

Traditional and Shadow Banks During The Crisis*

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Abstract

This paper analyzes the coexistence of and interaction between traditional and shadow banks. We document that during the 2007 financial crisis, both shadow banks' assets and liabilities have transferred to traditional banks, and assets were sold at fire sale prices. We propose a model that is able to accommodate those facts. In the model, bankers choose to run a traditional or a shadow bank. Both types of banks issue riskfree debt to cater to their creditors' demand for safety. Compared to shadow banks, traditional banks have higher operating costs and are subject to capital requirements, but they have access to a guarantee fund that enables them to issue riskfree debt precisely when shadow banks cannot. We define such a time a crisis and show that in a crisis, shadow banks liquidate assets to repay their creditors, while traditional banks purchase these assets at fire-sale prices. Higher capital requirements for traditional banks increase the number of bankers who run a traditional bank. The testable predictions are borne out in the data: traditional banks that purchased assets from shadow banks benefited from an inflow of insured deposits in the crisis.

Keywords: Traditional banking, Shadow banking, Safe money-like claims, Financial crisis

JEL Codes: E32, E44, E61, G01, G21, G23, G38.

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1 Introduction

Recent decades have seen the emergence of financial institutions that perform bank-like activities outside of the regulated (traditional) banking system. This so-called shadow banking system has now reached a size comparable to that of the traditional banking system, representing about one-fourth of total financial intermediation worldwide (IMF (2014)).¹ The collapse of shadow banking in 2007 to 2008 has arguably played a role in threatening traditional banks' stability and bringing about the financial crisis.² The crisis started with a run on shadow banks that endangered the stability of the entire financial system, raising important questions. How do different types of banks interact in a crisis? What does it tell us about the reasons of their coexistence? We propose a theory of the coexistence between traditional and shadow banks.

We show that a striking feature of the financial crisis is that both assets and liabilities moved from shadow to traditional banks, and assets were sold at fire-sale prices. We document these facts for U.S. traditional and shadow banks during the 2007 financial crisis. First, from 2007q4 to 2009q1 asset flows of approximately \$800 billion out of shadow banks and \$550 billion into traditional banks occurred concomitantly. Second, in 2008Q3, \$600 billion of deposits and borrowings went into the largest traditional banks in less than a month. Third, mortgage-backed securities were sold at fire sale prices; notably government-agency securities. These facts are clues for understanding the interaction between traditional and shadow banks, and building a realistic model of their coexistence.

In the model, bankers choose to run a shadow bank or a traditional bank.³ Unlike shadow banks, traditional banks (i) have higher operating costs, (ii) are subject to capital requirements and (iii) have access to a guarantee fund rendering their short-term debt riskfree in a crisis.⁴ Outside a crisis, both traditional and shadow banks can issue riskfree short-term debt to fund their assets. In a crisis, shadow banks cannot issue riskfree debt and must sell their assets to repay their creditors, while traditional banks are able to issue riskfree debt to purchase assets from shadow banks. Our model yields two sets of results.

¹For empirical descriptions of shadow banking, see Pozsar et al. (2013) for the United States, ESRB (2016) for the European Union, IMF (2014) and FSB (2015) for global estimates. Globally, shadow banks' assets were worth \$80 trillion in 2014, up from \$26 trillion more than a decade earlier (FSB (2015)).

²See e.g. He et al. (2010), Bigio et al. (2016), Krishnamurthy (2008), Gorton and Metrick (2011), Acharya et al. (2012b), Baron (2016), Ivashina and Scharfstein (2010), Campello et al. (2011) and others.

³The model is broadly inspired from Stein (2012). However, we consider two types of banks: traditional and shadow banks. It is different from Hanson et al. (2015) in that in our model traditional banks can issue debt in a crisis, and bankers endogenously choose which type of bank they run.

⁴They pay this insurance at an actuarially fair price. We think of this fund as the government insurance for traditional banks' deposits, e.g. the FDIC insurance in the United States.

First, we endogenize bankers' choice to run a shadow versus a traditional bank. We find that (i) bankers invest all their endowment in either type of bank, and (ii) coexistence between shadow and traditional banks is possible and intrinsically linked to fire sales of assets from shadow to traditional banks in a crisis. In a crisis, traditional banks' capital requirements limit the amount of riskless debt they can issue. Traditional banks therefore require a discount on asset prices in a crisis to forsake investment opportunities outside a crisis, which endogenously determines asset (fire sale) prices in a crisis. As explained, shadow banks must sell assets in a crisis to repay their creditors, and asset prices determine the amount of riskfree debt that shadow banks can issue before a crisis. Banks' expected profits and thereby bankers' choice to run either type of bank depend on the other banks' behavior through asset fire sales in the crisis. Traditional and shadow banks form an ecosystem.

Second, we find that tightening capital requirements for traditional banks has two opposite effects. On the one hand, increased capital requirements hinder traditional banks' ability to raise funds, which reduces their expected profits and induces fewer bankers to run a traditional bank.⁵ On the other hand, higher capital requirements lower traditional banks' demand for assets in a crisis, which creates downward pressure on the price of assets transferred from shadow to traditional banks. This in turn lowers shadow banks' *ex-ante* expected profits, which induces fewer bankers to run a shadow bank.⁶

We show that the second (new) effect dominates the former. Outside a crisis, traditional banks trade-off the costs and benefits of issuing short-term debt to fund assets versus keeping some buffer to be able to issue short-term debt in a crisis to purchase shadow banks' assets. This trade-off is key to understand why traditional banks require fire sale of shadow banks' assets: they need to be compensating for maintaining buffers and foregoing investment opportunities before a crisis. Higher capital requirements reduce asset prices in a crisis to the extent that shadow banks' profits decrease more than that of traditional banks. Bankers continue to invest all their endowment in either type of bank, but more bankers choose to run a traditional bank when capital requirements increase.

We then test the predictions of our model using data on U.S. commercial banks.⁷ We make different assumptions for the repayment rate of mortgage-backed securities (MBS) and total losses imputed to the traditional banking sector from 2007q4 to 2009q1, to provide an estimate

⁵This effect is reminiscent of that at play in the existing shadow-banking literature (see [Plantin \(2015\)](#), [Ordóñez \(2013\)](#), [Harris et al. \(2015\)](#)).

⁶To the best of our knowledge, this latter effect is absent from the existing literature.

⁷We also use estimates from [He et al. \(2010\)](#). We follow the procedure and variables of [Acharya and Mora \(2015\)](#) to construct our sample.

of MBS purchases by traditional banks over this period. In line with two testable predictions of our model, we find that (i) traditional banks purchased mortgage-backed securities (MBS) that flew out of shadow banks' balance sheets, and (ii) asset purchases were concomitant with an inflow of *insured* deposits into the traditional banking sector.⁸ In contrast, brokered deposits are not significantly correlated with asset purchases by traditional banks. Our analysis suggests that traditional banks that purchased assets from shadow banks did so at the expense of credit.⁹ These banks have benefitted from the Transaction Account Guarantee (TAG) program implemented by the Federal Deposit Insurance Corporation (FDIC), they paid lower interest rate on large deposits and they had lower capital ratios than the average traditional bank. The evidence supports our view that traditional banks purchased assets from shadow banks in the crisis, with limited funds despite inflows of (insured) deposits.

Related literature Our paper relates to several strands of the literature. The focus of our analysis lies in the coexistence of and interaction between traditional and shadow banks. [Rajan \(1998a,b\)](#) was among the first to question the future of banks, suggesting that many of the services provided by traditional banks are sustained by a financial structure that makes them inherently fragile. Our paper argues that traditional banks still compete with but also complement shadow banks.

In our model, asset fire sales are key to understand the intertwining between traditional and shadow banks. As in [Shleifer and Vishny \(1992\)](#), the price of assets sold during the crisis is the liquidation value shadow banks expect to recover from their assets *prior* to the crisis.¹⁰ [Shleifer and Vishny \(1997\)](#) and [Gromb and Vayanos \(2002\)](#) are seminal models of fire sales where mispricing occurs due to frictions on arbitrageurs' funding capacity. [Acharya et al. \(2012a\)](#) study interbank lending and asset sales when some banks have market power vis-à-vis other banks. [Diamond and Rajan \(2011\)](#) discuss liquidity risks on both sides of banks' balance sheet, and inefficient exposure to fire sales.

A second group of theories studies is connected to the coexistence between traditional and shadow banks.¹¹ [Hanson et al. \(2015\)](#) are interested in the implications of traditional versus

⁸Publicly available data on shadow banks at a granular level is still lacking.

⁹This confirms findings by [Abbassi et al. \(2015\)](#).

¹⁰Fire sales of assets in the 2007 crisis has been studied before (see e.g. [Krishnamurthy \(2008\)](#), [Gagnon et al. \(2011\)](#), [Gorton and Metrick \(2011\)](#)). A strand of the literature ties banks' investment choices with asset markets, substantially improving the quantitative dynamics of risk premia in crisis episodes where intermediaries' equity capital is scarce. Major contributions in this literature include [Adrian and Boyarchenko \(2015\)](#), [Brunnermeier and Sannikov \(2014\)](#), [He and Krishnamurthy \(2013\)](#) and [Viswanathan and Rampini \(2010\)](#).

¹¹Our model is in line with theories of financial intermediation as issuers of riskfree claims. A seminal paper is [Gorton and Pennacchi \(1990\)](#), and other papers include [Stein \(2012\)](#), [DeAngelo and Stulz \(2015\)](#) and [Plantin \(2015\)](#).

shadow banking businesses in terms of the assets that are held by financial intermediaries. [Plantin \(2015\)](#) studies optimal bank capital regulation in the presence of shadow banking, and finds that the optimal regulation needs not be in line with current regulatory reforms. [Ordenez \(2013\)](#) proposes a model in which reputational concerns are an effective disciplining device in the shadow banking sector. When reputation concerns are weak, banks can only operate using traditional banking. [Harris et al. \(2015\)](#) develop a model where capital requirements reduce banks' risk-taking incentives while lowering their funding capacity. They discuss the cyclicity of optimal bank capital regulation in light of the amount of capital in the economy. [Gornicka \(2016\)](#) and [Luck and Schempp \(2014\)](#) present models where a crisis in the shadow banking sector transmits to the traditional banking sector through guarantees to shadow banks.

Finally, other papers document changes in financial intermediaries' balances during the 2007 financial crisis.¹² [Acharya and Mora \(2015\)](#) show that deposits only flew into traditional banks when the government intervened in 2008Q3, when they grew by \$272 billion in just one quarter. [He et al. \(2010\)](#) and [Bigio et al. \(2016\)](#) document a net asset outflow of \$1,702 billion out of shadow banks and an asset inflow of \$1,595 billion into traditional banks during the 2007 financial crisis. [Abbassi et al. \(2015\)](#) provide micro evidence of the argument made by [Stein \(2013\)](#) that fire sales of assets might push banks to trade assets and reduce their supply of credit in crisis times.

