NBER WORKING PAPER SERIES

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Working Paper 17115
http://www.nber.org/papers/w17115

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2011

We are grateful to Viral Acharya, Tobias Adrian, Effi Benmelech, John Campbell, Robin Greenwood, Sam Hanson, Arvind Krishnamurthy, Rafael Repullo, Matt Richardson, Philipp Schnabl, Josh Schwartzstein, Alp Simsek, Jeremy Stein, Rene Stulz, Amir Sufi, and especially Charles-Henri Weymuller for helpful comments. Gennaioli thanks the Barcelona GSE and the European Research Council for financial support. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 17115
June 2011
JEL No. E44,G01,G21

ABSTRACT

We present a model of shadow banking in which financial intermediaries originate and trade loans, assemble these loans into diversified portfolios, and then finance these portfolios externally with riskless debt. In this model: i) outside investor wealth drives the demand for riskless debt and indirectly for securitization, ii) intermediary assets and leverage move together as in Adrian and Shin (2010), and iii) intermediaries increase their exposure to systematic risk as they reduce their idiosyncratic risk through diversification, as in Acharya, Schnabl, and Suarez (2010). Under rational expectations, the shadow banking system is stable and improves welfare. When investors and intermediaries neglect tail risks, however, the expansion of risky lending and the concentration of risks in the intermediaries create financial fragility and fluctuations in liquidity over time.

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1. Introduction

Several recent studies have documented the rise of the "shadow banking" system in the United States over the last decade (Coval et al. 2009a, Gorton and Metrick 2011a,b, Poszar, Adrian, Ashcraft, and Boesky 2010, Shin 2009a). Shadow banking (also known as securitized banking) refers to the origination and acquisition of loans by financial intermediaries, the assembly of these loans into diversified pools, and the financing of these pools with external debt, much of which is short term and supposedly riskless[2]. Some of the residual risk in the pool is also financed externally, but much of it is kept by the intermediaries either directly or as a guarantee for the pool (Acharya, Schnabl, and Suarez 2010, Poszar et al. 2010). During the financial crisis of 2007-2008, as the mortgages in securitization pools lost their value, the shadow banking system unraveled (e.g., Acharya and Richardson, eds. 2009, Gorton and Metrick 2011a,b). The external financing of the pools suddenly stopped, and the intermediaries suffered enormous losses from the risks they retained. Several of them failed.

In this paper, we present a new model of shadow banking. In the model, a financial intermediary can originate or acquire both safe and risky loans, and can finance these loans both from its own resources and by issuing debt. The risky loans are subject both to institution-specific idiosyncratic risk and to aggregate risk. Critically, but in line with the actual experience, outside investors are only interested in riskless debt (they are assumed to be infinitely risk averse). When outside investors' wealth is limited, demand for riskless debt is low, so intermediaries' own wealth and returns from safe projects are sufficient to guarantee whatever riskless debt they issue. However, at higher levels of investor wealth and demand for riskless debt, intermediaries cannot generate enough collateral with safe projects, and an intermediary's own risky projects cannot serve as useful collateral for

[2] The term "shadow banking" typically refers to activities outside of the regulated banking sector. While much of what we describe here takes place within the banking sector, a key element of our model is the supply of debt capital to banks from institutions such as Money Market Funds that lie outside the regulated banking sector.

riskless debt because they are vulnerable to idiosyncratic risk. To meet the demand for riskless debt, intermediaries diversify their portfolios by buying and selling risky loans and eliminating idiosyncratic risk, similarly to Diamond (1984). Their assets in the form of loan portfolios, and their liabilities in the form of riskless debt issued to finance these portfolios, both grow together. Intermediaries essentially pursue a carry trade, in which they pledge the returns on their loan portfolio in the worst aggregate state of the world as collateral for riskless debt, and earn the upside in the better states of the world.

As intermediaries expand their balance sheets by buying risky projects, they increase the systematic risk of their portfolios, and endogenously become interconnected by sharing each others' risks. This is the critical new result of the paper: the very diversification that eliminates intermediary-specific risks by pooling loans so as to support the issuance of debt perceived to be riskless actually raises the exposure of these intermediaries to the tail aggregate risks. Gordon Brown (2011) referred to this phenomenon as the "diversification myth": it emerges as the driving engine of shadow banking in our model. Still, under rational expectations, riskless debt is always repaid, and the system is very stable. The expansion of activity financed by the shadow banking system is Pareto-improving.

Things change dramatically when investors and intermediaries neglect tail risks, perhaps because the worst states of the world are extremely unlikely and they do not think about them during quiet times. In Gennaioli, Shleifer, and Vishny (henceforth GSV 2011), we argued that the neglect of tail risk is critical to understanding aspects of the crisis. There is growing evidence that even sophisticated investors prior to the crisis did not appreciate the possibility of sharp declines in housing prices (Gerardi et al. 2008), but also did not have accurate models for pricing securitized debt, particularly Collateralized Debt Obligations (Jarrow et al. 2007, Coval et al. 2009a). GSV argue that, with neglected risk, new financial products provide false substitutes for truly safe bonds, and as a consequence can reduce

welfare. In this paper, we further develop this argument by focusing more explicitly on how the shadow banking system offers insurance to investors. We model not only aggregate (as in GSV) but also idiosyncratic risk. By enabling the diversification of idiosyncratic risk, securitization promotes the expansion of balance sheets of the banks and increases financial links among them. Through these channels, the insurance against idiosyncratic risk interacts with the neglect of tail *aggregate* risks in creating extreme financial fragility.

When investors neglect tail downside aggregate risks, in the range of parameter values of our model corresponding to high investor wealth and securitization, investors believe that the payoffs on the collateral in the worst case scenario are higher than they actually are, and are therefore willing to buy more debt thinking that it is riskless. The balance sheets of intermediaries expand further than they would under rational expectations. But here comes the problem. As intermediaries pool loans and diversify their idiosyncratic risk to support debt issuance, they increase their exposure to systematic risk. When they and investors realize that a worse state of the world than they had previously contemplated might occur, intermediaries face massive exposure to that downside risk, which they bear because they sold "riskless" bonds to investors. When securitization has proceeded far enough, all intermediaries fail together. Whereas the "diversification myth" is harmless when market participants recognize all the risks they face, it becomes deadly when they do not.

The model describes the expansion of the shadow banking system prior to the crisis, but also, under the "neglected risk" assumption, accounts for key aspects of the crisis itself. First, the model explains the critical role of rising demand for safe assets in driving the growth of the shadow banking system. Several studies have previously noted the roles of global imbalances (Caballero, Farhi, and Gourinchas 2008, Caballero 2009, Caballero and Krishnamurthy 2009) and of the demand for riskless debt (Krishnamurthy and Vissing-Jorgensen 2008, Bernanke, Bertaut, DeMarco, and Kamin 2011) prior to the financial crisis.

Second, the model explains the famous finding of Adrian and Shin (2010) that intermediary leverage and balance sheet expansion go together. In the model, as investor wealth grows, intermediaries accommodate the growing demand for riskless debt by expanding their assets, creating the correlation identified by Adrian and Shin.

Third, the model captures how the operation of the shadow banking system necessitates the retention of massive exposure to systematic risk by financial intermediaries, precisely as a byproduct of delivering riskless debt to investors. As idiosyncratic risk is diversified, systematic risk is concentrated. This critical feature of securitization was first stressed by Coval, Jurek, and Stafford (2009b), and explains the puzzle raised by Acharya and Richardson (eds., 2010) that banks retained a large fraction of aggregate risk on their balance sheets in the wake of the crisis.

Fourth, under the neglected risk assumption, our model of securitization captures the fact that financial intermediaries lost money in the crisis on AAA-rated securities they held (Benmelech and Dlugosz 2009, Erel, Nadauld, and Stulz 2011). In our model, intermediaries pool and tranch projects to create collateral perceived to be completely safe, and then issue debt likewise perceived to be safe backed by this collateral and additional guarantees[3]. When a neglected bad state of the world is realized, the AAA-rated collateral turns out to be risky and falls in value, resulting in losses by intermediaries. To the extent that liquidity guarantees and other profits earned by the intermediaries do not suffice to pay off the debt they issue when the value of collateral falls, such debt becomes risky as well.

