Banks, Shadow Banking and Fragility*

Stephan Luck† Paul Schempp‡

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This paper studies a banking model of maturity transformation in which regulatory arbitrage induces the coexistence of commercial banks shadow banking. We derive two main results: First, the relative size of the shadow banking sector determines the stability of the financial system. If the shadow banking sector is small relative to the capacity of secondary markets for securitized assets, shadow banking is stable. However, once it grows too large, a panic-based run on shadow banks constitutes an equilibrium. Second, if commercial banks themselves sponsor shadow banks, a larger size of the shadow banking sector is sustainable. However, once this sustainable level is exceeded, the threat of a crisis reappears and also affects the sector of commercial banking. Because of regulatory arbitrage, a safety net for banks may not be able to prevent a banking crisis. Moreover, the safety net becomes costly for the regulator in case of a crisis.

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†luck@coll.mpg.de, University of Bonn and Max Planck Institute for Research on Collective Goods.

‡schempp@coll.mpg.de, University of Bonn and Max Planck Institute for Research on Collective Goods.

1 Introduction

A key ingredient to the 2007-2008 financial crisis was the maturity mismatch in the shadow banking sector (see, e.g., Brunnermeier, 2009; FCIC, 2011). The shadow banking sector financed long-term real investments (transformed into, e.g, Asset-Backed Securities (ABS)) via short-term borrowing (e.g., by issuing Asset Backed Commercial Paper (ABCP)) on a large scale. The increase in delinquency rates of subprime mortgages led to uncertainty about the performance of ABS, leading to the collapse of the market for ABCP, the central short-term financing instrument for off-balance sheet banking activities (see, e.g., Kacperczyk and Schnabl, 2009; Covitz et al., 2013; Krishnamurthy et al., 2013). The collapse of shadow banking ultimately translated into a broader financial sector turmoil, and several commercial banks as well as a leading investment bank failed and massive funds were withdrawn at money market mutual funds.

This paper contributes to the theoretical understanding of how shadow banking activities can set the stage for a financial crisis. We provide a model in which shadow banking exists to circumvent existing regulations. We then show that if the shadow banking sector grows too large relative to the capacity of secondary markets to purchase securitized assets, shadow banking becomes fragile in the sense that panic-based runs become possible. Moreover, if shadow banking activities are intertwined with activities of commercial banks, a crisis in the shadow banking sector may also trigger a crisis in the regulated banking sector and undermine the efficacy of existing safety nets.

Shadow banking activities are off-balance sheet banking activities such as credit, maturity, and liquidity transformation that take place without direct and explicit access to public sources of liquidity or credit backstops (Pozsar et al., 2010).[1] The existence of shadow banking is induced by regulatory arbitrage in our model. We thereby follow the regulatory arbitrage hypothesis which has received considerable support by the empirical findings of Acharya et al. (2013). In general, there are several other considerable reasons for why shadow banking exists: securitization as means to share interest rate risk (see, e.g., Hellwig, 1994), satisfying demand for safe debt (see, e.g., Gennaioli et al., 2013), making assets marketable and overcoming adverse selection processes (see, e.g., Gorton and Pennacchi, 1990; Gorton and Pennacchi, 1995; Dang et al., 2013), or increasing efficiency of bankruptcy processes (see, e.g., Gorton and Souleles, 2006).

There was a sharp contraction of short-term funding in the shadow banking sector in the 2007-2008 financial crisis. The empirical evidence suggest that the contraction in

[1] For overview literature on shadow banking see also Adrian and Ashcraft (2012) , Gorton and Metrick (2010), for securitization see Gorton and Souleles (2006) and Gorton and Metrick (2011) and on structured finance see Coval et al. (2009)

short-term funding resembles the essential features of run-like event (or equivalently of a rollover freeze) (see Kacperczyk and Schnabl, 2009; Gorton and Metrick, 2012; Covitz et al., 2013). Moreover, Asset Backed Commercial Paper (ABCP) has been identified as the most important source of funding for the shadow banking sector and its breakdown in summer 2007 was the quantitatively most important contraction (Krishnamurthy et al., 2013). Our model is an attempt to illustrate how this sharp contraction in ABCP became possible and how it ultimately spread to the commercial banking sector.

We discuss a simple banking model of and maturity transformation in the tradition of Diamond and Dybvig (1983) and Qi (1994) in order to illustrate how regulatory arbitrage induced shadow banking sows the seeds for a financial crisis. There are commercial banks that are covered by a safety net but also subject to regulatory costs. The shadow banking sector competes with commercial banks by offering maturity transformation services. We then derive three main results.