The paper proceeds as follows. Section 2 presents stylized facts about traditional and shadow banks during the crisis. Section 3 presents the model, which we analyze in section 4. We discuss the possible coexistence between shadow and traditional banks. Section 5 discusses the effect of capital requirements and section 6 tests the model's predictions. Section 7 concludes.

2 Motivating evidence

We document three stylized facts from the crisis in this section. We build on earlier descriptive work for our definition of the shadow banking system, which size has the same order of magni-

As in [Gennaioli et al. \(2013\)](#), [Krishnamurthy \(2010\)](#), [Caballero and Krishnamurthy \(2008\)](#) or [Caballero and Farhi \(2016\)](#), we model households' demand for safety as stemming from households' risk aversion.

¹²The rise and fall of shadow banking is documented in [Adrian and Shin \(2010\)](#), [Pozsar et al. \(2013\)](#), [Acharya et al. \(2013\)](#)). [Acharya et al. \(2013\)](#), [Gorton and Metrick \(2011\)](#) and [Pozsar et al. \(2013\)](#) describe shadow banking as regulatory arbitrage, and the role of shadow banks in the financial crisis is discussed in [Coval et al. \(2009\)](#), [Shleifer and Vishny \(2010\)](#), [Gorton and Metrick \(2011\)](#), [Stein \(2012\)](#), [Gennaioli et al. \(2012\)](#), [Gennaioli et al. \(2013\)](#), [Kacperczyk and Schnabl \(2010\)](#), [Krishnamurthy et al. \(2014\)](#), [Sunderam \(2015\)](#), [Moreira and Savov \(2014\)](#) and others.

tude as that of the traditional banking sector.¹³ We produce stylized balance-sheets of various entities of the US financial sector based on [Krishnamurthy and Vissing-Jorgensen \(2015\)](#). Our motivation lies in understanding what the following facts tell us about traditional and shadow banks' business models.

2.1 Fact 1: Asset flow from shadow to traditional banks

There is a growing literature that analyses the role of securities trading by banks and its various implications, e.g. in terms of credit supply ([Diamond and Rajan \(2011\)](#), [Shleifer and Vishny \(2010\)](#)) or asset prices ([He and Krishnamurthy \(2013\)](#)). Using data from the Financial Account of the United States (formerly known as the Flow of Funds), [figure 1](#) shows that in the crisis there were indeed active asset flows between financial intermediaries, and especially out of shadow banks and onto traditional banks' balance sheets. Although our data does not allow us to identify whether these changes were due to changes in the value of assets or changes in ownerships, there is a relative consensus among economist on the fall of the shadow banking sector (i.e. asset sales by shadow banks, see [Gorton and Metrick \(2011\)](#), [Pozsar et al. \(2013\)](#), [Chernenko et al. \(2014\)](#)). Recent work by [He et al. \(2010\)](#) and [Bigio et al. \(2016\)](#) provide estimates of the amount of assets that were transferred from shadow to traditional banks during the crisis. From 2007:Q4 to 2009:Q1, [He et al. \(2010\)](#) find that shadow banks decreased their holdings of securitized assets by approximately \$800 billion while traditional banks increased theirs by approximately \$550 billion. Looking at the wider date from 2007Q1 to 2013Q1 and considering total asset holdings, [Bigio et al. \(2016\)](#) document a net asset outflow of \$1702 billion out of shadow banks and an asset inflow of \$1595 billion into traditional banks.¹⁴

Holding loans on the balance sheets of banks is not profitable, and researchers argue this is one of the major reasons why the parallel or shadow banking system developed (see e.g. [Gorton \(2015\)](#), [Acharya et al. \(2013\)](#)). Bank regulation determines the size of the traditional banking sector, while special conduits are comparable to regular banks in many ways and form an integral part of financial intermediation (managed by traditional banks to a certain extent, e.g. through the sale of securitized loans to ABCP conduits). Importantly, the flip side of off-balance sheet leverage in the less regulated sector were liquidity guarantees from the traditional to the shadow banking sector. [Acharya et al. \(2013\)](#) show that investors in conduits covered by guarantees were repaid in full, which implies a monetary transfer from the traditional to the shadow banking system and a mirror asset transfer from shadow to traditional

¹³See e.g. [Pozsar et al. \(2013\)](#), [Adrian and Shin \(2010\)](#), [Bigio et al. \(2016\)](#)

¹⁴Another important aspect of this asset transfer is the sizable purchase of assets from the Federal Reserve, which balance sheets increased by approximately \$1954 billion, as calculated in [Bigio et al. \(2016\)](#)

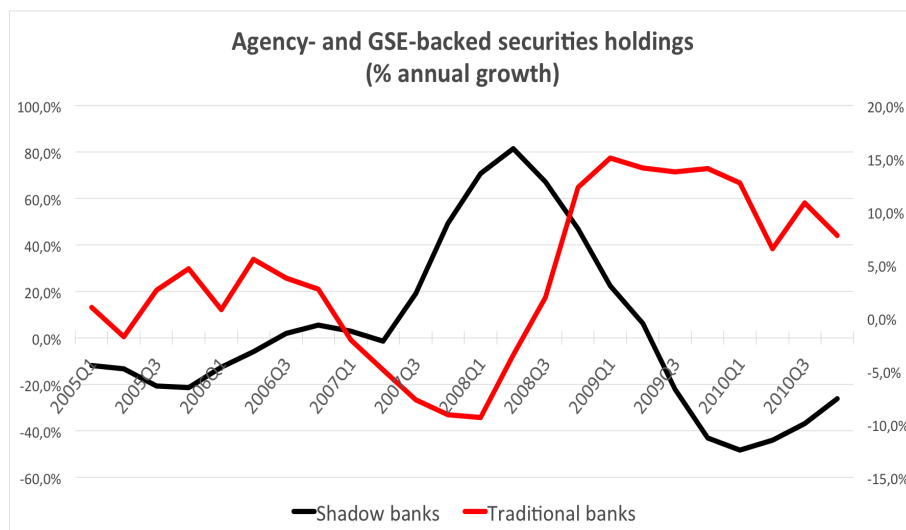


Figure 1: Shadow and traditional banks: asset flows

source: Financial Account of the United States

banks. Importantly, whether due to these guarantees or to outright purchases from distressed intermediaries, it is likely that assets were purchased by traditional banks at the expense of other activities. [Shleifer and Vishny \(2010\)](#) and [Stein \(2013\)](#) discuss how market conditions shape the allocation of scarce bank capital across lending and asset purchases, and [Abbassi et al. \(2015\)](#) provide empirical evidence. In the next subsection, we show how the traditional system absorbed these asset sales by issuing a comparable amount of deposits.

2.2 Fact 2: Liabilities flow from shadow to traditional banks

In the early phase of the financial crisis, investors stopped rolling over shadow banks' short-term funding. A well-documented stylized fact is the run on a major yet unstable source of funding for the shadow banking system: the sale and repurchase market (the "repo" market, see e.g. [Gorton and Metrick \(2011\)](#), [Shleifer and Vishny \(2010\)](#)). Table 2 shows the evolution of short-term debt¹⁵ for shadow and traditional banks.

It is clear from table 2 that there was a concomitant run on shadow banks and an inflow of short-term debt to traditional banks (around 60% of which is composed of small time and savings deposits in the 2007-09 date). This phenomenon of reintermediation is well known: in times of crisis, investors seek a safe haven for their wealth and they turn to traditional banks as these latter provide insurance due to the guarantee on their deposits. This inflow of deposits in turbulent times is the risk management motive emphasized in [Kashyap et al. \(2002\)](#) to explain

¹⁵See the appendix for an exact definition using the Financial Account of the United States.

Cumulative flows since 2006Q4		
	Shadow banks (\$Bill)	Traditional banks (\$Bill)
Mar-07	437,268	105,794
Jun-07	605,898	229,772
Sep-07	513,802	454,175
Dec-07	378,203	591,075
Mar-08	623,004	732,141
Jun-08	284,098	750,898
Sep-08	504,779	1104,037
Dec-08	-277,166	1733,17
Mar-09	-670,105	1659,037
Jun-09	-966,054	1427,668
Sep-09	-1132,013	1435,914
Dec-09	-1352,935	1408,961
Mar-10	-1354,446	1431,477
Jun-10	-1412,2	1316,759
Sep-10	-1440,003	1419,551
Dec-10	-1470,83	1595,792
Mar-11	-1397,567	2011,47

Figure 2: Shadow and traditional banks: liabilities flows

source: Financial Account of the United States

why traditional banks combine demand deposits with loan commitments or lines of credit. [Gatev and Strahan \(2006\)](#) further show the unique ability of traditional banks to hedge against systematic liquidity shocks such as that of the 2007 financial crisis.

An important aspect of this deposit flow into traditional banks' balance sheets is put forward by [Gatev and Strahan \(2006\)](#) and [Pennacchi \(2006\)](#). It is traditional banks' access to federal deposit insurance which causes economy's savings to move into bank deposits during times of aggregate stress, which explains why there is no evidence that funds flowed into the banking system when spreads widened during the 1920s, prior to the expansion of the federal safety net with the creation of federal deposit insurance. As was shown in [Acharya and Mora \(2015\)](#), it can be seen on figure 3 that it was not until the government interventions just before the Lehman failure on September 15, 2008 that deposit flew onto traditional banks' balance sheets. [He et al. \(2010\)](#) show that core deposits eventually increased by close to \$800 billion by early 2009. Table 2 shows that investors turned to traditional bank's short-term debt in end 2008Q2, and weekly times series in figure 3 shows that there was a \$600 billion deposits and borrowings inflow into the largest US traditional banks from the week of September 10th to the week of October 1st, 2008.

