \begin{cases} 
C_1, & \text{if conservative, with probability } e \\
C_2, & \text{if aggressive, with probability } 1 - e 
\end{cases}
\]

where \( C_i \) stands for agents’ consumption at period \( i \). Agents’ preference in each generation is exogenously determined: \( e \) of one generation is conservative and \( 1 - e \) is aggressive. \( e \) may change over generations and is unknown to agents in period 0.

Agents’ risk aversion changes over time as well. All agents in period 0 (uncertain agents) are risk-neutral. Conservative agents in period 1 are infinitely risk-averse so they stop investing or saving and consume everything. Aggressive agents in period 1 are risk neutral and will start to invest. To match reality, the uncertain agents in the model represent households who receive a fortune the first time and need time to figure out what to do with the fortune. After they figure out whether they are conservative or aggressive, the conservative households withdraw and consume the fortune immediately, and the aggressive households become active investors in financial market.

Investment bears aggregate risk in the capital market. For each time \( t \), invest-
ment yields return $R_t$, where $R_t \sim N(\mu_t, \sigma^2_t)$. $R_t's$ are assumed to be independent across time, and $\mu_t$ and $\sigma_t$ are exogenously determined.

In period 0, limited market participation is assumed as in Diamond (1997). Uncertain agents will either deposit the endowment in traditional banks, or lend to aggressive agents of previous generation through shadow banking. The rationale is that cash management decision is a trade-off between traditional banking and shadow banking, which are essentially different from equity or bond investment in terms of risk and liquidity. If one generation refers to one day, the generation starts at 3:00 PM when the market is closed, and investor can only choose to keep the cash either in traditional banking account or in shadow banking account such as purchasing overnight repo agreement.

Therefore, uncertain agents in generation $g$ deposit $w_g$ of their endowments in traditional bank and lend $1 - w_g$ to the aggressive agents of generation $g - 1$ through shadow banking. The deposits in traditional banks earn a fixed interest of $r_b$. The interest serving as the indemnity of deposit insurance is paid by the aggressive agents to the conservative agents within the same generation, which is related to the argument in Diamond and Dybvig (1983). I assume a fixed $r_b$ because traditional banking interest rate is closely related to federal funds rate which is usually much less volatile than shadow banking interest rate such as repo rate.

The shadow banking lending has a contracted interest of $r_{s,g}$. However, if the aggressive agents in previous generation default on the shadow banking debts, agents in generation $g$ are entitled to liquidate the aggressive agents’ assets and
have a return of \( r'_{s,g} \). Hence the payoff for agents in generation \( g \) at period 1 is

\[
V_{g,1} = \begin{cases} 
  w_gr_b + (1 - w_g) r_{s,g}, & \text{if shadow banking debt is not defaulted} \\
  w_gr_b + r'_{s,g}, & \text{if shadow banking debt is defaulted}
\end{cases}
\]

and the optimization problem for uncertain agents in generation \( g \) at period 0 is

\[
\max_{w_g} E(V_{g,1} | r_{s,g})
\]

The plot below illustrate the cash flows within generation and between generations.

In period 1, \((1 - e_g)\) agents turn to be aggressive and borrow \( \frac{1 - w_g + 1}{1 - e_g} \) from generation \( g + 1 \) through shadow banking. So the asset in place for aggressive agents in period 1 is

\[
A_g = w_g \frac{1 - r_b e_g}{1 - e_g} + n_{s,g} + \frac{1 - w_{g+1}}{1 - e_g}
\]
where \( \tilde{r}_{s,g} = (1 - w_g)r_{s,g} \) if shadow banking debt is not defaulted, \( \tilde{r}_{s,g} = r'_{s,g} \) if shadow banking debt is defaulted.