Fifth, the model accounts for the growing body of evidence that financial institutions increase their risk-taking when interest rates are low (Greenwood and Hanson 2011, Maddaloni and Peydro 2011, Jimenez et al. 2011). In our model, risk taking is high in low

[3] An important reason why banks may have retained AAA-rated asset backed securities and used them as collateral rather than sold them off directly is the demand by outside investors such as money market funds for short term debt. We do not model this maturity transformation in this paper.

interest rate environments because investor demand for riskless debt simultaneously drives down rates and increases the availability of capital to intermediaries.

Sixth, the model exhibits extreme vulnerability of the financial system to the neglect of tail risks. This vulnerability arises from the sheer size of the shadow banking system, the unwillingness of its outside investors to bear any risk, leaving it all to intermediaries, and the mechanics of securitization in increasing leverage and concentrating systematic risks.

Seventh, an extension of our basic model allows us to speak about liquidity dry ups during the crisis. When investors realize that debt they perceive to be riskless actually is not, they want to sell it. We show, however, that intermediaries would typically not have enough free resources to support the prices of this debt in the face of a selloff by outside investors, leading to a collapse of debt markets and growing risk premia (Shleifer and Vishny 1992, 2010, Brunnermeier 2009, Gorton and Metrick 2011a,b).

Our paper deals with several key aspects of securitization, but not all of them. First, we do not model the idea that collateral in securitizations is ring fenced and bankruptcy remote (available to creditors outside of bankruptcy proceedings), characteristics emphasized by Gorton and Souleles (2006) and Gorton and Metrick (2011b). In our model, financial intermediaries use their own wealth and returns from risky projects (when positive) to satisfy debt claims, which makes those claims comparable to general debt. Alternatively, one can think of the intermediaries providing liquidity guarantees.

Second, although we discuss short term debt in section 5, we do not stress the role of the maturity transformation and runs by short term creditors in precipitating a financial crisis. The run aspects of the crisis have been emphasized by several authors, including Shin (2009a), Brunnermeier (2009), and Gorton and Metrick (2011a,b). In our view, the financial crisis has a lot to do with a massive and unanticipated shock to the assets of the financial intermediaries, and specifically assets used as collateral for short term debt. Some

supporting evidence for this point of view is beginning to emerge (UBS shareholder report, Copeland et al. 2010, Krishnamurthy et al. 2011). In our view, the withdrawal of short term finance was largely a response to that shock and not a wholly separate cause of the crisis.

In addition to papers already mentioned, there is a large theoretical literature on aspects of securitization and shadow banking, much of it dealing with the role of pooling and tranching in alleviating adverse selection problems in financial markets. The foundational papers here include Gorton and Pennachi (1990), De Marzo and Duffie (1999), De Marzo (2005), and Dang, Gorton, and Holmstrom (2009). Some recent work has also focused on the importance of the maturity transformation for the shadow banking system and the creation of private money (Gorton and Metrick 2011a, Stein 2010). We do not focus on the informational aspects of securitization, but rather assume that investors are interested in riskless debt, as documented most recently by Bernanke et al. (2011). In Allen and Gale (2000), systemic risk also arises from insurance networks among intermediaries. In their model the crisis is precipitated by idiosyncratic risk due to incomplete insurance linkages. Allen, Babus and Carletti (2010) also model the trading of projects among banks. They show how pair-wise insurance connections among banks can increase bank correlation and cause systemic early liquidations. Their focus on partial bank linkages and bankruptcy costs is different from our focus on optimal insurance against idiosyncratic risks and the neglect of aggregate risks. Shin (2009b) investigates the aggregate consequences of growing assets and liabilities of the shadow banking system and bank interconnectedness; his boom-bust cycle is driven by value-at-risk constraints faced by intermediaries. Like Geanakoplos (2009), our model as extended in Section 5 yields asset price collapses and increasing risk premia upon the arrival of bad news, but we focus on risk allocation through securitization.

The next section of the paper presents our basic model of the shadow banking system. Section 3 solves the model under rational expectations, and shows how shadow banking

improves intertemporal trade, insurance opportunities, and welfare, in line with the basic theory of financial innovation (Ross 1976, Allen and Gale 1994). The rational expectations model delivers several of the notable features of the shadow banking system, including the Adrian and Shin (2010) finding of comovement of intermediary assets and leverage, as well as the "securitization without risk transfer" finding of Acharya, Schnabl, and Suarez (2010). In Section 4, we solve the model under the assumption of neglected risks, and show how the false insurance provided by financial intermediaries when risks are ignored can misallocate risks. The very benefits of shadow banking obtained through diversification and leverage become the source of its demise. In Section 5, we add the opportunities for interim trading to the model, and examine the evolution of liquidity in the shadow banking system under neglected risks. We also briefly examine the role of short term debt. Section 6 concludes.

2. The Model

We build on the production model of GSV (2011), with three dates $t = 0, 1, 2$ and a measure one of investors who receive at $t = 0$ a perishable endowment w and enjoy utility:

$$U = E_{\omega}[C_0 + \min_{\omega\in\Omega_1} C_{1,\omega} + \min_{\omega\in\Omega_2} C_{2,\omega}], \tag{1}$$

where $C_{t,\omega}$ is consumption at $t = 1,2$ in state of nature $\omega \in \Omega_t$. Investors are infinitely risk averse in the sense that they value future consumption levels at their worst-case scenario.

Investors save by buying financial claims from a measure one of risk neutral intermediaries, who are indifferent between consuming at t=0,1,2. Intermediaries receive an endowment $w_{\text{int}} < 1$ at $t = 0$, and use it - along with the funds raised from investors - to finance two activities H and L. Activity H is riskless: by investing at $t = 0$ an amount $I_{H,j}$ in it, intermediary j obtains the sure amount $R \cdot I_{H,j}$ at $t = 2$. Activity L is risky: by investing at t = 0 an amount $I_{L,j}$ in it, at $t = 2$ intermediary j obtains the amount:

$$f(I_{L,j}) = \begin{cases} AI_{L,j} & with \quad probability \quad \pi_\omega \\ 0 & with \quad probability \quad 1-\pi_\omega \end{cases}, \tag{2}$$

in state $\omega \in \Omega_2$. The return on the risky activity is i.i.d. across intermediaries, and π_ω captures the share of investments that "succeed" in ω. There are three final states $\Omega_2 \equiv \{g, d, r\}$ such that $\pi_g > \pi_d > \pi_r$. Here g captures a "growth" state where most investments succeed, d a less productive "downturn," r an even less productive "recession." At $t = 0$ it is known that state $\omega \in \Omega_2$ occurs with probability $\varphi_\omega > 0$, where $\sum_\omega \varphi_\omega = 1$. Unlike in GSV (2011), here intermediaries are subject to idiosyncratic, and not only aggregate, risk [see Equation (2)].

The expected return of H is not smaller than that of L, namely $R \geq E_\omega(\pi_\omega) \cdot A$, so that intermediaries (weakly) prefer to invest in the safe activity to investing in the risky one. Riskless projects are however in limited unit supply, formally $\int_j I_{H,j} dj \leq 1$ and there are no "storage" opportunities. To expand investment beyond this limit, intermediaries must undertake lower-return risky projects. We can view investment projects in this model as mortgages, with riskier mortgages also offering lower expected returns.[4]

Figure 1 shows the decreasing marginal return to investment in the economy. Also, low return projects are riskier, both in the aggregate and at the level of the intermediary (the dashed lines capture the possible realizations of returns at the level of an intermediary).

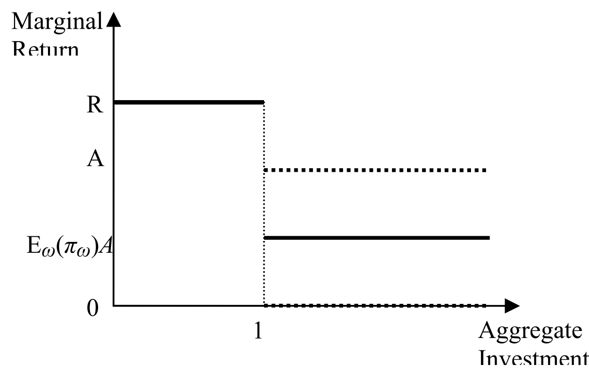

Figure 1: Marginal Return to Investment

[4] That is, activity L is a marginal and risky investment (e.g., subprime mortgages) that intermediaries wish to undertake only after better investment opportunities (e.g., prime mortgages) are exhausted.