The first main result is that the relative size of the shadow banking sector determines the stability of the financial system. If the shadow banking sector is small relative to the capacity of secondary markets for securitized assets, there is a unique equilibrium and shadow banking is stable. The underlying logic of this is results is that whenever there are more withdrawals from the shadow banking sector than originally expected, shadow banks can sell their assets in a secondary market at face-vale and fulfill their obligations. A self-fulfilling run can thus not be optimal.

In turn, if the shadow bank sectors size exceeds a certain threshold, multiple equilibria exist. In particular, a panic-based run in the shadow banking sector constitutes an equilibrium. This is the case because whenever there is a run, shadow banks sell their assets in a secondary market. We assume that shadow banks sell their assets in secondary markets to arbitrageurs that have a fixed budget. The budget of arbitrageurs being fixed gives rise to cash-in the market pricing a la Allen and Gale (1994). If the amount of the assets sold is larger than the budget if arbitrageurs, cash-in-the-market price leads to depressed fire-sale prices. Therefore, a run on shadow banks can become self-fulfilling. The inability of selling assets in the secondary market at face value because of limited fund of arbitrageurs is reminiscent of theories on the limits to arbitrage (see e.g. Shleifer and Vishny, 1997).

The second key finding is that if commercial banks themselves engage in shadow banking activities, a larger size of the shadow banking sector is sustainable as it indirectly benefits from the safety net of commercial banks. However, once this sustainable level is exceeded, the threat of a crisis reappears and also affects the sector of commercial banking.

Finally, the third important finding ist that a safety net for banks may not be able to prevent a banking crisis in the presence of regulatory arbitrage. If banks and shadow banking are not intertwined, runs in the shadow banking sector may occur. If they are intertwined, it becomes even worse: In this case, the safety net becomes costly for the regulator in case of a crisis. It thus loses its efficacy and may be costly at the same time.

The main contribution of our paper is to model the coexistence of banks and shadow banking in a uniform framework and to show how regulatory arbitrage induced shadow banking can contribute to financial crisis. We illustrate how shadow banking activities undermine the effectiveness of a safety net scheme that is installed to prevent a financial crises. Moreover, we shot how is even makes the safety net costly for the regulator in case of a crisis. Historically, deposit insurance schemes were introduced to prevent panic-based banking crises. The view that a deposit insurance can be an effective measure to prevent banking crisis is supported by traditional banking models of maturity transformation and was seen as conventional wisdom until recently.[2] In such models, a credible deposit insurance can break the strategic complementarity in the withdrawal decision of bank customers at no costs.[3] We show that this may not be the case when we allow for regulatory arbitrage.

We argue that the understanding of how shadow banking activities contribute to the evolution of systemic risk is a key to understand the recent financial crisis. Thereby, our results also emphasize that any regulation that aims at implementing financial stability should consider the effects it has on the incentive of financial institutions to conduct regulatory arbitrage. Especially the efficacy of stability mechanisms such as deposit insurance schemes have to be reconsidered.

Our model has clearly some obvious shortcomings. To mention the two foremost important: First, in our model, a financial crisis is a purely self-fulfilling phenomena. We do not want to claim that the turmoils in summer 2007 were a pure liquidity problem. From an ex-post perspective, it is pretty clear there were severe solvency issues of ABCP conduits that were a consequence of increase delinquency rates. However, our paper is an attempt to demonstrate how the structure of the financial system can set the stage for small shocks to lead to large repercussions. Second, focusing on regulatory arbitrage as the sole reason for shadow banking to exist makes a welfare analysis complicated.

There is a fast-growing literature on theoretical aspects of shadow banking. Closest to our model is the model by Martin et al. (2014), where the run on repo[4] is analyzed in a framework as used by Qi (1994). There focus lies on the differences between bilateral and

[2]See Gorton (2012) on "creating the quiet period".
[3]See e.g. Diamond and Dybvig (1983) and Qi (1994).
[4]See Gorton and Metrick (2012)

tri-party repo as well as on equity on financial corporations. Bolton et al. (2011) provide a origination and distribution model of banking. Finally, Gennaioli et al. (2013) provide a model in which the demand for safe debt drives securitization. In their framework, fragility in the shadow banking sector arises when tail-risk is neglected .

2 Model Setup

Our basic model is a transformation of the model of maturity transformation by Diamond and Dybvig (1983) in a setup with overlapping generation. It builds on the work by Qi (1994) and Martin et al. (2014).