The first term on the right hand side of (1) is \( w_g \frac{1-r_b}{1-e_g} \) instead of \( w_g r_b \) because, as argued in Diamond and Dybvig (1983), traditional banking transforms the credit between different agents in the future, and \( r_b \) becomes the interest aggressive agents pay to conservative agents once preference is revealed. Also, if aggressive agents know their preference in period 0 they would have invested in the risky assets, so \( w_g r_b - w_g \frac{1-r_b}{1-e_g} \) reflects aggressive agents’ opportunity cost brought by the preference shock.

Assuming the aggressive agents face quadratic adjustment cost for investment, the payoff in period 2 is

\[
V_{g,2} = \max \left[ A_g R_g - A_g^2 c - \frac{(1 - w_{g+1})r_{s,g+1}}{1 - e_g}, 0 \right]
\]

where \( R_g \) is the realized return of the investment for generation \( g \) in period 2. \( c \) is the adjustment cost coefficient. The adjustment cost can be seen as the fee of managing assets in place which prevents aggressive agents levering up without limits. \( r_{s,g+1} \) is the shadow banking interest contracted between generation \( g \) and \( g + 1 \). The optimization problem for aggressive agents in generation \( g \) at period 1 is

\[
\max_{r_{s,g+1}} E(V_{g,2} | w_{g+1})
\]
3 Equilibrium

Since uncertain agents in generation $g$ can observe the historical mean and volatility of the investment’s return for generation $g - 1$, they perceive the probability of shadow banking being defaulted as

$$
Prob(\text{default}) = F \left( R_{g-1} \leq \frac{A_{g-1}^2 c + \frac{(1-w_g) r_{s,g}}{1-e_{g-1}}}{A_{g-1}} \right)
$$

where $F(\cdot)$ is the c.d.f of normal distribution. Then, given the shadow banking interest rate $r_{s,g}$, the optimization problem for uncertain agents of generation $g$ in period 0 can be rewritten as

$$
\max_{w_g} \int_{d_{g-1}}^{\infty} (w_g r_b + (1-w_g) r_{s,g}) f(R_{g-1}) dR_{g-1} + \int_{-\infty}^{d_{g-1}} (w_g r_b + r'_{s,g}) f(R_{g-1}) dR_{g-1}
$$

s.t. $d_{g-1} = A_{g-1} c + \frac{(1-w_g) r_{s,g}}{(1-e_{g-1}) A_{g-1}}$

$$
r'_{s,g} = (A_{g-1} R_{t-1} - A_{g-1}^2 c)(1 - e_{g-1})
$$

where $d_{g-1}$ is the critical return of the investment that makes aggressive agents of generation $g - 1$ indifferent between default or not default. $r'_{s,g}$ is the liquidation return once default happens. The p.d.f $f(R_{g-1})$ is identified by the mean $\mu_{g-1}$ and standard deviation $\sigma_{g-1}$.

The solution to the optimization problem $w^*(r_{s,g})$ will be a function of shadow banking yield $r_{s,g}$, which means uncertain agents of generation $g$ decide lending amount based on the interest yield promised by aggressive agents of generation $g - 1$. Since aggressive agents are risk neutral, they will borrow through shadow
banking as long as the expected payoff is not worse than not borrowing. So the shadow banking yield $r_{s,g}$ is chosen to let the following inequality holds:

$$A_{g-1}\mu_{g-1} - A_{g-1}^2 c - \frac{(1-w_g)r_{s,g}}{1-e_{g-1}} \geq \left(A_{g-1} - \frac{1-w_g}{1-e_{g-1}}\right) \mu_{g-1} - \left(A_{g-1} - \frac{1-w_g}{1-e_{g-1}}\right)^2 c$$

In equilibrium, we have the equality and we can plug in $w^*(r_{s,g})$ to solve for $r^*_s$. $w^*_g$ and $r^*_{s,g}$ in equilibrium are solved numerically with state variables: (1) expected risky return $\mu_{g-1}$, (2) observed market volatility $\sigma_{g-1}$, (3) traditional banking yield $r_b$, (4) generation $g-1$’s shadow banking activities $1-w_g$, (5) generation $g-1$’s yield from shadow banking $\tilde{r}_{s,g-1}$, (6) percentage of generation $g-1$ as aggressive agents $1-e_{g-1}$, and (7) adjustment cost $c$.