Each intermediary faces, given the aggregate state of the world, an idiosyncratic risk on its projects (mortgages), perhaps because it is costly to fully diversify its investments. The intermediary can diversify its idiosyncratic (but not aggregate) risk by buying the projects issued by other intermediaries. We thus assume that an intermediary cannot diversify all idiosyncratic risk through its own projects; it must buy those of others. The available evidence on asset-backed commercial paper conduits indeed shows that such vehicles held a variety of securities of different kinds from different countries (Acharya and Schnabl 2010). Since the intermediary is risk neutral, however, it does not value diversification per se.

Intermediaries raise funds in two ways. First, they issue riskless debt claims promising a sure return $r \geq 1$ at $t = 2$. Riskless debt is a senior security that pledges the lowest realization of the payoff on an intermediary's total assets. Because this debt is senior, it is the last security to absorb losses, if any. Our focus on riskless debt captures investor demand for AAA rated securities as driven by regulation, taste for characteristics, and risk aversion.

The second way for intermediaries to raise funds is to "securitize" their projects (mortgages), which here refers to selling them at $t = 0$ in exchange for cash. The price received by an intermediary for selling one unit of investment at $t = 0$ is equal to p_H for a riskless project H and to p_L for a risky project L. Intermediaries can also trade projects amongst themselves, which as we show below boosts their debt capacity. In fact, in our model debt and securitization are complements, for the bank puts together a diversified portfolio of projects, tranches it, and pledges the safe portion of returns to raise riskless debt. Diversification allows the creation of AAA-rated collateral to raise AAA-rated debt. In the first part of the analysis, we do not consider the possibility of ring-fencing a set of projects as a pool of collateral. We allow intermediaries to back debt with risky collateral in Section 5.2.

The timing of the model works as follows. At $t = 0$, the return on risky projects is not known and each intermediary j: i) raises D_j units of riskless debt promising to repay rD_j at $t =$

2 (the intermediary lends if $D_j < 0$), and ii) sells $S_{H,j}$ and $S_{L,j}$ units of riskless and risky projects, respectively. Using its own wealth w_{int} and the resources raised, the intermediary: i) invests $I_{H,j}$ and $I_{L,j}$ units in the riskless and risky projects of its own, respectively, and ii) buys $T_{H,j}$ and $T_{L,j}$ units, respectively, of riskless and risky projects financed by other intermediaries. Each investor i chooses how much riskless debt D_i to issue (the investor lends if $D_i < 0$) and how many securitized projects $T_{H,i}$ and $T_{L,i}$ to buy. (In equilibrium, investors will buy riskless debt and not trade in projects, but at the moment we keep the framework general.) Markets for debt and for securitized projects clear at competitive prices r, p_H and p_L.

At $t = 1$, intermediaries can raise new funds, securitized projects can be re-traded, and investors can re-optimize their consumption decisions. At $t = 2$, output from projects is produced and distributed to intermediaries and investors. The world ends.

Crucially, at $t = 1$ everyone learns the return on intermediaries' risky projects and the aggregate state ω. Formally, in Equation (1) we have $\Omega_1 = \Omega_2 = \{g, d, r\}$. As a consequence, at $t = 1$ all market participants share the same preferences and the same reservation prices over assets. Thus, markets at $t = 1$ play no role. We can view this model as consisting only of two dates, $t = 0$ and $t = 2$. In the extension of Section 5, the $t = 1$ market plays a key role.

We simplify the equilibrium analysis by assuming:

A.1 $\pi_d \cdot A < 1$,

which implies that under both rational expectations and local thinking intermediaries can only borrow a limited amount of funds. Our main results do not rely on this assumption. We examine the joint determination of leverage and securitization, as well as the forms of securitization, by first assuming rational expectations and then turning to neglected risks.

3. Equilibrium under rational expectations

If an intermediary j adopts a borrowing, investment and securitization policy (D_j, $I_{H,j}$,

$I_{L,j}$, $S_{H,j}$, $S_{L,j}$, $T_{H,j}$, $T_{L,j}$) at $t = 0$, its expected profit is the following sum of three components:

$$[R\cdot(I_{H,j} + T_{H,j} - S_{H,j}) + p_H(S_{H,j} - T_{H,j})] +$$
$$+ [E_\omega(\pi_\omega)\cdot A\cdot(I_{L,j} - S_{L,j}) + E_\omega(\pi_\omega)\cdot A\cdot T_{L,j} + p_L(S_{L,j} - T_{L,j})] + \qquad (3)$$
$$- D_j - I_{H,j} - I_{L,j} + w_{int} - rD_j.$$

The term in the first square bracket is the return earned at $t = 2$ on the $I_{H,j}$ riskless projects that the intermediary has financed or purchased in the market (for net amount $T_{H,j} - S_{H,j}$), plus the revenue earned at $t = 0$ from the net sales of safe projects at unit price p_H.

The term in the second square brackets captures the same payoff for risky projects, with the key difference that now the expected return $E_\omega(\pi_\omega)\cdot A\cdot(I_{L,j} - S_{L,j})$ of an intermediary's own investments must be kept distinct from the return it earns on securitized risky projects bought in the market $E_\omega(\pi_\omega)\cdot A\cdot T_{L,j}$. From the standpoint of the risk neutral intermediary, ($I_{L,j} - S_{L,j}$) and $T_{L,j}$ are equally appealing investments, as they yield the same average return. The risk profiles of these investments are very different, however. The intermediary's own investment ($I_{L,j} - S_{L,j}$) is subject to both aggregate and idiosyncratic risk: in state ω it yields A with probability π_ω and 0 otherwise. In contrast, the securitized projects are subject only to aggregate risk, for risky projects are ex-ante identical and the intermediary buys a diversified portfolio of such projects. That is, the securitized holdings $T_{L,j}$ include part of each intermediary's investment project, yielding a sure return of $\pi_\omega\cdot A$ in state ω.

In this model, securitization and trading allow project "pooling," and also insurance contracts (in which case the "pooler" is the insurance company). Pooling is irrelevant for riskless projects, which yield R both with pooling and in isolation. In contrast, pooling of risky projects can allow intermediaries to reduce idiosyncratic risk in their balance sheets and risk averse investors to achieve better diversification in their portfolios. Our model allows us to investigate when pooling occurs and how intermediaries and investors exploit it.

The third and final piece of Equation (3) is the intermediary's profit at $t = 0$ net of

securities trading (i.e. the available funds minus investment costs), minus the payment of debt at $t = 2$. To ease notation, objective (3) excludes borrowing and trading in projects at $t = 1$. As we argued previously, these markets are irrelevant when ω is learned perfectly at $t = 1$.

The intermediary takes prices (r, p_H, p_L) as given and maximizes its expected profit in Equation (3) subject to the following constraints. First, at $t = 0$ investment and net asset purchases must be financed by the intermediary's own and borrowed funds, namely:

$$I_{H,j} + I_{L,j} + p_H(T_{H,j} - S_{H,j}) + p_L(T_{L,j} - S_{L,j}) \leq w_{int} + D_j. \tag{4}$$

Second, debt issuance at $t = 0$ must be such that the intermediary is able to repay riskless debt in the worst possible state of its balance sheet. This implies that:

$$rD_j \leq R\cdot(I_{H,j} + T_{H,j} - S_{H,j}) + \pi_r\cdot A\cdot T_{L,j}. \tag{5}$$

The intermediary can pledge to the creditors: i) its return $R\cdot(I_{H,j} + T_{H,j} - S_{H,j})$ from riskless projects, and ii) its holdings of securitized risky projects evaluated in the worst possible aggregate payoff π_r, namely $\pi_r\cdot A\cdot T_{L,j}$. The intermediary cannot pledge the non-securitized risky projects $(I_{L,j} - S_{L,j})$ as collateral for debt payments. Vulnerable to the idiosyncratic risk of yielding zero, these projects cannot support riskless debt.

The final constraints concern the feasibility of securitization:

$$S_{H,j} \leq I_{H,j}, \quad S_{L,j} \leq I_{L,j}, \tag{6}$$

which simply say that intermediaries cannot securitize more than they invest. Note that in (6) intermediaries do not re-securitize portions of the acquired pool $T_{L,j}$. Since the pool is already diversified, there is no benefit from doing so.

At prices (r, p_H, p_L) intermediaries maximize (3) subject to (4) – (6). A representative investor i maximizes utility in (1) subject to the constraint that consumption at different times and states is equal to $C_{0,i} = w + D_i - p_H T_{H,i} - p_L T_{L,i}$, $C_{1,\omega,i} = 0$, $C_{2,\omega,i} = -rD_i + RT_{H,i} + \pi_\omega\cdot A\cdot T_{L,i}$, where D_i is the investors' borrowing at $t = 0$, while $T_{H,i}$ and $T_{L,i}$ are the investor's $t = 0$ purchases of riskless and risky projects, respectively.