There is an economy that goes through an infinite number of time periods $t \in \mathrm{Z}$. There exists a single good that can be used for consumption as well as investment. In each period t, a new generation of investors is born. Each generation of investors consists of a continuum of agents of mass one. Each investor is born with an endowment of one unit of the good, and her lifetime is three periods: $(t, t+1, t+2)$. Upon birth, all investors are identically, but in period $t+1$, their type is privately revealed: With a probability of π, an investors is impatient and her utility is given by $u(c_{t+1})$. With a probability of $1-\pi$, the investor is patient investors and her utility is given by $u(c_{t+2})$. Assume that the function $u(\cdot)$ is strictly increasing, strictly concave, twice continuously differentiable, and satisfies the following Inada conditions: $u(0) = \infty$, and $u(\infty) = 0$.

In each period t, there are two different assets (investment technologies) available in $t = 0$: a short asset (storage technology), and a long asset (production technology). The short asset transforms one unit of the good at time t into one unit of the good at $t+1$, effectively storing the good. The long asset has a return of $R > 1$ in the long run. However, this asset is considered to be illiquid as it can only be liquidated at a return of $\ell < 1$ in $t = 1$.

Intergenerational Banking

In the following, we describe the mechanics of intergenerational banking and derive optimal steady state contracts. We assume that there is an infinitely lived bank operating in the economy, taking deposits and making investments. The bank can be interpreted to be run by a social planer, maximizing the welfare of depositors.

The bank offers demand deposit contracts and invests short-term and long-term. In each period $t \in \mathrm{Z}$, the bank takes new deposits D_t. It invests S_t in storage and I_t in the production technology. Depositors are offered a rate of return $r_{t,1}$ if they withdraw after one period, and $r_{t,2}$ if they withdraw after two periods.

Qi (1994) derives the steady states of this economy, which are characterized by con-