### 3.1 Shadow Banking and Expected Risky Return

[Figure 1 is inserted here]

When aggressive agents have a higher expectation about risky investment, they have an incentive to borrow more through shadow banking and offer relatively higher interest rate at the same time. According to figure 1, shadow banking activities $1-w_g$ is much more sensitive to the change of expected risky return $\mu_{g-1}$ than the shadow banking yield $r_{s,g}$ is. On one hand, with an increase of about 8% in expected risky return, uncertain agents in period 0 change from not funding through shadow banking at all to lending entire endowments through shadow banking. Shadow banking yield, on the other hand, changes marginally with the expected risky return.

The result is consistent with reality: when active investors observe a highly profitable investment opportunity, they tend to increase their leverage, and house-
holds who are optimistic about the underlying asset are willing to purchase more asset-backed securities. It is worth noting that even if no one wants to lend through shadow banking, \(1 - w_g = 0\), there still exists a shadow banking interest which merely reflects the hypothetical marginal interest that aggressive agents would like to pay.

### 3.2 Shadow Banking and Market Volatility

Figure 2 shows that shadow banking is more active when the market is less volatile. In a highly volatile market, it is more likely for the active investors to encounter a negative productivity shock, and the level of shock can be deeper than in a less volatile market. In shadow banking, a large negative shock from risky investments can lead to borrowers defaulting. To prevent a default happening, when a high volatility is observed, both borrowers and lenders choose to “cool down” the shadow banking activities.

In figure 2, shadow banking yield increases with market volatility. That is because a higher interest rate is needed to compensate the larger chance of default when the market is more volatile. And the requested higher interest rate further discourage active investors from borrowing through shadow banking. The curves also suggest a nonlinear relationship between market volatility and shadow banking activities. When market volatility is low, the marginal depression of shadow banking is small. But once the market becomes increasingly volatile, creditors sharply decrease their position in shadow banking. This finding can partially explain the fire sales of repos in 2007-2009 financial crisis.
3.3 Shadow Banking and Traditional Banking

As discussed in Hanson et al. (2015), the coexistence of traditional banks and shadow banks poses a new challenge to the government. Fire-sale is more likely to occur if shadow banks hold more risky asset. My model captures the incentive of shadow banking from the perspective of traditional banking. Higher traditional banking interest which is essentially risk-free due to deposit insurance and government guarantees makes the shadow banking which suffers default risk less attractive to the investors. Aggressive agents have to raise the shadow banking interest in order to borrow through shadow banking under increasing traditional banking interest.

In practice, the traditional banking interest rate is often adjusted by government as a policy tool. When the economy shows a hint of slowing down, government lowers the interest rate to encourage investment. However, as shown in my model, the decrease of traditional banking interest drives the savers to have deeper position in shadow banking which is exposed to aggregate risk. It makes the savers more vulnerable when the market crashes. This implication is consistent with the federal funds rate downward adjustments before 2001 and 2008 market crashes. Lower “safe” interest rate leads to active investors’ irrational enthusiasm about investment and leverage deeper through shadow banking. When the bubble burst, a series of defaults hurt the creditors in the shadow banking.

The bubble in shadow banking not only depends the traditional banking interest, but also depends on the percentage of aggressive agents in previous generation.
Figure 4 shows the relationships of traditional banking interest and shadow banking activities with different percentages of aggressive agents in previous generation. It illustrates that when $e_{g-1}$ is lower – meaning there are higher number of aggressive agents – one unit decrease of traditional banking interest encourages more shadow banking activities.

3.4 Shadow Banking between Generations

[Figure 5 is inserted here]

My model demonstrates the cyclical feature of shadow banking activities over generations as shown in Figure 5. If the previous generation invests more in shadow banking in period 0, aggressive agents of this generation in period 1 will have more collateral given no default in period 1. More collateral of debtors lowers the shadow banking rate that creditors require to compensate the possibility of default since debtors suffer a larger loss if defaulting at this time. The downward sloping curve of shadow banking yield illustrates this point.