2.3 Fact 3: Asset fire sales

Many examples in the literature suggest that asset prices have deviated significantly from "fundamental values" and sold at fire-sale prices during the crisis. Using data on insurance com-

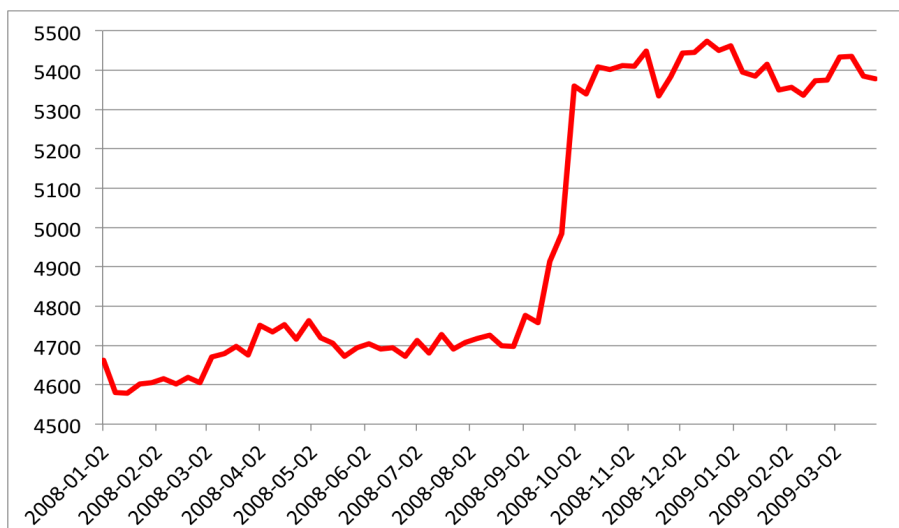


Figure 3: Large traditional banks: deposits and borrowings (\$ bn)

source: Fed H8 Releases

panies, [Merrill et al. \(2012\)](#) show that risk-sensitive capital requirements, together with mark-to-market accounting, can cause financial intermediaries to engage in fire sales of RBMS securities. [Krishnamurthy \(2008\)](#) discusses pricing relationships reflecting similar distortions on agency MBS, and notably the increasing option-adjusted spread of Ginnie Mae MBS versus the US Treasury with the same maturity. [Gagnon et al. \(2011\)](#) also document substantial spreads on MBS rates - well above historical norms. Such evidence of high spreads on a security which has no credit risk points to the scarcity of arbitrage capital in the marketplace and the large effects that this shortage can have on asset prices. Using micro-data on insurers' and mutual funds' bond holdings, [Chernenko et al. \(2014\)](#) finds that in order to meet their liquidity needs during the crisis, investors traded in more liquid securities such as government-guaranteed MBS. This strategy is consistent with theories of fire sales where investors follow optimal liquidation strategies: although spreads on GSE MBS were very high in the fall of 2008, those assets remained the most liquid securitization market during the crisis.

Our illustration of asset fire sales is from [Gorton and Metrick \(2011\)](#). The authors provide a snapshot of the fire sales of assets that occurred due to the financial crisis that we reproduce on figure 4. We see a negative spread between higher- and lower-rate bonds with the same maturity. Aaa-rated corporate bonds would normally trade at higher prices (i.e. lower spreads) than any lower-grade bonds with the same maturity (say, Aa-rated ones), and this negative spread is an evidence of such an important amount of Aaa-rated corporate bonds sales that the spread must rise to attract buyers.

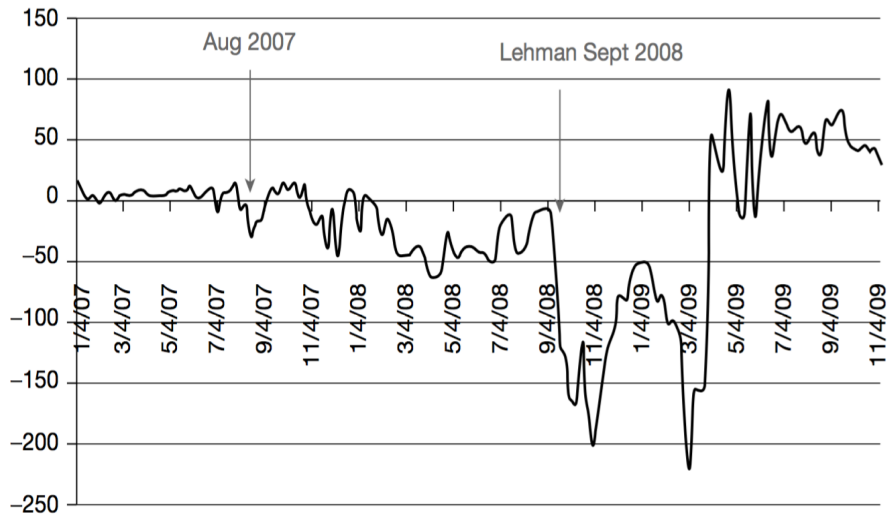


Figure 4: Interest rate spread: 5year AA-AAA Industrials

source: Gorton and Metrick (2009)

In line with the seminal paper by [Shleifer and Vishny \(1992\)](#) on the impact on asset (il)liquidity and prices in the presence of a limited number of informed buyers with finite borrowing capacity, we argue that capital requirements on traditional banks played a crucial role in fire sales during the crisis (see also [Shleifer and Vishny \(2011\)](#), and [Merrill et al. \(2012\)](#)). As discussed in subsection 2.2 and tested empirically in section 6, it was precisely those banks that had their deposits government-insured (and therefore were subject to regulation) that were able to grow in size during the crisis.

3 Analytical environment

We consider a model with three dates ($t = 0, 1, 2$), two sets of agents (households and bankers) and two types of goods (consumption goods and capital goods).¹⁶

3.1 Households

A unit mass of households are endowed with a large quantity of consumption good at each date. We assume that households are infinitely risk-averse,¹⁷ i.e., they have the following utility

¹⁶The model is broadly inspired from [Stein \(2012\)](#) and [Hanson et al. \(2015\)](#). We differ from [Stein \(2012\)](#) with the introduction of different types of banks. In contrast to [Hanson et al. \(2015\)](#), traditional banks can issue debt in a crisis and bankers choose whether they run a traditional or a shadow bank.

¹⁷See [Gennaioli et al. \(2013\)](#). Another usual specification in models of financial intermediaries as issuers of riskless claims to assume that households are Knightian: see [Caballero and Farhi \(2016\)](#), or [Caballero and Krishnamurthy](#)

function:

$$U = \mathbb{E}_0 \left[C_0 + \min_{\omega \in \Omega_1} C_{1,\omega} + \min_{\omega \in \Omega_2} C_{2,\omega} \right] \quad (1)$$

where $C_{t,\omega}$ is consumption at $t = 0, 1, 2$ in state of nature $\omega \in \Omega_t$. Households value future stochastic consumption streams at their worst-case scenario. This assumption is aimed at capturing the fact that investors have a strong aversion to negative skewness in returns (see [Harvey and Siddique \(2000\)](#) for evidence on conditional skewness preference and asset pricing).

At $t = 0$, households allocate their initial endowment between consumption and investment in financial assets issued by banks, the return of which allows consumption at dates 1 and 2.

3.2 Bankers

Bankers are in unit mass, they start at $t = 0$ with an endowment n of consumption goods. They are risk neutral and indifferent between consuming at $t = 0, 1, 2$. Each of them chooses between setting up a traditional bank (T-bank) or a shadow bank (S-bank) by investing a quantity $n^i \in [0, n]$ into one of the two ($i = \{S, T\}$), and consumes whatever is left from this endowment.

Banks' investment technology At $t = 0$, both T- and S-banks can transform consumption goods into capital goods one-for-one, in order to invest capital goods in a productive investment technology.¹⁸ At $t = 1$, both T- and S-banks can buy or sell capital goods for consumption goods, invest capital goods in their investment technology and raise funds from households. At $t = 2$, the investment pays off in terms of consumption goods, and all capital goods are destroyed.

Investing one unit of capital good in the investment technology at $t = 0$ yields a risky payoff $(R, r, 0)$ in consumption goods at $t = 2$, in each respective state of $\Omega_2 \equiv \{GG, BG, BB\}$. Information about the occurrence of states in Ω_2 at $t = 2$ is revealed at $t = 1$ upon realization of states in $\Omega_1 \equiv \{G, B\}$. At $t = 1$, state G (good news) materializes with probability p and state B (bad news) with probability $(1 - p)$. At $t = 1$ in state G, it is known with certainty that state $\{GG\}$ will materialize at $t = 2$ so that investment pays off R . At $t = 1$ in state B, the probabilities that each state $\{BG, BB\}$ materializes are $(q, (1 - q))$.

(2008). The Knightian specification goes back to [Gilboa and Schmeidler \(1989\)](#), whose maximin expected utility representation distinguishes risk from uncertainty.

¹⁸As in [Stein \(2012\)](#) we abstract from any agency problem between the intermediary and the firm manager and assume that the bank has all the bargaining power in the banking-firm relationship, thereby enabling it to extract all the profit from the investment and leaving the firm with no profit in expectation.

Payoffs from the investment technology are summarized on figure 5, where I_t^i denotes investment by an i -bank ($i = S, T$) at $t = 0, 1$. From the perspective of date 0, the probability of each state of nature occurring is p , $(1 - p)q$ and $(1 - p)(1 - q)$.

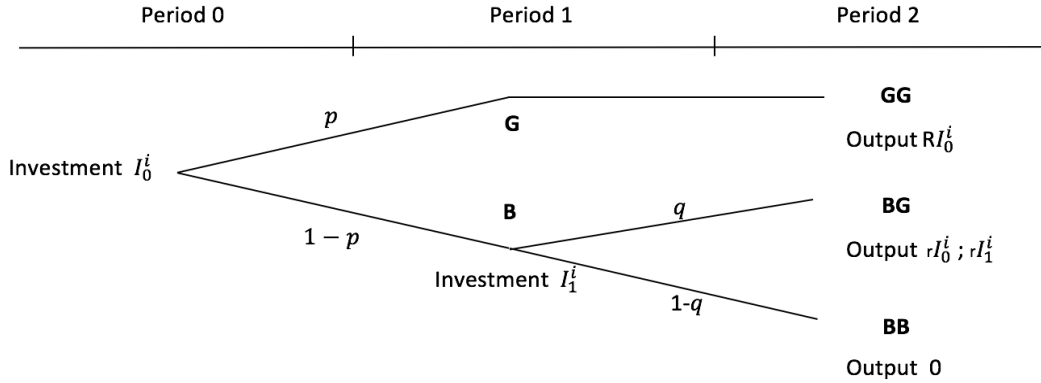


Figure 5: Investments payoffs (states in bold font)

Investment made at $t = 0$ can be liquidated at $t = 1$ at a cost $\varepsilon \in [0, 1]$ per unit of invested capital. ε represents the forsaken returns from liquidating illiquid projects.¹⁹ The freed-up capital can then be used by the bank to reinvest in the same technology, whose expected payoffs depend on the state Ω_1 at $t = 1$ as in figure 5.

Differences between shadow and traditional banks At $t = 0, 1$, each i -bank is randomly matched with a household. On top of its banker's endowment invested in an i -bank ($i = S, T$), denoted n^i , each i -bank can raise funds from households. In the remainder of the paper, we denote D_t^i the amount raised by an i -bank at $t = \{0, \{1, G\}, \{1, B\}$, and \bar{D}_t^i the face value due at date $t = 1$ ($t = 2$) in each state $\{G, B\}$ ($\{GG, BG, BB\}$).

We distinguish traditional from shadow banking by making the following assumption.