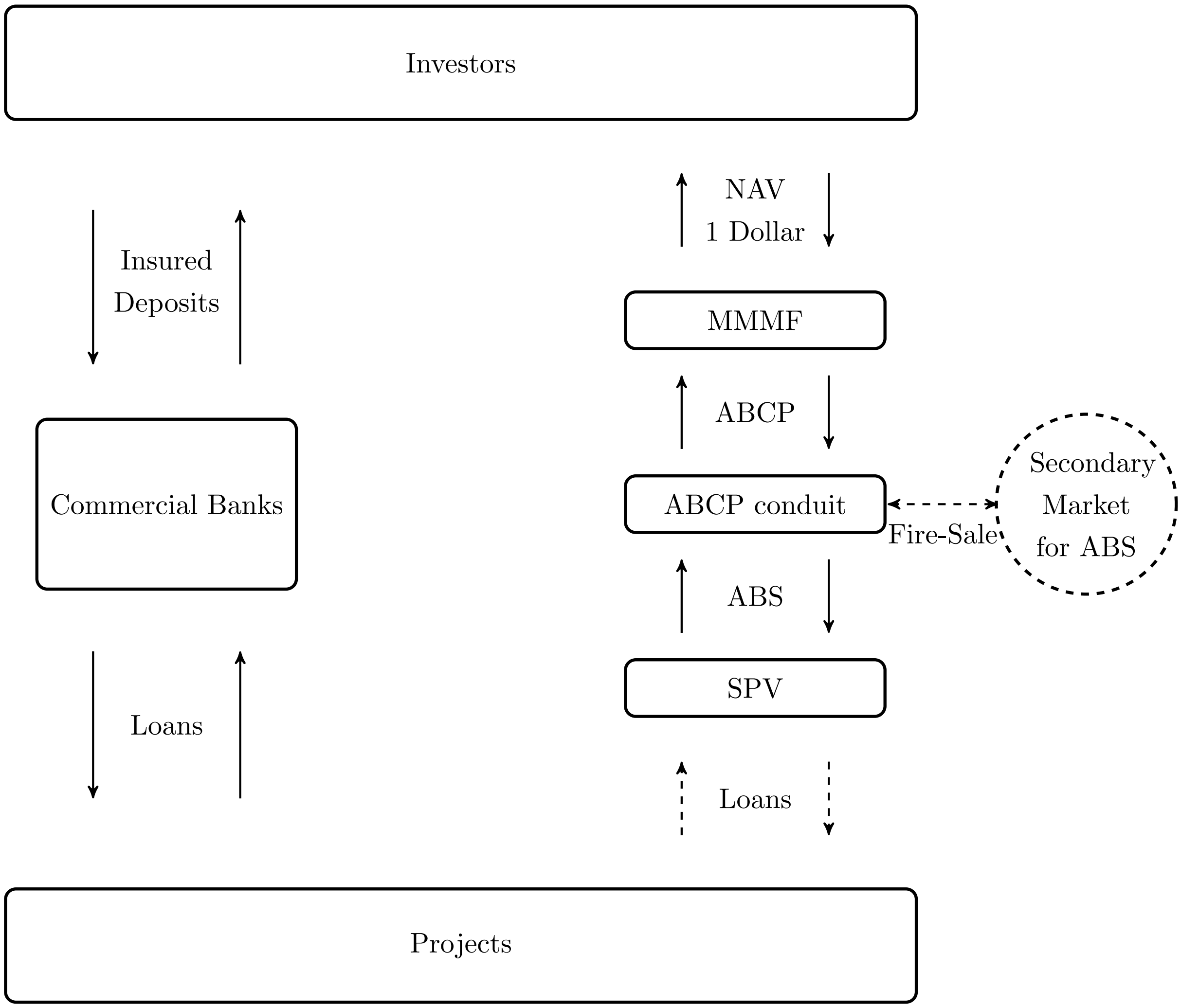

Figure 1: Structure of the Financial System

stant payoffs (r_1, r_2). In addition, he focuses on those steady states with $D_{-1} = I_{-1} = 1$ and $D_t = 1$ for all $t \geq 0$. Under these assumptions,[5] a steady-state payoff (r_1, r_2) is feasible if and only if $I_t = 1$ for all $t \geq 0$, and additionally

$$\pi r_1 + (1-\pi) r_2 \leq R. \tag{1}$$

We are now looking for optimal steady state payoffs. The objective is to maximize welfare of a representative generation, or alternatively, the expected utility of one representative investor. The first-best steady state payoff is given by $(r_1^{FB}, r_2^{FB}) = (R, R)$, i.e., it involves perfect consumption smoothing. However, the first-best cannot be implemented as it is not incentive compatible. The IC constraints are given by

$$r_1 \leq r_2, \tag{2}$$

$$r_1^2 \leq r_2, \tag{3}$$

$$\text{and} \quad r_2 \geq R. \tag{4}$$

Constraint (2) ensures that patient investors wait instead of withdrawing and storing, and constraint (3) ensures that they do not withdraw early and engage in reinvestment. Finally, constraint (4) ensures that investors do not engage in private investment and side-trading.

It turns out that both constraints (1) and (3) are binding in the optimum.

Proposition 1. *In the second-best, the interest offered by banks is given by*

$$r_1^* = \frac{\sqrt{\pi^2 + 4(1-\pi)R} - \pi}{2(1-\pi)}, \tag{5}$$

and

$$r_2^* = r_1^{*2}. \tag{6}$$

It holds that

$$r_2^* > R > r_1^* > 1. \tag{7}$$

[5] Of course, there also exist steady states with $I_t > D_t = 1$. In these steady states, higher payoffs can be paid to investors because there is a stock of capital in the bank that can constantly be reinvested. However, it seems implausible that a bank uses equity to increase the interest rate paid on deposits. Still, it is worth noticing that even in the steady state we are considering, investors benefit from the investment of the previous period, and banks have some form of equity. To see why, imagine that there are no new depositors in period t. In t, the bank uses all returns to pay off patient consumers of period $t-2$ and impatient consumers of period $t-1$. In period $t+1$, it only has to repay patient consumers of period $t-1$ and therefore has a surplus of πr_1. Qi (1994) shows which payoffs are feasible if a bank is founded in $t = 0$ without any capital.

Fragility

As in Diamond and Dybvig (1983), bank runs can also occur in this model.

Assumption 1. $\ell < (1-\pi)r_1^*$.

Assumption 1 implies that any subgame starting in some $t \in Z$ has an equilibrium where all depositors withdraw their funds and newborn investors do not deposit their money. If all depositors withdraw at once, the bank has to liquidate funds in order to serve withdrawing consumers. In addition to the expected withdrawal, the bank must serve one generation of patient consumers withdrawing early. Thus, it needs additional funds of $(1-\pi)r_1^*$. By Assumption 1, liquidation of all long-term investment is not sufficient to satisfy this liquidity need. However, a credible deposit insurance for present and future depositors or suspension of convertibility can eliminate run equilibria.

3 A Model of Banking and Shadow Banking

We now extend the model described above by four elements. First, make the assumption that commercial banks are subject to regulation and therefore have to bear regulatory costs. Second, there is a shadow banking sector that competes with banks by offering maturity transformation services. Third, there is a secondary market in which securitized assets can be sold to arbitrageurs. The liquidity in this market is exogenously given. Fourth, investors can choose whether to deposit her funds in a bank or in shadow banking sector. Depositing in the shadow banking sector is associated with a fixed cost (or some forgone benefit of commercial banks' services).