We now study the equilibrium of the model, starting with the allocation prevailing at $t = 0$ and then moving to see what happens as agents learn ω at $t = 1$. We focus on symmetric equilibria where all agents of a given type (intermediary or investor) make the same choices. Consistent with our prior notation, then, index j captures the actions of the representative intermediary while index i captures those of the representative investor. Here we provide the basic intuition behind our results, detailed proofs are in the appendix.

3.1 Securitization and leverage at $t = 0$

As a preliminary observation, note that in equilibrium investors lend to intermediaries (not the other way around) and the return on riskless bonds must satisfy $r \geq 1$. Since investors and intermediaries have the same time preferences, lending can only occur for investment purposes and intermediaries are the ones who can access investment projects. Accordingly, since investors are indifferent between consuming at $t = 0, 1, 2$, the condition $r \geq 1$ guarantees that lending to intermediaries makes investors weakly better off than autarky.

The second useful observation is that the purchase of a riskless bond and of a securitized riskless project must yield the same return, namely:

$$R/p_{\mathrm{H}} = r. \tag{7}$$

If (7) is violated, investors' preferences as to whether to buy safe debt or a safe loan are the opposite of intermediaries' preferences as to what to issue, so in equilibrium (7) must hold.

Third, and crucially, investors' reservation price $p_{\mathrm{L,inv}}$ for securitized risky assets (i.e. the highest price at which they are willing to buy them) is equal to:

$$p_{\mathrm{L,inv}} = \pi_r \cdot A. \tag{8}$$

Infinitely risk averse investors value a pool of risky projects at its lowest possible payoff, which is the one obtained in a recession. This is of course below these projects' average return $\mathrm{E}_\omega(\pi_\omega) \cdot A$. These points imply that in any equilibrium the following property holds:

Lemma 1 For any given investment profile ($I_{H,j}$, $I_{L,j}$), intermediaries are indifferent between securitizing and not securitizing riskless projects. When the riskless debt constraint (5) is slack, intermediaries are also indifferent between securitizing and not securitizing risky projects. When that constraint is binding, intermediaries strictly prefer to securitize at least some risky projects. In such equilibria, we have that $S_{L,j} > 0$ and risky projects are bought by intermediaries, not by investors, so that $S_{L,j} = T_{L,j}$.

In our model, issuing riskless debt against the return of a riskless project is equivalent to selling that project to investors. Thus, securitization of riskless projects is irrelevant and riskless debt perfectly substitutes for it. We therefore focus on equilibria where $S_{H,j} = 0$.[5]

Securitization of risky projects is initially irrelevant, but only until the point when the debt constraint (5) becomes binding. As intermediaries need to absorb more investor wealth to finance risky projects, they start selling them off and buying risky projects from other intermediaries. By diversifying idiosyncratic risk, such securitization creates acceptable collateral, relaxing the debt constraint (5). Indeed, the point of securitization in this model is to relax the collateral constraint. While risk averse investors are unwilling to lend anything against an individual risky project (as the latter's return may be 0), they are willing to lend something against a pool of risky projects since such a pool eliminates idiosyncratic risk.

As a consequence, to obtain financing intermediaries (not investors) end up holding securitized pools of risky projects. This is because risk neutral intermediaries are the efficient bearers of the pool's aggregate risk. Besides allocating aggregate risk efficiently, this arrangement also boosts leverage because now intermediaries can issue debt against the diversified pool of projects. As evident from Equation (5), by buying an extra unit of the pool intermediaries can increase debt repayment at most up to investors' reservation price $p_{L,inv} = \pi_r \cdot A$ for that unit. If the interest rate is r, intermediaries keep the excess return

[5] The presence of (negligible) inventory or production costs of securitization would reinforce this conclusion.

$[E_\omega(\pi_\omega)A - r]$ on the pool's extra unit for themselves. As long as $E_\omega(\pi_\omega)A > r$, intermediaries essentially invest in a carry trade: they borrow at the low safe interest rate from investors, but then take on risk to gain the upside of risky projects. With infinitely risk averse investors and risk neutral intermediaries, there are large gains from such trade.

In sum, securitization in our model is an instrument enabling intermediaries to boost leverage for financing risky projects. By pooling risky projects, intermediaries eliminate idiosyncratic risk. By pledging the senior tranche of the pool to investors, they raise leverage. Combined with liquidity guarantees from safe projects, the senior tranch of the diversified pool of projects is safe, and thus serves as acceptable collateral for riskless debt. The question then arises: when does securitization take place and what does this imply for leverage, interest rates, and investments? In particular, we would like to know whether greater leverage is associated with larger assets of the intermediaries, and greater aggregate risk. The appendix proves the following characterization result:

Proposition 1 If $E_\omega(\pi_\omega)\cdot A > 1$, there are two thresholds w^* and w^{**} ($w^{**} > w^*$) such that, in equilibrium, intermediaries issue $D_j = \min(w, w^{**})$ and the $t = 0$ allocation fullfils:

a) If $w \leq 1 - w_{int}$, investor wealth is so low that only the safe project is financed and securitization does not occur. Formally, $I_{H,j} = w_{int} + w$, $I_{L,j} = 0$, and $S_{L,j} = T_{L,j} = 0$. The equilibrium interest rate is $r = R$.

b) If $w \in (1 - w_{int},\ R/E_\omega(\pi_\omega)A]$, investor wealth is sufficiently high that some risky projects are also financed, but the return on safe investments is enough to repay all debt. As a consequence, securitization does not yet occur. Formally, $I_{H,j} = 1$, $I_{L,j} = w_{int} + w - 1$, and $S_{L,j} = T_{L,j} = 0$. The equilibrium interest rate is $r = E_\omega(\pi_\omega)\cdot A$.

c) If $w \in (R/E_\omega(\pi_\omega)\cdot A,\ w^*]$, investor wealth starts to be high enough that not only are some risky projects funded, but the safe return is insufficient to repay debt. Partial securitization emerges in the amount that allows intermediaries to just absorb all investor

wealth. Formally, $I_{H,j} = 1$, $I_{L,j} = w_{int} + w - 1$, and $S_{L,j} = T_{L,j} \in (0, I_{L,j})$. The equilibrium interest rate is still $r = E_{\omega}(\pi_{\omega}) \cdot A$.

d) If $w > w^*$, then investor wealth is so high that many risky projects are funded and securitization is maximal. Formally, $I_{H,j} = 1$, $I_{L,j} = w_{int} + \min(w, w^{**}) - 1$, and $S_{L,j} = T_{L,j} = I_{L,j}$. To allow intermediaries to absorb all of investor wealth, the interest rate must fall below the (average) return $E_{\omega}(\pi_{\omega}) \cdot A$ and is a decreasing function $r(w)$ of investors' wealth.

The details of the equilibrium, including the prices p_H and p_L, are described in the proof (which also studies the case in which $E_{\omega}(\pi_{\omega}) \cdot A \leq 1$). In Figure 1, the thick dashed line depicts the average return on investment, the bold line shows the equilibrium interest rate.

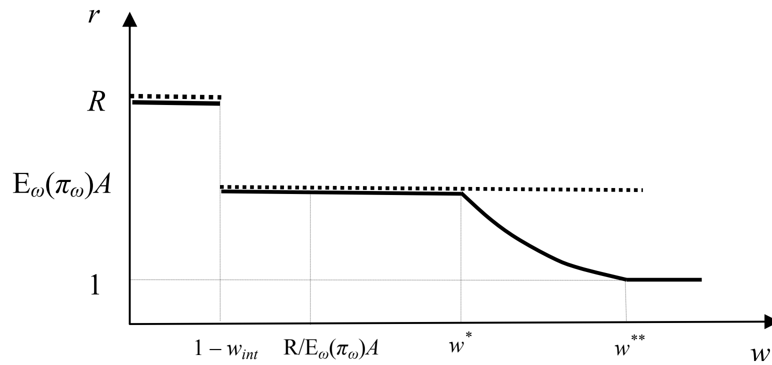

Figure 2: Interest rate, wealth, and securitization

The interest rate, securitization and leverage are driven by the interaction between the supply of funds, as captured by investors' wealth w, and the demand for funds, as captured by the return of investment and by intermediaries' ability to issue riskless debt in Equation (5).