Ceteris paribus, an overactive shadow banking in previous generation “cools down” the shadow banking activities in current generation, illustrated by Figure 5. This relationship suggests that shadow banking goes through a fluctuating process at beginning phase and will eventually become stable. In the long run, shadow banking will not fully replace the role of traditional banking.

3.5 Shadow Banking and Preference Shock

[Figure 6 is inserted here]
Since shadow banking is primarily initiated by aggressive agents who want to leverage their investment, the shadow banking activities are positively associated with the percentage of aggressive agents in their generation. In practice, the number of active investors depends on many factors – culture, economy, war, technology, etc.. For example, a predominant trend of entrepreneurship in the society may turn more people into aggressive investors, which increases the demand of shadow banking.

With very few aggressive agents, the shadow banking interest is high because there is little aggregate collateral. When there are more aggressive agents with more assets as collateral, the shadow banking interest sharply shrinks. It is consistent with people’s fear of default towards the start-ups. But when the group of start-ups becomes larger forming the scale effect, like the IT start-ups in Silicon Valley, investors are more willing to fund even though they know the firms are very immature. Once the shadow banking debt supply is capped, additional demand drives up the shadow banking interest as illustrated in figure 6 when $1 - e_{n-1} > 0.7$.

### 3.6 Shadow Banking and Adjustment Cost

[Figure 7 is inserted here]

As shown in figure 7, shadow banking activities are very sensitive to the adjustment cost. Higher adjustment cost discourages aggressive agents’ investment in the risky assets, which further reduces the demand of shadow banking debt. Also the higher adjustment cost makes aggressive agents more careful with selecting risky investment and lowers the chance of default. The lower chance of default reduces the interest required by the shadow banking creditors.
4 Simulation

To investigate the impact of shadow banking on both conservative agents and aggressive agents, I implement a simulation procedure. In period 1 of each generation, agents are split into two types: conservative agents who consume immediately and aggressive agents who invest in risky assets and consume in period 2. With traditional banking only, conservative agents always consume \( r_b \) because the interest payment is secured by the government, and aggressive agents consume \( \frac{1 - ne}{1 - e} R \) where \( R \) is the realized investment return. With both traditional banking and shadow banking, agents’ consumption depends on the state variables discussed above and the realized investment return.

If the realized risky return is high enough, aggressive agents do not default and conservative agents receive the contracted shadow banking yield. If realized risky return is low, aggressive agents default and lose everything while conservative agents consume the liquidation value of aggressive agents’ asset.

I let risky returns follow normal distribution with mean 1.12 and standard deviation 0.18. Since shadow banking activities and shadow banking yield are endogenously determined by the expected risky return and its volatility, I assume agents in the economy can only estimate the true mean and standard deviation by the historical average and sample standard deviation. As a result, the observed expected risky return and volatility vary over generations. The variability of the perceived expected risky return and volatility adds fluctuation to the simulated shadow banking yield.

[Figure 8 is inserted here]

Figure 8 shows the simulated conservative agents’ consumption over genera-
tions. The red line indicates the constant traditional banking yield. The blue wavy line is conservative agents’ consumption when shadow banking is available. As shown in the figure 8, conservative agents’ consumption is higher with than without shadow banking for most generations. It suggests that shadow banking does improve conservative agents’ welfare by risk sharing. However, once risky investment encounters large negative shock, conservative agents suffer dramatic loss. The scatter dramatic losses of conservative agents are caused by the aggregate risk brought in by the shadow banking channel. When a negative shock in risky investment is realized, shadow banking debts default and both agents share the loss.