Commercial Banking and Regulatory costs We assume that banks have to pay a regulatory cost γ for each unit invested in the long asset. The resulting gross return is thus $R-\gamma$.[6] This assumption needs some further explanation. The narrative we have in mind is that because banks are covered by a safety net they are not disciplined by their depositors and there is scope for moral hazard. In order to prevent moral hazard, the supervisor of the bank will need to impose some regulation. It is then natural to assume that the supervision costs that are needed to prevent moral hazard are at least partially imposed on banks.

The way we introduce the regulatory cost, resulting gross return is thus $R-\gamma$, we have that banks will now offer only an interest rate r_1^b such that

$$\pi r_1^b + (1-\pi)(r_1^b)^2 = R - \gamma.$$

[6] Either ex-post tax of γ for each unit invested, or upfront tax of $\gamma/(R-\gamma)$ per unit invested.

Or equivalently the interest rate is explicitly given by

$$r_1^b = \frac{\sqrt{\pi^2 + 4(1-\pi)(R-\gamma)} - \pi}{2(1-\pi)}. \tag{8}$$

Finally, we also assume that regulatory costs are not too high, i.e., even after subtracting the regulatory costs, the long asset still is more attractive then storage. This results in the following assumption.

Assumption 2. $R > 1 + \gamma$.

The banking sector is thus as in the Qi model, only with the difference that banks cannot transfer the complete returns from investment to investors but they also have to pay the regulatory costs γ. So far, everything else is as above.

Shadow Banking Sector

We now introduce the shadow banking sector. The structure of the shadow banking sector (compare Figure 1), is mostly exogenous in our model. We mostly follow and simplify the descriptions by Pozsar et al. (2010).

In our setup, shadow banking consists of investment banks (broker dealers), ABCP conduits such as special investment vehicles (SIVs) and money market mutual funds (MMMFs). Investment banks securitize assets via special purpose vehicle (SPVs) in order to make them tradable, i.e., they conduct liquidity transformation. We leave out that typically SPVs do not lend to firms or consumers directly but purchase loans from loan originators which can be mortgage agencies or commercial banks.

Once the projects are securitized they are purchased by shadow banks. Shadow banks in turn finance their holdings of securitized assets with long-term maturity by borrowing short-term from money market mutual funds (MMMFs), i.e. they conduct maturity transformation. Finally, MMMFs are the door to the shadow banking sector by offering deposit-like assets to investors, i.e., shares with a stable net assets value (NAV). For simplicity, we will talk about MMMFs as if they were literally taking deposits. While all of the institutions named above belong to the shadow banking sector, we will refer to the SIVs (ABCP conduits) as "shadow banks".

Liquidity Transformation The investment banks purchase assets from some unspecified originator via SPVs. These assets are identical to the production technology introduced earlier. Investment banks are endowed with a securitization technology. Securitization comes with a per-unit cost of ρ. Investment banks sell securitized loans (ABS) with a per unit return of $R - \rho$. Again, we assume that also securitization costs are not too high, i.e., even after subtracting the securitization costs, the long asset still is more attractive then storage:

Assumption 3. $R > 1 + \rho$

Maturity Transformation Shadow banks buy securitized assets (ABS) from investment banks. These assets have a return of $R - \rho$. Shadow banks finance themselves by borrowing from MMMFs. Competition implies that shadow banks offer r_1^{abcp} such that

$$\pi r_1^{abcp} + (1 - \pi)(r_1^{abcp})^2 = R - \rho,$$

implying a return of

$$r_1^{abcp} = \frac{\sqrt{\pi^2 + 4(1 - \pi)(R - \rho)} - \pi}{2(1 - \pi)}.$$

Shadow banks (or their sponsors) can also sell securitized assets to arbitrageurs if they cannot serve MMMFs otherwise.

Money Market Mutual Funds In reality, MMMFs sell shares to investors. Each MMMF has a sponsor that guarantees stable net asset value (NAV), i.e., it guarantees to buy back shares at a price of one. As mentioned above, the stable NAV makes MMMF shares a demand-deposit like asset. For simplicity, we will assume that MMMFs are literally taking deposits. They are offering a per-period interest rate r_{mmf}. Purchasing ABCP (short-term debt) from shadow banks offers return r_{abcp} per period. Competition implies that $r_{mmf} = r_{abcp}$.

Upon, birth, investors can choose whether to deposit their endowment at a regulated bank banks or at a MMMFs. Switching to a MMMF comes at a cost of s_i, where s_i is iid with cdf $G(\cdot)$. We assume that $G(0) = 0$.