Assumption 1. *We make three distinctions between traditional and shadow banks:*

1. *T-banks have relatively higher operating costs, i.e. the investment technology at $t = 0$ yields a risky payoff $(\delta R, \delta r, 0)$ in consumption goods at $t = 2$, where $\delta \in [0, 1]$, respectively in states $\{GG, BG, BB\}$.*
2. *At $t = 1$ in state B, T-banks' claims are guaranteed by a guarantee fund. The guarantee fund pays*

¹⁹One can also interpret ε as the cost of breaking up a lending relationship. The adjustment cost $(1 - \varepsilon)$ is a form of technological illiquidity, whose importance is emphasized in Brunnermeier and Sannikov (2014).

$\frac{q}{(1-q)}\tau_{1,B}$ if state BB occurs at $t = 2$, and it costs $\tau_{1,B}$ if state BG occurs at $t = 2$. We assume²⁰

$$q\tau_{1,B} = (1 - q)\overline{D}_{2,B}^T \quad (2)$$

3. T-banks are subject to the following capital requirements:

$$D_{1,B}^T \leq (1 - c) [\alpha I_0^T + p_{1,B} qr I_1^T] \quad (3)$$

where $D_{1,B}^T$ denotes the amount of funds borrowed from households at $t = 1$ in state B, I_0^T the quantity of capital goods invested at $t = 0$ and α the fraction of these goods on traditional banks' balance-sheets at $t = 1$ in state B. I_1^T is the quantity of capital goods invested at $t = 1$ in state B and $p_{1,B} qr$ their market price.

T- and S-banks are otherwise similar.

Assumption 1 captures what we view as the main differences between T- and S-banks. We argue that T-banks have higher operating expenses compared to S-banks because they traditionally employ more workers, have higher operating expenses, provide more expensive services to their customers and have several types of regulation to satisfy. [Hanson et al. \(2015\)](#) estimate the bricks-and-mortar costs associated with retail deposit-taking to be quite high for T-banks, averaging on the order of 1.3% of deposits over the period from 1984 to 2012.²¹ We argue that capital requirements are one of the most costly regulations banks have to comply with (see e.g. [Baker and Wurgler \(2015\)](#) for a discussion of the cost of capital requirements). In our model, capital requirements in (3) limit the fraction of investment that can be financed by raising funding from households at $t = 1$ in state B, i.e. they set a lower bound on the fraction of investment backed by T-bankers' net worth.

Assumptions on expected returns In 2 we make the following two assumptions about the investment technology.

Assumption 2. At $t = 0$, investing is efficient for both T- and S-banks:

$$\delta (pR + (1 - p)qr) > 1 \quad (4)$$

At $t = 1$ in state B, expected returns are equal to one:

$$qr = 1 \quad (5)$$

²⁰The guarantee fund cannot be used to transfer funds from state BG to state BB. [Greenwood et al. \(2015\)](#) and [Hanson et al. \(2015\)](#) are other examples of models with similar guarantee funds on traditional banks' claims.

²¹These estimates include the costs of other types of regulation as well as the bricks-and-mortar costs of setting up the sort of branch network that attracts sticky retail deposits.

Condition (4) ensures that as of $t = 0$, investing is efficient. This implies that each banker invest her full endowment in a S-bank ($n^S = n$) or a T-bank ($n^T = n$). Condition (5) reflects the fact that in a crisis, asset returns are lower.²²

4 Model analysis

4.1 Optimal financial contracts

We consider all feasible contracts in which a bank borrows funds at $t = 0, 1$ and promises positive repayments in the following dates (i.e. we assume the household cannot credibly promise to refinance).

Proposition 1. *For each type of bank, at $t = 0$ and at $t = 1$ in each state G and B, the optimal financial contract is short-term.*

Proof. It suffices to show that neither S- nor T-banks can promise to repay households at $t = 2$ when issuing claims at $t = 0$.

We first show that it is optimal for an S-bank not to promise any payment at $t = 2$ in a financial contract at $t = 0$. Denote $(D_{0 \rightarrow 1, G}^S, D_{0 \rightarrow 1, B}^S, D_{0 \rightarrow 2, BG}^S, D_{0 \rightarrow 2, BB}^S, D_{0 \rightarrow 2, GG}^S) \in \mathbb{R}_+^5$ the repayment schedule of the S-bank when it borrows $D_0^S > 0$ units of consumption goods at $t = 0$. The consumption goods borrowed are then invested into I_0^S units of capital goods.²³ The financial contract between the S-bank and the household must satisfy the household's participation constraint, i.e.

$$D_0^S \leq \min(D_{0 \rightarrow 1, G}^S, D_{0 \rightarrow 1, B}^S) + \min(D_{0 \rightarrow 2, BG}^S, D_{0 \rightarrow 2, BB}^S, D_{0 \rightarrow 2, GG}^S)$$

Now, the S-bank cannot credibly commit to reimburse a positive amount of funds at $t = 2, BB$, because the investment payoff is 0 in that state (see figure 5). The impossibility for S-banks to transfer funds to this state of the world implies $D_{0 \rightarrow 2, BB}^S = 0$.

We now show that it is optimal for a T-bank not to promise any payment at $t = 2$ in a financial contract established at $t = 0$ with the household it is matched with. The only way for a T-bank to transfer funds to $t = 2, BB$ is by using the guarantee fund. Because the guarantee fund only guarantees short-term claims, no long-term contract can be credibly set up and $D_{0 \rightarrow 2, BB}^T = 0$.

Due to household's utility function (1), households only value the lowest possible payoff. Using $D_{0 \rightarrow 2, BB}^S = D_{0 \rightarrow 2, BB}^T = 0$, we obtain $\min(D_{0 \rightarrow 2, BG}^i, D_{0 \rightarrow 2, BB}^i, D_{0 \rightarrow 2, GG}^i) \leq 0$ where $i =$

²²The model's exposition is simpler when $qr = 1$, but results are unchanged when $qr \leq 1$.

²³We show later that S-bankers' net worth n is also invested at $t = 0$.

S, T. Therefore any i-bank sets

$$D_{0 \rightarrow 2, BG}^i = D_{0 \rightarrow 2, BB}^i = D_{0 \rightarrow 2, GG}^i = 0.$$

We find that all financial contracts issued by any i-bank at $t = 0$ is short term, i.e. no long-term financial contracts are signed. QED. \square

4.2 Shadow banks' program

We solve S-banks' program by backward induction.

At $t = 1$, in each state G, B, S-banks choose how much (if any) funding to raise, how much capital goods to sell on the market, and how much capital goods to newly invest in the technology.

t = 1, state G. At $t = 1$ in state G, S-banks must repay short-term debt \bar{D}_1^S . They then choose the fraction α of their date-0 investment I_0^S they want to hold to maturity, and new investment $I_{1,G}^S$.²⁴ They sell their residual capital goods $(1 - \alpha)I_0^S$ and raise $D_{1,G}^S$ units of consumption goods, promising to repay $\bar{D}_{2,GG}^S$ at $t = 2$ in state GG.

The program at $t = 1$ in state G writes

$$\max_{\alpha, D_{1,G}^S, \bar{D}_{2,GG}^S, I_{1,G}^S} \Pi_{1,G}^S = \left[(\alpha R I_0^S + R I_{1,G}^S - D_{2,G}^S) + \left((1 - \alpha) I_0^S p_{1,G} (1 - \varepsilon) + D_{1,G}^S - \bar{D}_{1,G}^S - p_{1,G} I_{1,G}^S \right) \right]$$

subject to

$$(1 - \alpha) p_{1,G} I_0^S (1 - \varepsilon) + D_{1,G}^S \geq \bar{D}_{1,G}^S + p_{1,G} I_{1,G}^S \quad (6)$$

$$\bar{D}_{2,GG}^S \geq D_{1,G}^S \quad (7)$$

$$\alpha R I_0^S + R I_{1,G}^S \geq \bar{D}_{2,GG}^S \quad (8)$$

$$\alpha, D_{1,G}^S, \bar{D}_{2,GG}^S, I_{1,G}^S \geq 0 \quad (9)$$

$$\alpha \leq 1 \quad (10)$$

where (6) is the S-bank budget constraint at $t = 1$ in state G, (7) is the household participation constraint, (8) is the limited-liability constraint, (9) are the positivity constraints and (10) is the short-sale constraint at $t = 1$ in state G.

t = 1, state B. At $t = 1$ in state B there is a non-zero probability for the investment technology to return a zero payoff at $t = 2$. Therefore infinitely risk-averse households will not value

²⁴ Any new investment by a bank at $t = 1$ is another bank's sale of capital good because we assume that there is no other capital good in the economy than that available at $t = 0$.

claims issued by S-banks at $t = 1$ in state B, since they are not riskless. The only way for S-banks to reimburse households is then to sell capital goods on the market and channelling the proceeds of this sale to households so as to meet their obligations. Shadow banks then choose the fraction of their investment they want to interrupt so as to consume or purchase capital goods from other banks at $t = 1$ in state B.

Remark that S-banks can only invest at $t = 1$ in state B by interrupting previous investments made at $t = 0$. Because expected returns from date-0 and date-1 investments are similar, S-banks will not be willing to interrupt date-0 investment (at a cost ε by unit of interrupted investment) to invest at $t = 1$ in state B. Without loss of generality, we therefore write the program at $t = 1$ in state B as

$$\max_{\alpha} \Pi_{1,B}^S = \alpha q r I_0^S + ((1 - \alpha)(1 - \varepsilon) p_{1,B} I_0^S - D_0^S)$$

subject to

$$(1 - \alpha)(1 - \varepsilon) p_{1,B} I_0^S \geq D_0^S \quad (11)$$

$$\alpha \geq 0 \quad (12)$$

$$\alpha \leq 1 \quad (13)$$

where (11) is the S-bank budget constraint, (12) are the positivity constraints and (13) the short-sale constraint.

Focusing on cases where $R \leq p_{1,G} \leq \frac{R}{1-\varepsilon}$ without loss of generality, we show in the appendix that the maximization of S-banks' program at $t = 1$ yields the following lemma.