[Figure 9 is inserted here]

Figure 9 illustrates the simulated aggressive agents’ consumption over generations. As discussed in previous sections, shadow banking helps lever up aggressive agents’ investment, so the gain and loss are both exaggerated. But since the loss is capped at 0, the average consumption of aggressive agents is higher with than without shadow banking. Aggressive agents are risk neutral so shadow banking improves their welfare as well.

The simulated results suggest that shadow banking improves both agents’ welfare, however, making the economy more instable. During 2007-2009 crisis, the unanticipated sudden drop of housing price made the households who invest passively and pursue the stable earning suffer the most. The risk-taking investors are voluntarily exposed to high risk so the financial crisis does not impact their utility that much.
5 Conclusion

My model of shadow banking system answers two important questions: (1) what determines the level of shadow banking activities? (2) how does shadow banking influence the economy, especially the financial instability? For the first question, my model suggests that, in dynamic equilibrium, shadow banking is more active when investors expect higher return or less volatility from risky investment, lower traditional banking interest, higher demand of shadow banking debts from active investors, and lower adjustment cost of investments.

For the second question, the simulations show that shadow banking improves the welfare of both conservative agents and aggressive agents by providing extra risk sharing. Conservative agents consume more since they earn more from lending through shadow banking. Aggressive agents are risk neutral and better off with shadow banking because their gain from positive shock of risky investment is levered up while their loss is capped by defaulting on the shadow banking debts. However, when the economy experiences negative shock, conservative agents suffer dramatic loss which they will never have without shadow banking. The simulation result suggests that shadow banking makes the financial market more instable and expose the savers who pursue stable interest income to the production risk.
References


Muir, Tyler, 2016, Financial crises and risk premia, *Available at SSRN 2379608*.


Figure 1: Shadow Banking and Expected Risky Return

\[
\sigma_{g-1} = 0.18, \ r_b = 1.02, \ w_{g-1} = 0.25, \ \tilde{r}_{s,g-1} = 0.8, \ e = 0.5, \ c = 0.02
\]
Figure 2: Shadow Banking and Market Volatility

\[ \mu_{g-1} = 1.12, \ r_b = 1.02, \ w_{g-1} = 0.25, \ \tilde{r}_{s,g-1} = 0.8, \ e = 0.5, \ c = 0.02 \]
Figure 3: Shadow Banking and Traditional Banking

\[ \mu_{g-1} = 1.12, \sigma_{g-1} = 0.18, w_{g-1} = 0.25, \tilde{r}_{x,g-1} = 0.8, e = 0.5, c = 0.02 \]
Figure 4: Shadow Banking and Traditional Banking with Preference Shock

\[ \mu_{g-1} = 1.12, \quad \sigma_{g-1} = 0.18, \quad w_{g-1} = 0.25, \quad \tilde{r}_{s,g-1} = 0.8, \quad c = 0.02 \]
Figure 5: Shadow Banking between Generations

\[ \mu_{g-1} = 1.12, \sigma_{g-1} = 0.18, r_b = 1.02, \tilde{r}_{s,g-1} = 0.8, e = 0.5, c = 0.02 \]
Figure 6: Shadow Banking and Preference Shock

\[ \mu_{g-1} = 1.12, \sigma_{g-1} = 0.18, r_b = 1.02, w_{g-1} = 0.25, \tilde{r}_{g-1} = 0.8, c = 0.02 \]
Figure 7: Shadow Banking and Adjustment Cost

\( \mu_{g-1} = 1.12, \ \sigma_{g-1} = 0.18, \ r_{b} = 1.02, \ w_{g-1} = 0.25, \ \tilde{r}_{s,g-1} = 0.8, \ e = 0.5 \)
Figure 8: Simulation of Conservative Agents’ Consumption

\[ \mu_{g-1} = 1.12, \sigma_{g-1} = 0.18, r_b = 1.02, e = 0.5, c = 0.02 \]
Figure 9: Simulation of Aggressive Agents’ Consumption

\[
\mu_{g-1} = 1.12, \sigma_{g-1} = 0.18, r_b = 1.02, e = 0.5, c = 0.02
\]