An investor that stays with a bank gets and expected utility of $\pi u(r_1) + (1 - \pi)u((r_1^b)^2)$ Switching to a shadow bank givens an expected payoff of

$$R - \rho - s_i$$

Bank: $EU(bank) = \pi u(r_1^b) + (1 - \pi)u((r_1^b)^2)$ Shadow bank: $EU(shadowbbank)\pi u(r_1^{abcp}) + (1 - \pi)u((r_1^{abcp})^2)$ Investor i switches if

$$EU(bank) - s_i > EU(shadowbank) \quad \Leftrightarrow \quad s_i < EU(bank) - EU(shadowbank)$$

Define $s^* \equiv \gamma - \rho$ All investors with $s_i \leq s^*$ switch to the shadow banking sector The mass of investors in the shadow banking sector is given by $G(s^*)$ For general utility functions, $s^* = f(\gamma, \rho)$, where f is increasing in γ and decreasing in ρ

Secondary Markets and Arbitrageurs There is a secondary market for securitized assets (ABS). There is no market power on any side of the market. Arbitrageurs are willing to buy ABS at face value, no risk (neither idiosyncratic nor aggregate / systemic). Arbitrageurs have a total budget of A. Cash-in-the-Market Pricing:

Steady State

Proposition 2. *There exists a steady state in which banks offer an interest rate r_1^b to investors such that*

$$\pi r_1^b + (1-\pi)(r_1^b)^2 = R - \gamma,$$

and MMMF offer an interest $r_1^{mmf} = r_1^{abcp}$ to investors such that

$$\pi r_1^{abcp} + (1-\pi)(r_1^{abcp})^2 = R - \rho.$$

The banking sector has size $1 - G(s^*)$, and the shadow banking sector has size $G(s^*)$, where $s^* \equiv f(\gamma, \rho)$.

Fragility

Because investors of shadow banks are not insured, a run is not excluded per se. In the most adverse scenario, all funds are withdrawn from the shadow banks, and no new funds are deposited. The question whether this can be an equilibrium depends on whether shadow banks can raise enough funds in the secondary market to serve all their obligations.

In case of a run by MMMFS on shadow banks, shadow banks will have to repay what the MMMFs demand for the the mass of $(1-\pi)$ patient investors that invested in the MMMF in $t-2$, and what they need for all investors hat invested in $t-1$ in the MMMF. Overall, shadow banks will face a total liability of $(1-\pi)(r_1^{abcp})^2 + r_1^{abcp}$.

On the other hand, the shadow banks have liquid fund of $R - \rho$ from investment in ABS they made in $t-2$ that are maturing in t. The liquidity shortfall is given by the difference and equal to $(1-\pi)r_1^{abcp}$.

This shortfall can be covered by selling the ABS that the shadow bank has bought in $t-1$ to the arbitrageurs. The following assumption assures that liquidation of ABS will never be enough to cover the shortfall.

Assumption 4. $\ell < (1-\pi)r_1^{abcp}$

Observe that in case of a run, the supply of shadow banks is partially inelastic: they have to raise a total amount of $G(s^*)(1-\pi)r_1^{abcp}$.

There are two cases to be considered. The first case in which the arbitrageurs funds are sufficient to purchase all funds the shadow banks sell, and the second case in which the arbitrageurs cannot buy all funds and the price is determined by cash-in-the-market pricing.

Case 1: Assume that $A \geq G(s^*)(1-\pi)r_1^{abcp}$. In this case, ABS can be sold at face value ($p = R$)- The value of shadow banks' ABS as well as the amount of cash in the market exceed the shadow banks' potential liquidity needs. Therefore, in case of a run, all old investors can be served, and new investors have an incentive to deposit new funds. A run cannot constitute an equilibrium.

Case 2: Now assume that $A < G(s^*)(1-\pi)r_1^{abcp}$. In this case, shadow banks cannot raise the required funds to fulfill their obligations by selling their ABS. The price of ABS drops below face value. This in tunr force to sell all assets, i.e. to sell their complete ABS portfolio. The mechanism is that prices are determined by cash-in-the-market pricing, thus enabling runs of MMMFs on shadow banks.

Proposition 3. *Whenever*

$$G(s^*) > \frac{A}{(1-\pi)r_1^{abcp}} \equiv \xi$$

a run of MMMFs on ABCP conduits is an equilibrium.

In order to better understand the proposition was has to consider the hypothetical fire-sale prive. Cash-in-the-market pricing implies that p is such that

$$pG(s^*) = A$$

The (hypothetical fire-sale) price can then be calculated as a function of the size that are on the market in case of a (shadow banking) system wide run, which depends on the size if the shadow banking sector G^*. It is given by:

$$p(G^*) = \begin{cases} R & \text{if } G^* \leq \frac{A}{(1-\pi)r_1^{abcp}}, \\ A/G^* & \text{if } G^* \in \left(\frac{A}{(1-\pi)r_1^{abcp}}, \frac{A}{\ell} \right], \\ \ell & \text{if } G^* > \frac{A}{\ell}. \end{cases}$$

Observe that the price cannot drop below ℓ. If $p < \ell$, some institution could make arbitrage by buying ABS and liquidate the underlying assets immediately. This does not require liquidity.