Lemma 1. *At $t = 1$, S-banks' take the following decisions.*

1. *In state G, there can only be an equilibrium if $\bar{D}_{1,B}^T \leq R I_0^S$. Equilibria are such that $\bar{D}_{2,G}^S = D_{1,G}^S$ and*

(a) *If $p_{1,G} = R$ then $\alpha = 1$, any $I_1^S \geq 0$ and any $D_{1,G}^S$ such that $\bar{D}_{1,G}^S + R I_{1,G}^S \leq D_{1,G}^S \leq R I_0^S + R I_{1,G}^S$ is an equilibrium.*

(b) *If $R < p_{1,G} < \frac{R}{1-\varepsilon}$ then $\alpha = 1$, $I_1^S = 0$ and any $D_{1,G}^S$ such that $\bar{D}_{1,G}^S \leq D_{1,G}^S \leq R I_0^S$ is an equilibrium.*

(c) *If $p_{1,G} = \frac{R}{1-\varepsilon}$ then $\alpha \in [0; 1]$, $I_1^S = 0$ and any $D_{1,G}^S$ such that $\bar{D}_{1,G}^S - (1 - \alpha) R I_0^S \leq D_{1,G}^S \leq \alpha R I_0^S$ and $D_{1,G}^S \geq 0$ is an equilibrium.*

Their profit writes

$$\Pi_{1,G}^S = R I_0^S - \bar{D}_{1,G}^S.$$

2. In state B, S-banks choose to continue a fraction $\alpha = 1 - \frac{\bar{D}_{1,B}^S}{(1-\varepsilon)p_{1,B}I_0^S}$ of their investment at $t = 1$ in state B. Their profit writes

$$\Pi_{1,B}^S = qrI_0^S \left(1 - \frac{\bar{D}_{1,B}^S}{(1-\varepsilon)p_{1,B}I_0^S} \right)$$

$t = 0$. We focus on cases where $0 < p_{1,B} \leq 1$ without loss of generality.²⁵ At $t = 0$, shadow banks' program writes

$$\max_{D_0^S, \bar{D}_{1,B}^S, \bar{D}_{1,G}^S, I_0^S} \Pi_0^S = (1-p)\Pi_{1,B}^S(D_1^S, I_0^S) + p\Pi_{1,G}^S(D_1^S, I_0^S)$$

$$(1-\varepsilon)p_{1,B}I_0^S \geq \bar{D}_1^S \quad (14)$$

$$\bar{D}_{1,B}^S \geq D_0^S \quad (15)$$

$$\bar{D}_{1,G}^S \geq D_0^S \quad (16)$$

$$I_0^S = D_0^S + n \quad (17)$$

$$D_0^S \geq 0 \quad (18)$$

where (14) is S-banks' limited liability, (15) and (16) are households' participation constraints, (17) is the shadow bank budget constraint and (18) is the positivity constraint.

We now introduce assumption 3, which is a little more strict than previous restriction (4) in assumption 2. This assumption implies that investment payoffs are high enough so that there exists parametric restrictions ensuring that from a $t = 0$ perspective, S-banks are willing to sell capital goods at $t = 1$ in state B below fundamental value. Assumption 3 ensures that in expectation, returns at $t = 1$ in state G are high enough to compensate for this.

Assumption 3.

$$R > 1 + \frac{1-p}{p} \cdot \frac{\varepsilon}{1-\varepsilon}$$

Denoting $\bar{p}_1^S = \frac{1}{(1-\varepsilon)(1+\frac{p(R-1)}{1-p})}$ and using assumption 3, we obtain the following proposition.

Proposition 2. *At $t = 0$, S-banks take the following decisions.*

²⁵On the one hand, $p_{1,B} = 0$ would yield an infinite demand for capital goods at $t = 1, B$ that could not be matched with an equal supply, thereby preventing an equilibrium in the secondary market. On the other hand, $p_{1,B} > 1$ would yield a zero demand for capital goods at $t = 1$ in state B because the price of capital goods would be above the investment expected payoff. Note that $p_{1,B} < 1$ indicates fire sales, i.e. asset sales at prices lower than expected value.

1. If $0 < p_{1,B} < \bar{p}_1^S$, $D_0^S = 0$, $I_0^S = n$. Shadow banks do not issue short-term claims at $t = 0$, i.e. they do not lever themselves.
2. If $p_{1,B} = \bar{p}_1^S$, any $D_0^S \in \left[0; \frac{(1-\varepsilon)\bar{p}_1^S q r}{1-(1-\varepsilon)\bar{p}_1^S q r} n\right]$ is an equilibrium solution, and $I_0^S = n + D_0^S$. Shadow banks sell all their capital goods at $t = 1, B$, so as to repay their date-0 creditors. Shadow banks do not sell any capital goods at $t = 1$ in state G.
3. If $p_{1,B} > \bar{p}_1^S$ and $D_0^S = \frac{(1-\varepsilon)p_{1,B} q r}{1-(1-\varepsilon)p_{1,B} q r} n$, $I_0^S = n + D_0^S$. Shadow banks sell all their capital goods at $t = 1, B$, so as to repay their date-0 creditors. Shadow banks do not sell any capital goods at $t = 1$ in state G.

Proof. See the appendix. □

Although S-banks do not enjoy government insurance, they can issue safe claims at $t = 0$ insofar as they are backed by the liquidation value of the fraction $(1 - \alpha)$ of their existing investment they sell at $t = 1$ in state B. It is S-banks' ability to pull the plug in the crisis that enables them to issue safe short-term debt at $t = 0$. When liquidating at $t = 1$ in state B, proceeds from selling capital goods are $(1 - \alpha)(1 - \varepsilon)p_{1,B}I_0^S$ where $p_{1,B}$ is the price of a capital good in the secondary market at $t = 1$ in state B. The proceeds of this sale depend on T-banks' ability to purchase capital goods in the crisis, which itself relies on the guarantee fund these latter can access. Indirectly, S-banks therefore rely on the guarantee fund via T-banks. We now turn to T-banks' maximization program.

4.3 Traditional banks' program

We solve for T-banks' program by backward induction.

$t = 1$, **state G** At $t = 1$ in state G, traditional banks' problem is exactly the same as that of shadow banks. They choose how much consumption goods to raise from households, how much capital goods to sell on the market, how much capital goods to refinance and how much

capital goods to purchase on the market. The program at $t = 1$ in state G writes

$$\max_{\alpha, D_{1,G}^T, \bar{D}_{2,GG}^T, I_{1,G}^T} \Pi_{1,G}^T = \left[(\alpha R I_0^T + R I_{1,G}^T - \bar{D}_{2,GG}^T) + \left((1 - \alpha) I_0^T p_{1,G} (1 - \varepsilon) + D_{1,G}^T - \bar{D}_{1,G}^T - p_{1,G} I_{1,G}^T \right) \right]$$

subject to

$$(1 - \alpha) p_{1,G} I_0^T (1 - \varepsilon) + D_{1,G}^T \geq \bar{D}_{1,G}^T + p_{1,G} I_{1,G}^T \quad (19)$$

$$\bar{D}_{2,G}^T \geq D_{1,G}^T \quad (20)$$

$$\alpha R I_0^T + R I_{1,G}^T \geq \bar{D}_{2,GG}^T \quad (21)$$

$$\alpha, D_{1,G}^T, I_{1,G}^T \geq 0 \quad (22)$$

$$\alpha \leq 1 \quad (23)$$

where (19) is the T-bank budget constraint at $t = 1$ in state G, (20) is the household participation constraint, (21) is the limited-liability constraint, (22) are the positivity constraints and (23) is the short-sale constraint at $t = 1$ in state G.

$t = 1$, **state B** In contrast to S-banks, T-banks are able to issue safe claims at $t = 1$ in state B because they can access a guarantee fund that makes these claims safe despite a non-zero probability of a zero output if state BB materializes at $t = 2$.²⁶ The possibility of a zero output at $t = 2$ therefore does not deter T-banks from entering a contract with households at $t = 1$ in state B.

At $t = 1$ in state B, T-banks make the same choices as in $t = 1$ in state G, subject to two additional constraints: they have to pay for the guarantee fund on their short-term debt and to comply with capital requirements. The program at $t = 1$ in state B writes

$$\max_{\alpha, D_{1,B}^T, \bar{D}_{2,BB}^T, \bar{D}_{2,BG}^T, I_{1,B}^T} \Pi_{1,B}^T = \left(q(\alpha r I_0^T + r I_{1,B}^T - \bar{D}_{2,BG}^T - \tau_{1,B}^T) + (1 - q) \left(q \frac{\tau_{1,B}^T}{1 - q} - \bar{D}_{2,BB}^T \right) \right) \\ + \left((1 - \alpha) I_{1,B}^T p_{1,B} q r (1 - \varepsilon) + D_{1,B}^T - \bar{D}_{1,B}^T - p_{1,B} q r I_{1,B}^T \right)$$

subject to

²⁶As explained in the introduction, we view this insurance as the insurance that traditional banks benefit from on their deposits (e.g. the FDIC insurance in the US), in exchange for having to satisfy regulatory capital requirements.

$$(1 - \alpha)p_{1,B}qrI_0^T(1 - \varepsilon) + D_{1,B}^T \geq \bar{D}_{1,B}^T + p_{1,B}qrI_{1,B}^T \quad (24)$$

$$\alpha rI_0^T + rI_{1,B}^T \geq \bar{D}_{2,BG}^T + \tau_{1,B}^T \quad (25)$$

$$q\tau_{1,B} = (1 - q)\bar{D}_{2,B}^T$$

$$D_{1,B}^T \leq (1 - c)(\alpha I + p_{1,B}qrI_1) \quad (26)$$

$$\bar{D}_{2,BG}^T \geq D_{1,B}^T \quad (27)$$

$$\bar{D}_{2,BB}^T \geq D_{1,B}^T \quad (28)$$

$$\alpha, D_{1,B}^T, I_{1,B}, \bar{D}_{2,BB}^T, \bar{D}_{2,BG}^T \geq 0 \quad (29)$$

$$\alpha \leq 1 \quad (30)$$

where (24) is T-banks' budget constraint, (25) is their limited liability constraint, (2) is the actuarially fair insurance price (see below for a discussion), (26) is the capital requirement they face when using the guarantee fund, (27) and (28) are households' participation constraints, (29) are the positivity constraints and (30) the short-sale constraint.

Denoting $\tau_{1,B}$ the T-banks' contribution to the guarantee fund, we assume actuarially fair insurance premia in (2) such that $q\tau_{1,B} = (1 - q)D_{1,B}^T$.

We make a simplifying restriction concerning capital requirements in assumption 4.

Assumption 4.

$$\delta(1 - \varepsilon) \leq (1 - c) \leq \delta \quad (31)$$

The first inequality in (31) ensures that T-banks are not willing to sell capital goods at $t = 1$ in state B, and the second one makes the capital constraint restrictive enough compared to the limited liability constraint.

Focusing on cases where $p_{1,B} \leq 1$ without loss of generality, we show in the appendix that the maximization of T-banks' program at $t = 1$ yields the following lemma:

Lemma 2. *At $t = 1$, T-banks take the following decisions.*

1. *In state G, T-banks take the same decisions as S-banks. See lemma 1.*

2. *In state B, there can only be an equilibrium if $\bar{D}_{1,B}^T \leq (1 - c)I_0^T$. In all equilibria, T-banks choose not to interrupt any investment at $t = 1$ in state B, ie $\alpha = 1$. Equilibria are such that $\bar{D}_{2,BB}^T = \bar{D}_{2,BG}^T = D_{1,B}^T$ and*

(a) *If $p_{1,B} = 1$ then any $D_{1,B}^T$ and $I_{1,B}^T$ such that $D_{1,B}^T \geq \bar{D}_{1,B}^T + I_{1,B}^T$ and $D_{1,B}^T \leq (1 - c)(I_0^T + I_{1,B}^T)$ is an equilibrium.*

(b) If $p_{1,B} < 1$ then $D_{1,B}^T = \frac{(1-c)}{c} (I_0^T - \bar{D}_{1,B}^T)$ and $I_{1,B}^T = \frac{(1-c)I_0^T - \bar{D}_{1,B}^T}{cp_{1,B}}$.