When intermediaries are able to pay interest on the debt equal to the marginal return of investment, the equilibrium interest rate is given by that return, as in the standard neoclassical analysis. Indeed, if r fell below the marginal return on investment, intermediaries would wish to issue more debt than investors' wealth, which cannot happen in equilibrium. This is what happens in case a), where investors' wealth is so low that only

riskless projects are financed, namely $I_{H,j} = w + w_{int}$, in which case it is obvious that $r = R$. But this is also true in case b), where investors' wealth allows some risky projects to be undertaken (i.e. $I_{H,j} = 1$, $I_{L,j} = w + w_{int} - 1$). Since investors' wealth is so low that $R \geq E_\omega(\pi_\omega) \cdot A \cdot w$, intermediaries can pay the full marginal return to investors out of safe cash flows. Thus, in cases a) and b) investors' wealth is sufficiently low that riskless debt can be issued without securitization.

Matters are different when $w > R / E_\omega(\pi_\omega) \cdot A$. Now investors' wealth is so large that the return from the limited supply of safe projects is alone insufficient to pay off debt at the marginal rate of return on investment. As (5) illustrates, to expand borrowing intermediaries must now engage in at least some securitization. In case c), investors' wealth is not too large, and intermediaries can absorb this wealth by securitizing only partially. Here the interest rate can rise to the marginal product of investment to ensure that intermediaries have no appetite for further expanding securitization and borrowing beyond w. As a result, given that now $r = E_\omega(\pi_\omega) \cdot A$ and $D_j = w$, Equation (5) implicitly pins down securitization through the constraint:

$$E_\omega(\pi_\omega) \cdot A \cdot w = R + \pi_r \cdot A \cdot S_{L,j}, \tag{9}$$

in which we have replaced the equilibrium condition $S_{L,j} = T_{L,j}$. Equation (9) holds until all projects are securitized, namely until $S_{L,j} \leq I_{L,j} = w_{int} + w - 1$. This is the case provided:

$$w \leq w^* \equiv \frac{R / A + \pi_r (w_{int} - 1)}{E_\omega(\pi_\omega) - \pi_r}, \tag{10}$$

which highlights the role of intermediaries' own wealth and of the safe project as buffers against project risk, supporting the intermediary's ability to borrow. High intermediary wealth w_{int} reduces the outside financing needs of risky projects, while the safe return R creates a cushion for repaying riskless debt and financing risky projects when $r < R$.

As investors' wealth grows beyond w^*, we are in case d). Now financing constraints become very tight and intermediaries fully securitize the risky projects financed, setting $S_{L,j} = I_{L,j}$. In this case, the interest rate must fall below the marginal product of investment for the

riskless debt constraint to be satisfied, i.e. $r < E_{\omega}(\pi_{\omega})\cdot A$. This is the range in which securitization effectively allows intermediaries to obtain – on each specific unit of the pool acquired – an excess return $[E_{\omega}(\pi_{\omega})\cdot A - r]$ from the carry trade of financing risky projects with safe debt. At the equilibrium quantities of investment and securitization $I_{L,j} = S_{L,j} = w_{int} + w - 1$, Equation (5) determines the equilibrium interest rate as:

$$r(w) = \frac{R + \pi_r A(w_{\text{int}} + w - 1)}{w}, \tag{11}$$

which falls in investors' wealth w. As w increases, there is a spiral of increasing leverage, investment, securitization and decreasing interest rates. This process continues as w continues to grow up to the level w^{**} at which $r(w^{**}) = 1$. At this point r is at its lower bound of 1. Further increases in investors' wealth beyond w^{**} cannot be absorbed by intermediaries. The spiral of leverage, securitization and falling interest rate has now stopped.

In sum, in our model securitization appears only when marginal, risky, projects are financed. It is not needed when only safe projects are financed. As investor wealth becomes so large that many risky projects must be financed, securitization combined with the pledging of AAA-rated securities and liquidity guarantees is used to accommodate growing leverage.

3.2 The outcome at $t = 1, 2$ after ω is learned

Given the investment and securitization patterns $(I_{H,j}, I_{L,j}, S_{L,j})$ at $t = 0$, consider what happens after ω is learned. We focus on the most interesting case where the debt constraint (5) is binding and securitization is positive. Since investors have lent under a riskless debt contract, at $t = 2$ they in aggregate receive – for any given ω – the promised amount:

$$rD_j = R\cdot I_{H,j} + \pi_r\cdot A\cdot S_{L,j}. \tag{12}$$

Intermediaries, on the other hand, efficiently bear the aggregate risk associated with ω, but they also bear the idiosyncratic risk created by their own risky project to the extent that they only partially securitized it. For any ω, at $t = 1$ there are two classes of intermediaries.

The first class consists of "successful" intermediaries, whose risky project pays out. In state ω there are by definition π_ω such intermediaries, and their $t = 2$ revenues are equal to:

$$RI_{H,j} + \pi_\omega \cdot A \cdot S_{L,j} + A \cdot (I_{L,j} - S_{L,j}). \quad (13)$$

By subtracting (12) from (13), we find that, for these successful intermediaries, profits at $t = 2$ are equal to $(\pi_\omega - \pi_r) \cdot A \cdot S_{L,j} + A \cdot (I_{L,j} - S_{L,j})$. These profits accrue from the securitized pool if $\pi_\omega > \pi_r$ and from the non-securitized investments that pay out.

The second class consists of "unsuccessful" (and not fully diversified) intermediaries whose risky project has not paid out. The revenues of these $1 - \pi_\omega$ intermediaries are equal to:

$$RI_{H,j} + \pi_\omega \cdot A \cdot S_{L,j} + 0 \cdot (I_{L,j} - S_{L,j}). \quad (14)$$

By subtracting (12) from (14), we find that, for these "unsuccessful" intermediaries, profits at $t = 2$ are equal to $(\pi_\omega - \pi_r) \cdot A \cdot S_{L,j}$. All these profits accrue from holding the upside of the securitized pool of assets.

When securitization is full ($S_{L,j} = I_{L,j}$), there is no distinction between successful and unsuccessful intermediaries. All intermediaries earn the same profit $(\pi_\omega - \pi_r) \cdot A \cdot I_{L,j}$ in (13) and (14). This observation will turn out to be critical to understanding the link between securitization and fragility.

From this analysis, we can draw the following lessons. When all market participants hold rational expectations, securitization is a welfare improving instrument that facilitates a better allocation of risks, boosting leverage and thus productive investment. Thanks to securitization, the extremely risk averse market participants, namely investors, shed all of their risks. The risk neutral market participants, namely intermediaries, are happy to bear all the residual risk to earn the extra return. As long as all investors understand the risks, the system is stable and there is no link between securitization and fragility. Full securitization eliminates idiosyncratic risk and creates stability. Even when securitization is only partial, investors anticipate that some idiosyncratic risk will turn out badly, which reduces the ability

of any individual intermediary to borrow, so that even ex-post unsuccessful intermediaries are able to repay their debt.

This analysis of the shadow banking system explains a range of empirical phenomena. It accounts for the role of the wealth of extremely risk averse investors, which comes from the global imbalances, or institutional demand, in driving the demand for securitization (e.g., Farhi et al. 2008, Krishnamurthy and Vissing Jorgensen 2008). It explains how leverage and assets of intermediaries grow together (Adrian and Shin 2010). It explains how, in equilibrium, intermediaries pursuing a carry trade take marginal risky projects when interest rates are low (Jimenez et al. 2011). Finally, it explains how the diversification of idiosyncratic risk through securitization is accompanied by the concentration of systematic risks on the books of financial intermediaries (Acharya, Schnabl, and Suarez 2010). Under rational expectations, however, all these developments are benign.

At the same time, it is clear from the organization of the shadow banking system that it is extremely vulnerable to unanticipated shocks. The enormous size of the shadow banking system when outside investor wealth is high, the extreme distaste of those investors for bearing any risk which consequently piles up these risks with intermediaries, and the role of securitization in increasing leverage and concentrating systematic risks, all render shadow banking vulnerable to shocks. When we add such shocks to the model in the form of neglected low probability tail risks, the system becomes fragile. Shadow banking provides illusory rather than true insurance to investors, and as such it massively misallocates risk.

4. The case of local thinking

We model local thinking by assuming, following Gennaioli and Shleifer (2010) and GSV (2011), that at $t = 0$ both investors and intermediaries only think about the two most likely states. Recall that the recession is the least likely state (i.e. $\varphi_g > \varphi_d > \varphi_r$), reflecting a

period of economic prosperity. At $t = 0$ expectations are thus formed based on the restricted state space $\Omega^{\mathrm{LT}} \equiv \{g, d\}$, covering only the possibilities of growth and downturn. Superscript LT denotes the information set and beliefs of a local thinker.