Now, whenever the size of the shadow banking sector is such that that in case of a fire-sale the price for ABS in the secondary market will fall below the face-value, i.e. if $G(s^*) > \frac{A}{(1-\pi)r_1^{abcp}}$, runs become possible.

To a certain extends, this is related to the idea of limits to arbitrage by Shleifer and Vishny (1997). The fact that there are not enough arbitrageurs to purchase the entire assets of the shadow banking system lets the price in he fire sale fall short of the face value. This implies that shadow banks may in fact not be able to serve thei obligation completely. This in turn makes it optimal for a MMMF to run on its shadow bank once all other MMMFs run.

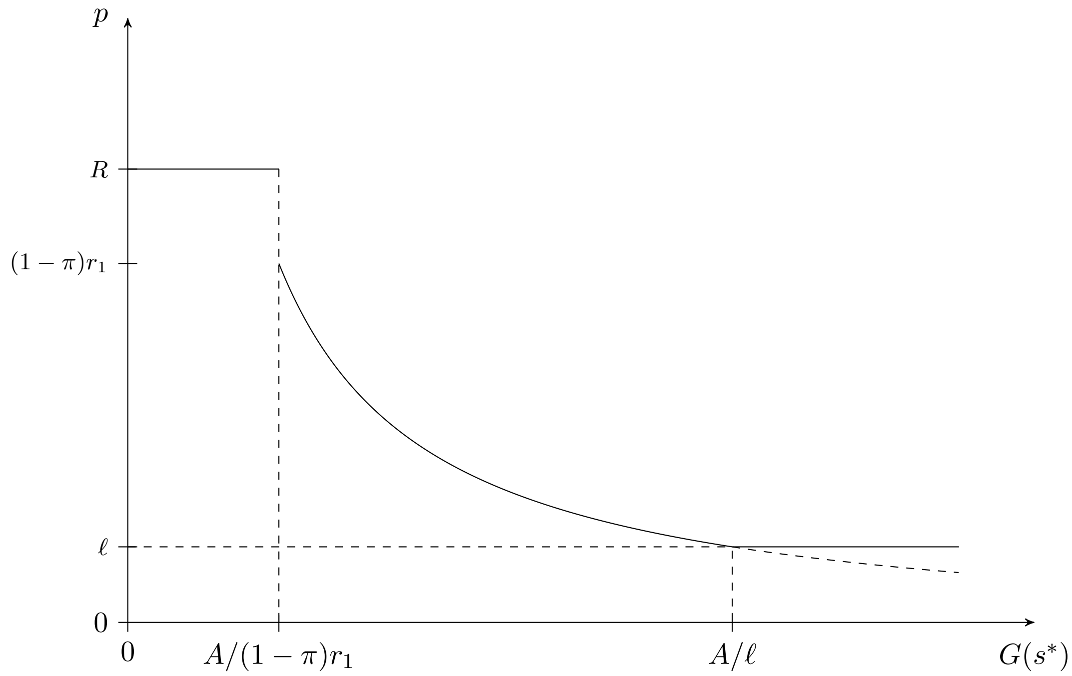

Figure 2: Fire-Sale Price

4 Liquidity Guarantees

So far, there was no connection between the regulated commercial banking sector and the shadow banking sector. We now assume that commercial banks themselves actively engage in shadow banking by running shadow banks themselves. I.e, we assume that commercial banks sponsor ABCP conduits.

As above, we assume that commercial banks liabilities are covered by a safety net. This safety net being credible implies that commercial banks do not experience runs.