Their profit writes

$$\Pi_{1,B}^T = I_0^T - \bar{D}_{1,B}^T + \left((1-c)I_0^T - \bar{D}_{1,B}^T \right) \left(\frac{1-p_1}{cp_1} \right)$$

At $t = 0$ As before, we focus on cases where $0 < p_{1,B} \leq 1$. At $t = 0$, T-banks choose how much funds to raise, and how much consumption goods to transform into capital goods. Their program at $t = 0$ writes

$$\max_{D_0^T, \bar{D}_{1,B}^T, \bar{D}_{1,G}^T, I_0^T} \Pi_0^T = p\Pi_{1,G}^T(D_1^T, I_0^T) + (1-p)\Pi_{1,B}^T(D_1^T, I_0^T) \quad (32)$$

subject to

$$\bar{D}_{1,B}^T \leq (1-c) I_0^T \quad (33)$$

$$\bar{D}_{1,G}^T \leq R I_0^T \quad (34)$$

$$D_0^T + n = I_0^T \quad (35)$$

$$D_0^T \leq \bar{D}_{1,B}^T \quad (36)$$

$$D_0^T \leq \bar{D}_{1,G}^T \quad (37)$$

$$D_0 \geq 0 \quad (38)$$

where I_0^T is T-banks' investment at $t = 0$. The objective (32) can be interpreted as follows. At $t = 1$ in state $j = G$ (respectively $j = B$), T-banks' expected profits are $\Pi_{1,G}^T(D_1^T, I_0^T)$ ($\Pi_{1,B}^T(D_1^T, I_0^T)$), (33) (respectively (34)) is T-banks' limited liability constraint in case state G (B) materializes, (35) is their budget constraint, (36) and (37) are household's participation constraints and (38) are the positivity constraints.

Again, we focus without loss of generality on cases where $0 < p_{1,B} \leq \delta$. Denoting $\bar{p}_1^T = \frac{\delta}{\delta + \frac{p(\delta R - 1)}{1-p}}$, T-banks' program yields the following proposition.

Proposition 3. *At $t = 0$, T-banks take the following decisions.*

1. If $0 < p_{1,B} < \bar{p}_1^T$, $D_0^T = 0$, $I_1^T = \frac{(1-c)}{cp_{1,B}} n$, traditional banks do not issue short-term claims at $t = 0$, i.e. they do not lever themselves at $t = 0$. They however lever themselves and reinvest at $t = 1$ in state B.
2. If $p_{1,B} = \bar{p}_1^T$, any $0 \leq D_0^T \leq \frac{(1-c)}{c} n$ is an equilibrium solution, and $I_1^T = \frac{(1-c)I_0^T - D_1^T}{cp_{1,B}}$. Traditional banks might lever themselves at $t = 0$, and they lever themselves and reinvest at $t = 1$ in state B.

3. If $\delta \geq p_{1,B} > \bar{p}_1^T$, $D_0^T = \frac{(1-c)}{c}n$, $I_1^T = 0$. Traditional banks issue as much short-term debt as they can at $t = 0$, and they do not reinvest at $t = 1$ in state B.

Depending on the price of capital goods on the secondary market at $t = 1$ in state B, T-banks choose how much short-term debt to issue at $t = 0$ to invest in positive NPV projects, versus how much leeway to keep so as to purchase capital goods from S-banks at $t = 1$ in state B. Although it is thanks to the guarantee fund that T-banks can issue short-term debt in the crisis, they have to trade-off between those two investment opportunities because their issuance of short-term debt is limited by capital requirements and the supply of capital is fixed at $t = 1$ in state B.

4.4 Market equilibria

In this section, we derive the market-clearing conditions for different values of $p_{1,B}$ such that $0 < p_{1,B} \leq 1$ taking the shares χ^S ($(1 - \chi^T)$) of S-banks (T-banks) as given. Let us define an equilibrium on the secondary market for capital goods at $t = 1$ in state B.

Definition 1. A market equilibrium is defined by

1. A quantity $S(p_1)$ of capital goods supplied
2. A quantity $D(p_1)$ of capital goods demanded
3. A price p_1 such that $D(p_1) = S(p_1)$

t = 1 state G At $t = 1$ in state G, interrupting investment destroys a fraction ε of the invested capital. The freed-up capital can then be used to (i) invest in an investment technology with the same expected return, or (ii) be sold in exchange for consumption goods consumed right away. Neither S- nor T-banks are willing to pay more for a capital good than the expected returns from investing it,²⁷ therefore no intermediary is willing to supply capital at $t = 1$ in state G as they are better off holding on to their investment.

t = 1 state B As before, we focus without loss of generality on cases where $0 < p_{1,B} \leq \delta$. At $t = 1$ in state B, with $\chi^S \in [0; 1]$ denoting the share of S-banks and $(1 - \chi^S)$ that of T-banks. At $t = 1$ in state B, the aggregate demand for capital goods is

²⁷T-banks are as efficient as S-banks in investing capital goods. Despite their higher operating costs, they are not willing to sell capital goods at $t = 1$ in state G because the profits from this sale would be subject to higher operating costs too.

$$D(p_{1,B}) = \begin{cases} \frac{1-c}{cp_{1,B}qr} n (1-\chi^S) & \text{if } 0 < p_{1,B} < \bar{p}_1^T \\ \in \left[0; \frac{1-c}{cp_{1,B}qr} n (1-\chi^S)\right] & \text{if } p_{1,B} = \bar{p}_1^T \\ 0 & \text{if } \bar{p}_1^T < p_{1,B} \leq \delta \end{cases}$$

At $t = 1$ in state B, the aggregate supply for capital goods is

$$S(p_{1,B}) = \begin{cases} 0 & \text{if } 0 < p_{1,B} < \bar{p}_1^S \\ \in \left[0; \frac{n}{1-(1-\varepsilon)p_{1,B}qr} \chi^S\right] & \text{if } p_{1,B} = \bar{p}_1^S \\ \frac{n}{1-(1-\varepsilon)p_{1,B}qr} \chi^S & \text{if } \bar{p}_1^S < p_{1,B} \leq \delta \end{cases}$$

Lemma 3. *There exists a set of parameters $(c, p, q, R, r, \varepsilon, \delta, \alpha) \in \mathbb{R}_+^8$ such that assumption 4 is met and*

$$\bar{p}_1^T > \bar{p}_1^S \quad (39)$$

Proof. Note that $\frac{d\bar{p}_1^T}{d\delta} = \frac{-p}{(1-p)\left(\delta + \frac{p(\delta R - 1)}{1-p}\right)^2} < 0$, and $\lim_{\delta \rightarrow (pR + (1-p))^{-1}} \bar{p}_1^T = +\infty$. Continuity ensures that, for any given set of parameters, we can find a value δ such that (39) holds and assumptions 4 are met. \square

We assume that the parameters are such that condition (39) is met in the rest of the paper. In that case, there is an exchange of capital goods between T- and S-banks in the secondary market at $t = 1$ in state B when $\chi^S \in (0; 1)$. In equilibrium in the secondary market for capital goods:

$$D(p_{1,B}) = S(p_{1,B})$$

and three cases might occur:

1. Either $\chi^S = 0$, $D = S = 0$, and $p_{1,B}$ is such that $\bar{p}_1^T \leq p_{1,B} \leq \delta$.

2. Or $\chi^S \in (0; 1)$, $D = S$, and

(a) Either $\frac{(1-c)}{c\bar{p}_1^S} n (1-\chi^S) \leq \frac{n}{1-(1-\varepsilon)\bar{p}_1^S} \chi^S$ and $p_{1,B} = \bar{p}_1^S$

(b) Or $\frac{(1-c)}{cp_{1,B}} n (1-\chi^S) = \frac{n}{1-(1-\varepsilon)p_{1,B}} \chi^S$ and $p_{1,B} = \frac{1}{\left(\frac{c}{1-c} \frac{\chi^S}{1-\chi^S} + (1-\varepsilon)\right)} \in [\bar{p}_1^S; \bar{p}_1^T]$

(c) Or $\frac{(1-c)}{c\bar{p}_1^T} n (1-\chi^S) \geq \frac{n}{1-(1-\varepsilon)\bar{p}_1^T} \chi^S$ and $p_{1,B} = \bar{p}_1^T$

3. Or $\chi^S = 1$, $D = S = 0$, and $p_{1,B}$ is such that $0 < p_{1,B} \leq \bar{p}_1^S$.

The two graphs 6a and 6b plot two numerical examples in which $\chi^S \in (0; 1)$, such that the secondary market for capital goods at $t = 1$ in state B is in equilibrium.

In figure 6a we have $\delta = 1$ in which case T-banks have the same operating costs as S-banks. We see that in such a case, there is no asset trade at $t = 1$ in state B, therefore S-banks cannot

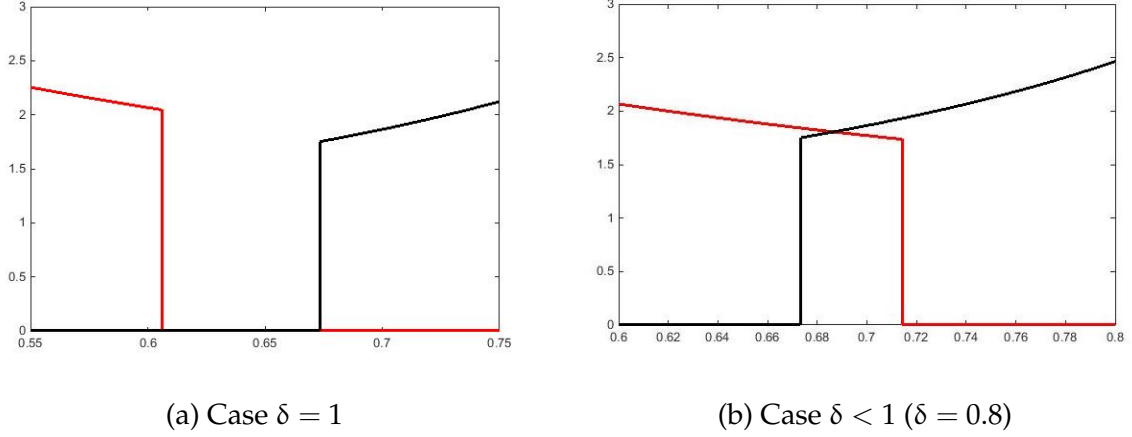


Figure 6: Demand and supply for assets in the secondary market

issue claims at $t = 0$. Bankers' choice is to run a T-bank or an unlevered S-bank. In contrast, the graph in 6b illustrates the fact that when $\delta < 1$ such that (39) is met, there exists $p_{1,B} \in [\bar{p}_1^S; \bar{p}_1^T]$ for which T- and S-banks trade capital goods at $t = 1$ in state B. It follows that S-banks can issue short-term debt at $t = 0$.