There is a superficial tension between our assumptions of infinite risk aversion of investors and their neglect of tail downside risk. Shouldn't infinite risk aversion imply extreme alertness to precisely such risks? The answer, in our view, is no. First, one assumption concerns preferences and the other concerns beliefs, which are logically separate. Experimental evidence suggests that individuals sometimes overweigh small probability events when those are salient, but other times ignore them when they do not come to mind (Kahneman and Tversky 1979, Bordalo et al. 2011). Second, and perhaps most relevant to the current context, investors' misperception may have been amplified by the fact that they bought AAA rated securities, discouraging any interest in investigating potential risks.

Unlike in GSV (2011), market participants are fully aware that intermediaries are subject to the idiosyncratic risk of obtaining a zero payoff. The subtler failure of rationality here is that market participants neglect the *aggregate* risk that only as few as π_r intermediaries may be successful. Given the technology of Equation (2), this neglect creates two problems. First, it induces over-optimism about the average return of an individual intermediary, i.e. $\mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega})\cdot A > \mathrm{E}_{\omega}(\pi_{\omega})\cdot A$. Second, it induces market participants to neglect the fact that an intermediary may be unsuccessful precisely in a state, a recession with aggregate payoff $\pi_r \cdot A$, in which many other intermediaries are also unsuccessful. This second effect plays some role in Section 4.2, but will be especially important in Section 5.

4.1 Securitization and leverage at $t = 0$ under local thinking

Since expectations are the only object that changes relative to the case with full rationality, the equilibrium as of $t = 0$ is isomorphic to the rational expectations equilibrium

of Proposition 1, except that: i) the true expected return $E_\omega(\pi_\omega)\cdot A$ is replaced by the local thinker's expected return $E_\omega^{LT}(\pi_\omega)\cdot A = E(\pi_\omega|\omega = g, d)\cdot A$ and ii) the worst-case contemplated scenario is now a downturn rather than a recession. As a consequence, the thresholds w^* and w^{**} of Proposition 1 are replaced by $w^{*,LT}$ and $w^{**,LT}$ and one can check that $w^{**,LT} > w^{**}$ while $w^{*,LT}$ may be above or below w^*. The equilibrium is characterized by Proposition 2.

Proposition 2 In equilibrium under local thinking, for any given level of investors' wealth w:

1) The interest rate is weakly higher than under rational expectations, i.e. $r^{LT} \geq r$.

2) Debt (and thus investment) is weakly higher than under rational expectations, i.e. $D^{LT} \geq D$.

3) Securitization arises for lower levels of wealth w than under rational expectations, and for w sufficiently large is higher than under rational expectations, i.e. $S_L^{LT} \geq S_L$.

To see the above results, note that the debt constraint under local thinking becomes:

$$r D_j^{LT} \leq R\cdot I_{H,j}^{LT} + \pi_d\cdot A\cdot S_{L,j}^{LT}. \tag{15}$$

Under rational expectations, the corresponding expression was $rD_j \leq R\cdot I_{H,j} + \pi_r\cdot A\cdot S_{L,j}$. The shadow value of securitization is higher under local thinking: an extra securitized project expands leverage by $\pi_d\cdot A$ under local thinking but only by $\pi_r\cdot A$ under rational expectations. The insurance mechanism provided by securitization is believed to be very effective by local thinkers because in the worst-case scenario they consider a sizeable share (π_d) of the pooled projects succeed. This is not so under rational expectations, where only π_r of the projects are expected to succeed for sure.

This property implies that local thinking tends to boost the amount of debt repayment that can be sustained by securitization, but it does not say whether this boost will trigger an

upward adjustment in the interest rate r or in the amount of leverage D^{LT} and investment I^{LT}. Figure 3 graphically addresses this question for the case where $w^{*,\mathrm{LT}} < w^{*}$.[6]

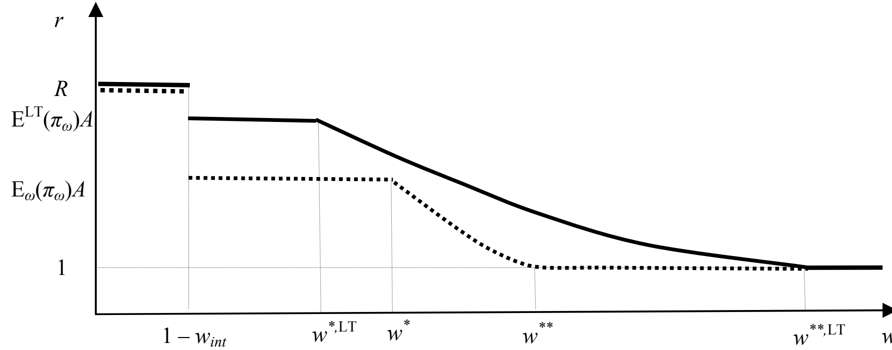

Figure 3: The interest rate under local thinking

The bold and dashed lines plot the equilibrium interest rate under local thinking and rational expectations, respectively. The lines differ in the range when risky projects are undertaken, as local thinking intermediaries believe the return of these projects to be higher than under rational expectations. This boosts the interest rate to $r = \mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega})\cdot A$ and tightens debt constraints, forcing intermediaries to securitize starting at lower wealth levels and more extensively (indeed, $R/\mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega})\cdot A < R/\mathrm{E}_{\omega}(\pi_{\omega})\cdot A$). As long as $w \leq w^{**}$, intermediaries absorb all of investors' wealth under both rational expectations and local thinking, so investment is the same in two cases (i.e., $I_{\mathrm{L}} = I_{\mathrm{L}}^{\mathrm{LT}} = w + w_{int} - 1$). In this range, the greater pace of securitization prevailing under local thinking just reflects a rat race among intermediaries that results in a higher interest rate, not in higher investment. As we will see, this implies that over some range, securitization creates fragility without an ex-ante benefit of greater investment.

In the range $w \geq w^{**}$, local thinking fosters not only securitization, but also leverage and investment beyond the level prevailing under rational expectations. As investors' wealth becomes very high, the interest rate must fall in order for intermediaries to absorb that

[6] When $w^{*,\mathrm{LT}} < w^{*}$ securitization is higher under local thinking, namely $S_{\mathrm{L}}^{\mathrm{LT}} \geq S_{\mathrm{L}}$ for all w. When instead $w^{*,\mathrm{LT}} > w^{*}$ there might be an intermediate wealth range where securitization is higher under rational expectations. The intuition is that, precisely because under rational expectations the shadow value of securitization is lower, intermediaries may need to use more of it to absorb investors' wealth.

wealth, but relatively less so under local thinking. Until wealth reaches $w^{**,\mathrm{LT}}$, the shadow value of securitization under local thinking allows intermediaries to absorb more wealth from investors and to pay them a higher interest rate than under rational expectations. For $w > w^{**,\mathrm{LT}}$, the interest rate under local thinking reaches its minimum of 1 and no more investor wealth can be absorbed. Now the only difference with rational expectations is reflected in the amount of leverage, which is higher under local thinking.

In sum, at $t = 0$ local thinking boosts the use of securitization relative to rational expectations, resulting either in a higher interest rate only (for $w \leq w^{**}$), or in higher borrowing and interest rate (for $w^{**} < w < w^{**,\mathrm{LT}}$), or in higher borrowing only (for $w \geq w^{**,\mathrm{LT}}$). Similar effects are at play when $w^{*,\mathrm{LT}} > w^{*}$. We now consider the implications of this feature for the reaction of markets to news at $t = 1$.

4.2 Securitization and fragility at $t = 1$ under local thinking

Consider the investment and securitization profile ($I^{\mathrm{LT}}_{\mathrm{H},j}$, $I^{\mathrm{LT}}_{\mathrm{L},j}, S^{\mathrm{LT}}_{\mathrm{L},j}$). If the state is growth or downturn, idiosyncratic shocks affect the profit of specific intermediaries, but riskless projects and securitized assets provide intermediaries with enough resources to repay their debt a $t = 2$. When the realized ω is in the support of the states considered by the local thinker, the outcome is qualitatively similar to that arising under rational expectations.