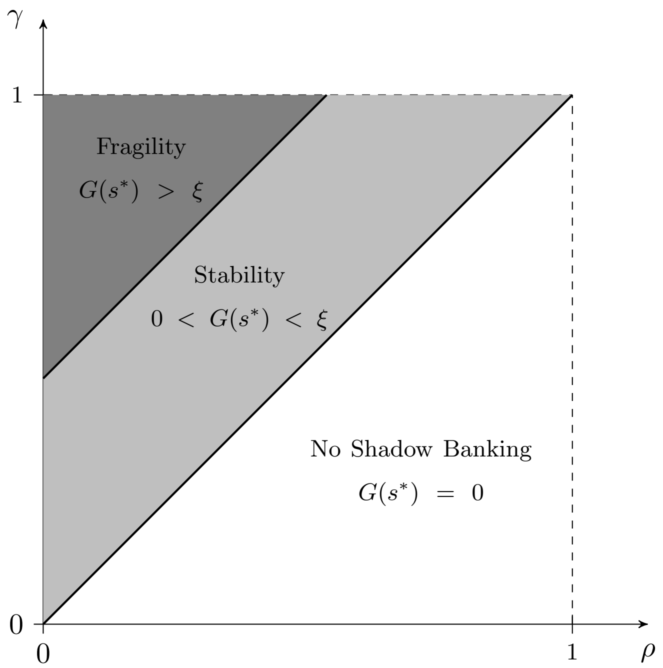

Figure 3: This figure visualizes the equilibrium characteristics of the financial system for different values of γ and ρ. The parameters are chosen to be $R = 2$, $\ell = 0.4$, and the distribution function of switching costs is chosen as $G(s) = 1 - \exp\{\frac{-s}{1-\pi}\}$. For $\gamma < \rho$, shadow banking is dominated by classical banking. If $\gamma - \rho$ is positive but small, the shadow banking sector has positive size but is too small to destabilize the financial system. If the difference increases, the shadow banking sector also increases and finally introduces fragility into the financial system.

Patient investors that are located at a commercial bank will thus never withdraw their funds early.

In turn, commercial banks owning shadow banks implies that in case of a run on shadow banks, commercial banks supply liquid funds to shadow banks. In the following we show that this makes a larger level of shadow bankin gto be stable. However the caveat being that once there is a crisis, the crisis spreads to the commercial banking sector and makes the safety net costly.

Proposition 4. *Assume that commercial banks sponsor ABCP conduits and provide liquidity guarantees. A run of MMMFs on ABCP conduits constitutes an equilibrium iff*

$$G(s^*) > \vartheta,$$

where

$$\vartheta \equiv \frac{\max[A,\ell]+1}{(1-\pi)r_1^{abcp}+1} > \xi.$$

Proof. Banks have liquid funds of $1 - G(s^*)$ available. Liquidity need of shadow banks can be satisfied if

$$A \geq (1-\pi)r_1^{abcp}G(s^*) - (1 - G(s^*))$$

or after rewriting:

$$G(s^*) > \frac{\max[A,\ell]+1}{(1-\pi)r_1^{abcp}+1}$$

□

A larger shadow banking sector becomes sustainable compared to a situation withour liquidity guarantees, i.e. the cirtical threshold is now given by $\vartheta > \xi$. he underlying logic of this results is that banks always have additional liquid funds from new depositors as well as because their late depositors never withdraw.

The caveat is that once the shadow banking sector exceeds the size ϑ, there is a run despite liquidity guarantees the crisis in the shadow banking sector spreads to the regulated banking sector.

Proposition 5. *Assume that $G(s^*) > \vartheta$. In case of a run on shadow banks, the safety net for regulated banks is tested and becomes costly.*

The proposition shows that once regulated commercial banking and regulatory arbitrage induced shadow banking become intertwined, the safety net becomes costly for the regulator in case of a crisis. Therefore, the model challenged the view that e.g. a deposit insurance is an efficient mechanism in preventing self-fulfilling crises. The view that a deposit insurance can be an effective measure to prevent banking crisis is supported by traditional banking models of maturity transformation and was seen as conventional wisdom until recently.[7] In such models, a credible deposit insurance can break the strategic complementarity in the withdrawal decision of bank customers at no costs.[8] We show that this may not be the case when we allow for regulatory arbitrage.

5 Runs on MMMFs

under construction

[7]See Gorton (2012) on "creating the quiet period".

[8]See e.g. Diamond and Dybvig (1983) and Qi (1994).

6 Discussion

We see the strength of our paper in being one of the first attempts to model the coexistence of banks and shadow banking in a uniform framework, and to show how regulatory arbitrage induced shadow banking can contribute to financial crisis. We illustrate how shadow banking activities undermine the effectiveness of a safety net scheme that is installed to prevent a financial crises. Moreover, we shot how is even makes the safety net costly for the regulator in case of a crisis.

Our model has clearly some obvious shortcomings. To mention the two foremost important: First, in our model, a financial crisis is a purely self-fulfilling phenomena. We do not want to claim that the turmoils in summer 2007 were a pure liquidity problem. From an ex-post perspective, it is pretty clear there were severe solvency issues of ABCP conduits that were a consequence of increase delinquency rates. Second, focusing on regulatory arbitrage as the sole reason for shadow banking to exist makes a welfare analysis complicated. However, our paper is a simple and tractable attempt to demonstrate how the structure of the financial system can set the stage for small shocks to lead to large repercussions.

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