We analyze in subsection 4.5 bankers' choice between running a T- versus S-bank in that case.

4.5 Bankers' business choice

We now endogenize bankers' choice to run a T-or a S-bank by observing that bankers will choose whatever banking business is more profitable. They compare *ex ante* expected profits from the perspective of $t = 0$. To that extent, we start by defining an equilibrium allocation between shadow and traditional banking.

Definition 2. An equilibrium allocation is a share $\chi^S \in [0; 1]$ such that

1. Each financial intermediary maximizes its date-0 expected utility
2. Capital good (secondary) markets are in equilibrium at $t = 1$ in state G and B
3. Either $\chi^S \in [0; 1]$ and $\Pi_0^S(\chi^S) = \Pi_0^T(\chi^S)$, or $\chi^S = 0$ and $\Pi_0^S(\chi^S) < \Pi_0^T(\chi^S)$, or $\chi^S = 1$ and $\Pi_0^S(\chi^S) > \Pi_0^T(\chi^S)$.

Solving for an equilibrium as defined in 2 yields the following proposition.

Proposition 4. The fraction χ^S (respectively $(1 - \chi^S)$) of bankers who choose to run a S-bank (T-bank) is the following.

1. If operating costs in T- and S-banks are the same, i.e. $\delta = 1$, all bankers choose to run a T-bank ($\chi^S = 0$).
2. If operating costs in T-banks are higher than in S-banks, i.e. $\delta < 1$, T- and S-banks can coexist ($\chi^S \in [0, 1]$).

The proof of proposition 4 comes in two steps.

Step 1: $\delta = 1$. When $\delta = 1$, we have $\Pi_0^T = [pR + (1 - p)]n + [pR + (1 - p) - 1] \frac{1-c}{c}n$ and $\Pi_0^S = [pR + (1 - p)]n$. Hence $\Pi_0^S < \Pi_0^T$ for any parameters $(p, R) \in \mathbb{R}_+^2$ satisfying assumption 2. \square

T- and S-banks face inter-temporal tradeoffs. On the one hand, T-banks trade off investment opportunities at $t = 0$ versus maintaining buffers at $t = 0$ to raise funds at $t = 1$ in state B to purchase capital goods from S-banks. On the other hand, S-banks must trade off raising one unit of fund to investing at $t = 0$ versus the risk of having to liquidate this investment early, by selling it to traditional banks at a discount. Due to the additional cost ε of technological illiquidity,

When T-banks do not have higher operating costs ($\delta = 1$), S-banks are not willing to raise funds at $t = 0$ when T-banks are willing to raise funds at $t = 1$ in state B. This is due to the additional cost ε of technological illiquidity. Therefore S-banks do not issue short-term debt at $t = 0$: they do not *lever* themselves outside a crisis because the price of assets in a crisis is too low. The comparison between the two types of banks when $\delta = 1$ is one of T-banks versus unlevered S-banks. Because T-banks are always able to raise funds at a fair price at $t = 1$ in state B, this provides them with a general advantage over unlevered S-banks. Since T-banks always are able to lever themselves more than S-banks, T-banks' profits are always higher than that of S-banks when $\delta = 1$.

Figure 6a plots a numerical example in which $\chi^S \in (0; 1)$, such that the secondary market for capital goods at $t = 1$ in state B is in equilibrium. The graph illustrates the fact that in the baseline framework, there is no price $p_{1,B}$ for which there can be an exchange of capital goods at $t = 1$ in state B. It follows that S-banks cannot issue short-term debt at $t = 0$, and proposition 4 shows that in that case, all bankers choose to run a T-bank rather than a S-bank. There is no coexistence of the two bank types in equilibrium in the baseline framework.

Step 2: $\delta < 1$. We define

$$\Delta : p_{1,B} \rightarrow \Pi_0^{TB}(p_{1,B}) - \Pi_0^{SB}(p_{1,B})$$

Δ is a continuous, strictly decreasing function on $(0; \delta]$.

As, $\Delta \xrightarrow[p_{1,B} \rightarrow 0^+]{+} \infty$, it can cancel at most once on this interval. Let us detail the different possibilities:

1. Either $\Delta(\bar{p}_1^S) < 0$. In this case, there is a unique $p_{1,B}^* \in (0; \bar{p}_1^S)$ such that $\Delta(p_{1,B}^*) = 0$. Then $\chi^S = 1$ and any $p_{1,B} \in [p_{1,B}^*; \bar{p}_1^S]$ is an equilibrium market price at $t = 1$ in state B. No assets are traded in these equilibria.
2. Or $\Delta(\bar{p}_1^S) = 0$. In this case, any χ^S such that $\frac{(1-c)}{c\bar{p}_1^S}n(1-\chi^S) \leq \frac{n}{1-(1-\varepsilon)\bar{p}_1^S}\chi^S$ is an equilibrium allocation, and $p_{1,B} = \bar{p}_1^S$.
3. Or $\Delta(\bar{p}_1^S) > 0$ and $\Delta(\bar{p}_1^T) < 0$. Then, there is a unique $p_{1,B}^* \in (\bar{p}_1^S; \bar{p}_1^T)$ such that $\Delta(p_{1,B}^*) = 0$. In this case $\chi^S = \frac{(1-(1-\varepsilon)p_{1,B}^*)}{p_{1,B}^* \frac{c}{1-c} + (1-(1-\varepsilon)p_{1,B}^*)} = 1 - \frac{1}{1+(1-(1-\varepsilon)p_{1,B}^*) \frac{(1-c)}{cp_{1,B}^*}}$, and $p_{1,B} = p_{1,B}^*$ is the unique equilibrium market price at $t = 1$ in state B.
4. Or $\Delta(\bar{p}_1^T) = 0$. In this case, any χ^S such that $\frac{(1-c)}{c\bar{p}_1^T}n(1-\chi^S) \geq \frac{n}{1-(1-\varepsilon)\bar{p}_1^T}\chi^S$ is an equilibrium allocation, and $p_{1,B} = \bar{p}_1^T$.
5. Or $\Delta(\bar{p}_1^T) > 0$. In this case $\chi^S = 0$ and any $p_{1,B} \geq \bar{p}_1^T$ such that $\Delta(p_{1,B}) > 0$ is an equilibrium market price. No assets are traded in these equilibria.

□

Our model yields a unique solution when $\delta < 1$, that can be from type 1 to 5. The conclusion we draw from this result is that both types of intermediaries can coexist. When they do, S-banks are able to lever themselves thanks to T-banks' ability to purchase capital goods sold by shadow banks in a crisis (i.e. at $t = 1$ in state B). In such a situation, fire-sales always occur. Indeed, T-banks' capital requirements limits their ability to issue short-term debt, and thereby the total quantity of investment they can make at $t = 0$ and $t = 1$ in state B. In order to purchase capital goods from S-banks in the crisis, T-banks need to be compensated for foregoing investment opportunities at $t = 0$. T-banks face a trade-off between issuing short-term debt at $t = 0$ and keeping some buffer in order to issue short-term debt at $t = 1$ in state B so as to purchase S-banks' capital goods. Interestingly this make the fire sale price always lower than the price at which the traditional banks value the asset (i.e. δ): the fire sale is not entirely driven by the need for T-banks to be compensated for higher functioning costs. This trade-off therefore is key to understand the occurrence of fire-sales in a crisis.

Numerical illustration According to the values of the parameters, either equilibrium 1 to 5 is attainable. Therefore there exist equilibria (i) with T-banks only, (ii) with S-banks only (in

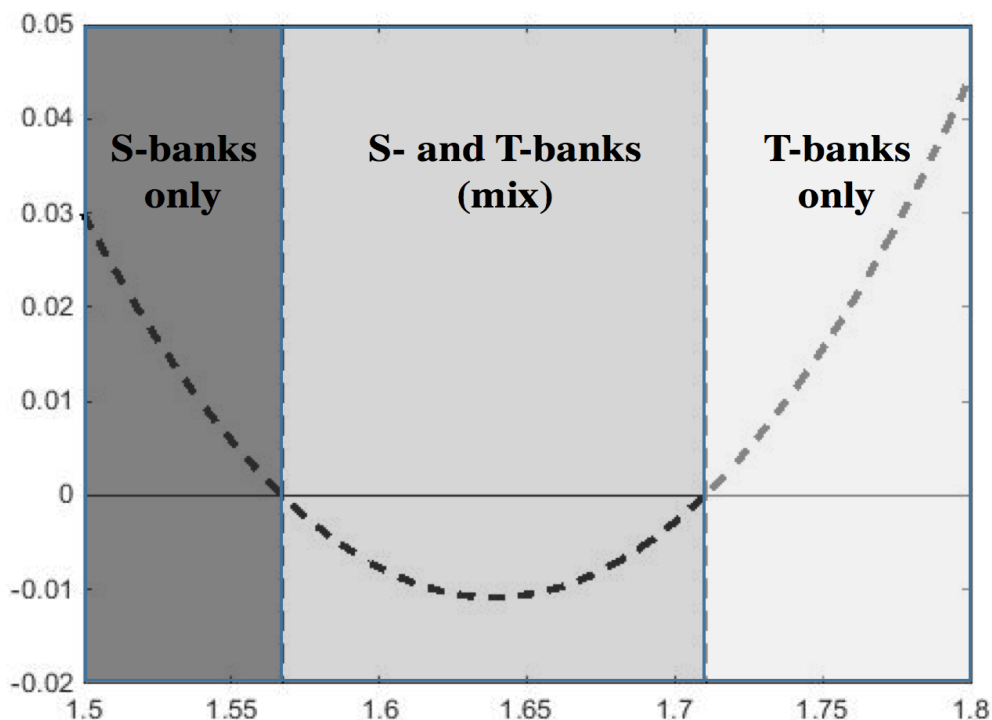


Figure 7: Numerical simulation of $\Delta(\bar{p}_1^S) \times \Delta(\bar{p}_1^T)$ for $R \in [1.5, 2]$

We choose the following numerical variables: $p = 0.5, q = 0.99, r = 1/q, \varepsilon = 0.1, \delta = 0.8, n = 1, c = 0.2$ and let R vary between 1.5 and 1.8.

which case they do not issue any short-term debt at $t = 0$, i.e. they are unlevered), and (iii) with a mix of both S- and T-banks. We now illustrate numerically on figure 7 that there exists parameter sets where both S- and T-banks coexist in the model. Figure 7 plots the product $\Delta(\bar{p}_1^S) \times \Delta(\bar{p}_1^T)$. What figure 7 illustrates is two equilibria where both S- and T-banks coexist, when the parametric restrictions are met.