Matters change drastically in a recession. Now intermediaries realize that at $t = 2$ they may not have enough resources to repay their debt, thereby precipitating a default. To see how this possibility arises, consider the debt constraint of Equation (15). Since by Lemma 1 securitization is used when this constraint is binding, in any equilibrium with positive securitization the intermediary at $t = 0$ commits to repay at $t = 2$ the amount:

$$r^{\mathrm{LT}}D^{\mathrm{LT}} = R\cdot I^{\mathrm{LT}}_{\mathrm{H},j} + \pi_d\cdot A\cdot S^{\mathrm{LT}}_{\mathrm{L},j}\,. \tag{16}$$

Consider now the ability of different intermediaries to repay this debt. The measure $(1-\pi_r)$ of unsuccessful intermediaries learns that their $t = 2$ operating profits are equal to:

$$R\cdot I_{\mathrm{H},j}^{\mathrm{LT}} + \pi_r\cdot A\cdot S_{\mathrm{L},j}^{\mathrm{LT}} + 0\cdot(I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}). \tag{17}$$

By subtracting Equation (16) from (17), we see that unsuccessful intermediaries default at $t = 2$ because their operating profits are below the face value of debt by the amount $(\pi_d - \pi_r)\cdot A\cdot S_{\mathrm{L},j}^{\mathrm{LT}} > 0$. The neglect of the risk of a recession plays a key role here: even though intermediaries try to keep their debt safe by insuring against idiosyncratic risk, the fact that the securitized pool performs worse than expected by $(\pi_d - \pi_r)$ reveals that debt is risky and triggers a default. This problem arises because the local thinker neglects the possibility that an adverse idiosyncratic shock, against which the intermediary is insured, occurs precisely in a recession state when many other intermediaries are experiencing the same shock.

The measure π_r of successful intermediaries learns that their $t = 2$ profits are equal to:

$$R\cdot I_{\mathrm{H},j}^{\mathrm{LT}} + \pi_r\cdot A\cdot S_{\mathrm{L},j}^{\mathrm{LT}} + A\cdot(I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}). \tag{18}$$

By subtracting Equation (16) from (18), we see that successful intermediaries may or may not be able to repay their debt. In particular, Equation (18) is higher than (16) and thus successful intermediaries are solvent if and only if:

$$\frac{I_{\mathrm{L},j}^{\mathrm{LT}}}{S_{\mathrm{L},j}^{\mathrm{LT}}} > 1 + (\pi_d - \pi_r). \tag{19}$$

This is a key equation. It says that for successful intermediaries not to default, the fraction of risky investment that is non-securitized must be sufficiently high relative to the cash flow shortfall resulting from their neglect of aggregate downside risk. If securitization is close enough to 0, condition (19) is satisfied and successful intermediaries repay their debt. In this case, after the unexpected recession occurs, a share $1-\pi_r$ of intermediaries defaults but a (potentially high) share π_r of intermediaries does not. If instead securitization is close to full ($S_{\mathrm{L},j}^{\mathrm{LT}} \approx I_{\mathrm{L},j}^{\mathrm{LT}}$), even successful intermediaries default. In this case, all intermediaries default!

When securitization is full, with probability φ_g, intermediaries get a true bonanza payoff; when their luck turns sour, with probability φ_r, they get a fouled carry trade and financial distress. Interestingly, Equation (19) reveals that financial fragility results from the combination of the neglect of risks and high investor wealth through the volume of securitization $S^{\mathrm{LT}}_{\mathrm{L},j}$. Even if the neglect of risk is small, formally $\pi_d \cong \pi_r$, the financial system can collapse when investor wealth is so large that securitization is massive.

Somewhat paradoxically, the more intermediaries insure against idiosyncratic risk, the more they become exposed to unexpected and adverse aggregate shocks. The problem is that securitization does not only dampen the fluctuations in intermediaries' balance sheets, but also allows them to take on more leverage. It is precisely this boost in leverage financing carry trades that renders intermediaries fragile. The combination of insurance and leverage is problematic because it creates a large correlation among the intermediaries' response to neglected risks, de facto transforming riskless debt claims into catastrophe bonds, as noted by Coval et al. (2009b). This last point can be readily seen in the previous formalism: when condition (19) is not met, conditional on the realization of the unexpected state, a non-securitized (risky) debt claim defaults with probability $1-\pi_r$, whereas an allegedly safe fully securitized debt claim defaults with probability 1!

By endogenizing leverage and securitization, our model allows us to determine when condition (19) is met and when it is not. The appendix proves the following result:

Corollary 1 If $\mathrm{E}_{\omega}(\pi_{\omega})\cdot A > 1$, then there is a threshold $\underline{w} \in (R/\mathrm{E}^{\mathrm{LT}}_{\omega}(\pi_{\omega})\cdot A, w^{*,\mathrm{LT}})$ such that when a recession occurs, for $w \leq R/\mathrm{E}^{\mathrm{LT}}_{\omega}(\pi_{\omega})\cdot A$ no intermediary defaults, for $w \in (R/\mathrm{E}^{\mathrm{LT}}_{\omega}(\pi_{\omega})\cdot A, \underline{w})$ only $1-\pi_r$ intermediaries default, and for $w > \underline{w}$ all intermediaries default.

This result highlights the role of investors' wealth, via the interest rate, in shaping financial fragility. When investors' wealth is low, borrowing is limited. Intermediaries'

wealth w_{int} is thus sufficient to sustain riskless borrowing, providing an effective buffer against unexpected shocks. As investors' wealth rises, intermediaries' wealth becomes too small to buffer against shocks. To sustain further borrowing, intermediaries must reduce balance sheet risk by securitizing some of their investments. When securitization is moderate, the unsuccessful intermediaries become vulnerable to unexpected aggregate shocks but the successful ones are still able to repay from the income generated by their own projects. When investors' wealth becomes very high and the interest rate very low, intermediaries boost leverage by maxing out securitization. Now all intermediaries are equally unprepared to withstand the aggregate shock. Here securitization spreads unexpected aggregate shocks across all intermediaries, leading all of them to default.

The analysis links several aspects of the financial crisis that were previously noted but not seen as related. We have already noted that, even under rational expectations, our model explains the role of the world savings glut in driving securitization (Caballero 2009), the cyclical comovement of bank assets and leverage (Adrian and Shin 2010), procyclical risk-taking by banks (Jimenez et al. 2011), and the concentration of aggregate risks on bank balance sheets in securitization (Acharya, Schnabl, and Suarez 2010). In our model, a high level of investor wealth leads to expanded securitization, growing leverage, growing assets of the intermediary sector, lower interest rates, and increased bank risk taking. Under the neglected risk assumption, the model yields additional implications. Most importantly, it shows that the system that is highly stable under rational expectations becomes extremely fragile and sensitive to tail risks because securitization entails growing bank interdependence. It also delivers the important prediction that securities perceived to be completely safe (AAA-rated) and used by banks as collateral for raising safe outside debt suffer losses when tail risks are realized. Bank losses in a crisis come precisely from these AAA-rated securities

created by tranching diversified portfolios of projects (Benmelech and Dlugosz 2009). In section 5, we show how an extension of the model also explains liquidity dryups in a crisis.

The source of fragility is the neglect of aggregate risk. Unlike in the case of rational expectations, where securitization allows an appropriate increase in leverage and investment, when market participants are local thinkers, securitization sustains excessive insurance and thus excessive leverage, which renders the economy very sensitive to unexpected adverse aggregate shocks. In the current model, excess securitization benefits intermediaries (who are able to exploit more profitable carry trades), but hurts investors by inducing them to over-lend and by exposing them to unexpected aggregate shocks. Since risk averse investors are inefficient bearers of this risk, excess securitization leads to a net social loss.

There is an alternative, but closely related, interpretation of the model. According to this view, securitization works through the creation of a standardized liquid market in whatever assets investors perceive to be safe (e.g., AAA-rated MBS). All the intermediaries borrow against these "safe" assets and probably even tilt their carry trades toward these assets because they are easier to lever up. The net result is that any investor misperception of risks results in massive investment in and borrowing against this "safe" asset class, creating a situation in which all intermediaries are vulnerable to the same sectoral risk. The high correlation of defaults across the intermediaries in the bad state results from loading up on exposure to this neglected risk. In our model it is diversification (and tradability, see Section 5) that creates the false perception of absolute safety and the high correlation of defaults, but the mechanism is potentially more general.

In the current model, agents learn about the neglected risk at $t = 1$ but fragility and losses are realized at $t = 2$, when defaults occur. In reality, in contrast, when bad news hit we often observe asset trading, price drops, and spikes in risk premia. The next section presents a modification of our basic setup where all of these features naturally emerge.