5 Increased capital requirements

In our extended framework, shadow and traditional banks can coexist. This setting therefore enables us to study the question of the impact of capital requirement on bankers' choice between running a S- and a T-bank in an ecosystem where the two banks exist.

Increased capital requirements has two effects. On the one hand, an increase in traditional banks' capital requirements hinder their ability to issue short-term debt at $t = 1$ in state B, thereby lowering their expected date-0 profits. This effect therefore reduces the fraction of bankers choosing to run a traditional bank, and it is reminiscent of earlier findings in the liter-

ature (see [Plantin \(2015\)](#), [Ordenez \(2013\)](#), [Harris et al. \(2015\)](#)). On the other hand, a new effect is at play in our model, stemming from our modeling of traditional banks as buyers of shadow banks' assets in the crisis.

Proposition 5. *Increased capital requirements on traditional banks creates two competing effects. The net effect is that an increase in capital requirements on traditional banks increases the share of traditional banks (ie, the second effect dominates).*

Proof. See appendix. □

Proposition 5 determines which of the two effects dominates. We find that the net effect of increased capital requirements is an increase of the relative size of T-banks compared to S-banks.

We now turn to section 6 for an econometric test of one of our central conclusions that relates to the concomitant flow of assets and liabilities between shadow and traditional banks: did traditional banks purchase assets using new deposit funding during the crisis?

6 Empirical analysis

One main testable prediction of our model is that T-banks are able to purchase assets from S-banks during the crisis, insofar as they benefit from a guarantee on their deposits. They then attract deposits at the time where shadow banks have to pay their creditors. In this section we examine the data more formally to test this hypothesis. We use the following model:

$$\begin{aligned} \text{MBS Purchases}_i = & \beta_0 + \beta_1 \cdot \text{Liquidity}_i + \beta_2 \cdot \text{Solvency}_i + \beta_3 \cdot \text{Insured.deposits}_i \\ & + \beta_4 \cdot \text{Non}_i \text{insured.deposits}_i + \beta_5 \cdot \text{Credit_granted}_i \\ & + \beta_6 \cdot \text{Evolutions}_i + \beta_7 \cdot \text{controls}_i + \epsilon_i \end{aligned}$$

The first number that follows the variable is the net repayment rate used to construct the variable. The second number is total losses imputed to the financial sector. The variable "MBS Purchases pure" is constructed without correcting for losses nor the net repayment rate. The central results of our model are corroborated by our empirical analysis.

7 Conclusion

We document and integrate stylized facts from the 2007 financial crisis into a simple model that speaks to the coexistence of traditional and shadow banks. To the best of our knowledge,

The determinants of MBS purchases during the financial crisis

	(1)	(2)	(3)
	MBS_Purchases (scenario 1)	MBS_Purchases (scenario 2)	MBS_Purchases (naive)
credit growth	-0.11*** (0.03)	-0.10*** (0.03)	-0.09*** (0.02)
G_interest_rate_large_deposits	-0.83*** (0.23)	-0.51*** (0.19)	-0.20 (0.16)
G_liquidity	-0.38*** (0.04)	-0.33*** (0.04)	-0.29*** (0.03)
G_Net_Wholesale_fund	0.12*** (0.04)	0.12*** (0.03)	0.11*** (0.03)
G_Real_estate	-0.01 (0.05)	-0.03 (0.04)	-0.05 (0.04)
G_NPL_Ratio	-0.37*** (0.08)	-0.29*** (0.07)	-0.22*** (0.06)
G_capital_ratio	-0.70*** (0.12)	-0.59*** (0.11)	-0.48*** (0.11)
Vunused_commitments_ratio7	-0.00 (0.03)	-0.02 (0.03)	-0.04 (0.02)
Vliquidity_ratio7	-0.02 (0.03)	0.00 (0.02)	0.02 (0.02)
VMat_Gap7	-0.12*** (0.01)	-0.08*** (0.01)	-0.04*** (0.01)
Vinterest_rate_large_deposits7	-1.03*** (0.23)	-0.66*** (0.18)	-0.29* (0.15)
VNet_Wholesale_fund_ratio7	0.03 (0.02)	0.02 (0.02)	0.01 (0.01)
VReal_Estate7	-0.05*** (0.02)	-0.04*** (0.01)	-0.03*** (0.01)
Vcapital_ratio7	-0.07 (0.06)	-0.05 (0.05)	-0.04 (0.05)
VNPL_ratio7	-0.27** (0.11)	-0.26*** (0.09)	-0.25*** (0.08)
Vg_in_insured_deposits	0.23*** (0.05)	0.23*** (0.04)	0.22*** (0.04)
Vg_in_brokered_deposits	0.02 (0.05)	0.03 (0.04)	0.05 (0.04)
Tag_deposits2	0.15*** (0.04)	0.11*** (0.04)	0.07** (0.03)
logassets	0.01*** (0.00)	0.00*** (0.00)	0.00 (0.00)
_cons	0.09*** (0.03)	0.08*** (0.03)	0.07*** (0.02)
Test (pvalue)	0.000	0.000	0.000
Nbr obs	3,965	3,965	3,965
Nbr clusters			

* p < 0.10, ** p < 0.05, *** p < 0.01

Data come from the quarterly Call Reports and [He et al. \(2010\)](#) estimates. Variables ending in 7 are from 2007Q4. Variables starting in G are growth rates from 2007Q4 to 2009Q1. The dependent variable MBS_Purchases represents purchases of mortgage-backed securities by traditional banks in the year 2008 - expressed in terms of total assets in 2007Q4. We test many scenarios and report three of them (the extreme ones in terms of assumptions and the naive one). Under scenario 1 the repayment rate used to construct the MBS_Purchases variable is 7% and total losses imputed to the financial sector are \$500 billion. Under scenario 2, repayment rate is 12% and total losses are \$176. Under the "naive" scenario, we do not correct for the net repayment rate nor total losses. The white robust standard error estimator is used. The appendix details the procedure used to construct our sample and the variables (mostly based on [Acharya and Mora \(2015\)](#)). Here are the definitions of the main variables. Credit growth is the growth rate in credit where credit is the sum of loans and unused commitments. The liquidity ratio corresponds to the fraction of liquid assets less MBS over total assets. The unused commitments ratio corresponds to the ratio of unused loan commitments to the sum of loans plus unused commitments. Real_Estate₇ measures the share of real estate loans in total loans. NPL_ratio₇ stands for the ratio of non performing loans to total loans. Brokered deposits are large-denomination bank deposits that are received from brokers or dealers. Insured deposits are deposits that are guaranteed by the FDIC. The Net wholesale funding variable is the ratio of wholesale funds less liquid assets to asset ratio, where wholesale funds are managed liabilities in the Federal Reserve Bulletin.

this paper offers the first model of traditional versus shadow banking that encompasses the following facts from the crisis: (i) asset transfer from shadow to traditional banks, (ii) liabilities transfer from shadow to traditional banks, and (iii) fire sales of assets.

The model describes the different technologies used by traditional and shadow banks in order to issue safe claims against risky collateral. Interestingly, shadow banks could not issue safe claims and their size would be smaller were traditional banks not purchasing their assets in bad times. Moreover, the lower capital requirements on traditional banks, the higher the price of assets in a crisis, and the more levered the shadow banks outside a crisis. We analyze the effects of tightening traditional banks' capital requirements and find two opposite effects. One is reminiscent of [Plantin \(2015\)](#) and [Ordóñez \(2013\)](#): increased capital requirements hinder traditional banks' ability to raise funds in a crisis, thereby reducing their expected profits, which induces less bankers to run a traditional bank. The other one is new compared to the existing literature: higher capital requirements lower traditional banks' asset demand in the crisis, which creates a downward pressure on the equilibrium price of assets transferred from the shadow to the traditional banking sector. This in turn lowers shadow banks' expected profits, thereby increasing the fraction of bankers choosing to run a traditional bank instead of a shadow one. We show that this latter effect dominates, the net effect of increased capital requirements being an increase in the relative size of the traditional banking sector. This new effect of increased capital requirements on traditional banks brings up important regulatory challenges. We leave the question of the optimal regulation of traditional banks in light of their role in the crisis for future research.

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A The data

A.1 Stylized balance sheets of US financial intermediaries

A.2 Book versus market value of equity

We take the definition of the largest US bank-holding companies on figure ?? from the Federal Reserve's website (<https://www.ffiec.gov/nicpubweb/nicweb/HCSGreaterThan10B.aspx/>).

A.3 Empirical Analysis

Preliminary:

B Variable constructions

Variable name	Ticket Call reports
Unused commitment	rcfd3814+rcfd3816+rcfd3817+rcfd3818+rcfd6550+rcfd3411
Unused commitments ratio	unused_commitments/(unused_commitments+rcfd1400)
Cash	rcfd0010
Federal Funds Sold	rcfd1350+rconb987
MBS	rconb987+rcfdb989 if after 2002/03/30 rcfd1699+rcfd1705+rcfd1710+rcfd1715+rcfd1719+rcfd1734 +rcfd1702+rcfd1707+rcfd1713+rcfd1717+rcfd1732+rcfd1736 rcfd1754+rcfd1773-(rcfd8500+rcfd8504+rcfdc026+rcfd8503+rcfd8507+rcfdc027)
Securities (MBS excluded)	rcfd1754+rcfd1773-(rcfd8500+rcfd8504+rcfdc026+rcfd8503+rcfd8507+rcfdc027)
Liquid assets	Securities (MBS excluded)+ Federal Funds Sold+Cash
Liquidity ratio	Liquid Assets/rcfd2170
Wholesale funding	rcon2604+rcfn2200+rcfd3200+rconb993+rcfdb995+rcfd3190
Wholesale funding ratio	Wholesale funding/rcfd2170
Net Wholesale fund ratio	Wholesale funding -(Securities (MBS excluded)+Federal Funds Sold+Cash)
Non performing loan	rcfd1407+rcfd1403
Non performing loan ratio	Non performing loan/rcfd1400
Capital ratio	(rcfd3210+rcfd3838)/rcfd2170
Real Estate Loan Share	rcfd1410/rcfd1400
Residential Mortgages	(rcfdf070+rcfdf071)/rcfd2170
Financial Assets	rcfd0081+rcfd0071+rcfda570+rcfda571+rcona564+rcona565 +rcfd1350+rcfda549+rcfda550+rcfda556+rcfda248
Short Term Liabilities	rcon2210+rcona579+rcona580+rcona584+rcona585+rcfd2800+rcfd2651+rcfdb571
Mat Gap	Financial Assets-

All variable with a "point" are considered as equal to a 0 when we sum different items to construct variables. ID ticket is rssid9001, and for the BHC name entity: rssid9348.

B The model (TBW)