5. Securitization and leverage under slow arrival of information

We modify two assumptions from the previous setup. First, we assume that a fraction of risky projects pays off its return A at $t = 1$ rather than at $t = 2$. At $t = 0$, it is not known which projects pay out early. A project not repaying early need not be unsuccessful, since some successful project pay out late (e.g., restructured mortgages). The second departure from the previous setup is that the fraction of early-paying projects is partially informative about ω, perhaps because it acts as a signal of aggregate output.

Formally, we assume that at $t = 1$ either state h or l is realized. In state h, a share q_h of intermediaries obtains A on their risky projects at $t = 1$, while the remaining $1 - q_h$ intermediaries must wait until $t = 2$ for their return to realize. In state l, a share $q_l < q_h$ of intermediaries receive A on their risky projects while the remaining $1 - q_l$ must wait until $t = 2$ for their return to realize. As a result, $\Omega_1 \equiv \{l,h\}$ and $\Omega_2 \equiv \{g,d,r\}$. The share of projects paying out "early" is informative about the aggregate state: the probability that any "late" project is successful at $t = 2$ is higher in state h than in state l. We formalize this notion by assuming that the unfolding of events is captured by the following event tree (which is chosen to nest the distribution of final states previously considered):

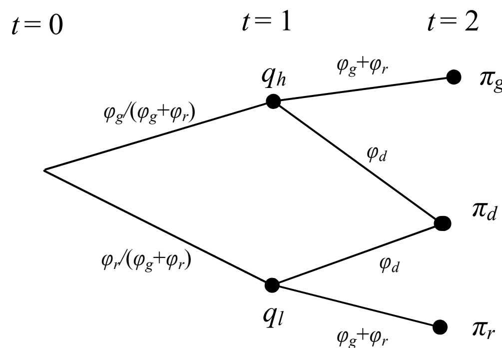

Figure 4: Information tree

In Figure 4, the nodes at $t = 1$ report the share of successful intermediaries at $t = 1$, while the nodes at $t = 2$ report the total share of successful intermediaries (at $t = 1$ and $t = 2$).

The numbers in the branches capture the probabilities of moving up or down at a given node. The aggregate state that we previously called "growth" here consists of a streak of good news, "downturn" consists of a mix of good and bad news, and "recession" is a streak of bad news. As of $t = 1$, state h is good news, but it remains uncertain whether the overall state is π_g or π_d, while state l is bad news but it remains uncertain whether the overall state is π_d or π_r.

Besides their informational content, the key implication of the presence of early projects is that intermediaries may use the portion of early returns that was not pledged to creditors to buy back some debt claims in secondary markets at $t = 1$. This second effect becomes critical in shaping changes in market liquidity when at $t = 1$ investors realize the presence of neglected risks.

At a more technical level, the presence of "early" projects also implies that some debt repayment must occur at $t = 1$ when the early projects in securitized holdings yield $q_\omega \cdot A \cdot S^{\mathrm{LT}}_{\mathrm{L},j}$ (recall that there is no storage). This arrangement can be described as a long term fully safe debt contract promising one coupon at $t = 1$ and another at $t = 2$.[7] We stress that, consistent with our prior assumption, debt continues to be fully riskless (within the states of the world that come to mind). To simplify the analysis, but with no consequence for our key results, we also assume a two tiered seniority structure within riskless debt. The most senior riskless debt is pledged up to the safe return $RI^{LT}_{H,j}$ and gets repaid at $t = 2$, while the less senior riskless debt is pledged the lowest return on the pool of securitized assets $\pi_d S^{LT}_{L,j}$. This second class of riskless debt gets part of its repayment at $t = 1$ and part at $t = 2$. The only role of this assumption is to simplify the working of secondary markets at $t = 1$, effectively turning them into markets where securitized pools are re-traded.

[7] The same effects can be obtained by having short term debt rolled over at $t = 1$. We stick to long term debt for consistency with our previous analysis. An alternative is to have all projects pay out at $t = 2$ but to have some revealed to be successful at $t = 1$. In this case, intermediaries revealed to be successful at $t = 1$ could issue safe debt at this date to purchase claims in secondary markets. This alternative formulation would yield similar results to the current one, but requires a more cumbersome characterization of the market equilibrium at $t = 1$.

5.1 Securitization, Liquidity and Financial Fragility

To study the model, we focus on the case of local thinking. Consistent with the previous analysis, we model local thinking by assuming that at $t = 0$ agents only think about the two most likely *paths* in the tree. Under the assumption $\varphi_d > \varphi_r/(\varphi_g+\varphi_r)$, which we impose throughout, the most likely paths are growth and downturn, so that at $t = 0$ local thinkers prune the lower branch of the tree, considering only the upper one:

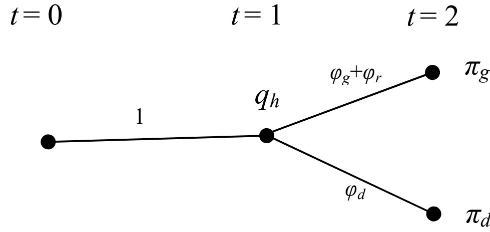

Figure 5: The local thinker's information tree

Upon observing the neglected state q_l at $t = 1$, the only possible paths lead to a downturn or a recession. Market participants realize that they are in the lower branch of the tree, and take the previously neglected risk of a recession into account.

Consider the optimal policy of intermediaries at $t = 0$. Given the event tree in Figure 5, the investment-financing policies of intermediaries are isomorphic to those described in Section 4.1 under local thinking and full revelation of information. First, since investors are indifferent between consuming at different dates, at $t = 0$ they do not care about the timing of returns and lend the same amount they lent when they fully learned ω at $t = 1$ and consumed only at $t = 2$. The only technical difference is that now Figure 5 implies that the local thinker's expected return is equal to $E_\omega(\pi_\omega|t=0)\cdot A$ = $\lfloor(\varphi_g+\varphi_r)\pi_g+\varphi_d\pi_d\rfloor\cdot A$, which differs from the average return expected by the local thinker in the static setup of Section 3.

Second, at any investment-securitization profile ($I^{\mathrm{LT}}_{\mathrm{H},j}, I^{\mathrm{LT}}_{\mathrm{L},j}, S^{\mathrm{LT}}_{\mathrm{L},j}$), the supply of riskless bonds by intermediaries at $t = 0$ is unaffected by either of our new assumptions: the presence of "early" projects or by partial learning. The maximum amount of riskless cash flow that

intermediaries can pledge is equal to the safe return $R \cdot I^{\mathrm{LT}}_{\mathrm{H},j}$ plus the early return from securitization $q_h \cdot A \cdot S^{\mathrm{LT}}_{\mathrm{L},j}$, plus the "late" return from securitization $(\pi_d - q_h)A \cdot S^{\mathrm{LT}}_{\mathrm{L},j}$ valued at the worst state investors are thinking about. The riskless debt constraint faced by intermediaries at $t = 0$ is thus given by:

$$rD_j \leq R \cdot I^{\mathrm{LT}}_{\mathrm{H},j} + \pi_d \cdot A \cdot S^{\mathrm{LT}}_{\mathrm{L},j}, \tag{20}$$

which is identical to Equation (15) prevailing under full information revelation. Once again, the form of the debt constraint (20) is due to the fact that we focus on riskless debt. Section 5.2 however shows that, under the assumption of slow information arrival, intermediaries may boost debt capacity by issuing risky debt.

Although early projects and slow information arrival do not change the results of Proposition 2 concerning the $t = 0$ equilibrium prevailing under local thinking, this is not so outside of normal times, in the unexpected aggregate state q_l at $t = 1$. Now matters become very different. If at $t = 1$ market participants observe an unexpectedly low share q_l of "early" projects, they realize that they are in the lower branch of the tree in Figure 4, which they had previously neglected.

As in the local thinking analysis of Section 4.2, investors now suddenly realize that what can be pledged in the worst state of nature by each intermediary from its own securitized holdings $S^{\mathrm{LT}}_{\mathrm{L},j}$ drops by the amount $(\pi_d - \pi_r)A \cdot S^{\mathrm{LT}}_{\mathrm{L},j}$.[8] Most important, since at $t = 1$ there is residual uncertainty as to whether the final state is recession or downturn, there is residual risk in the claim held by investors. Since investors are not efficient bearers of this risk, there is a rationale for them to sell their (now risky) debt claim to risk neutral intermediaries. This is particularly problematic for "late" intermediaries whose risky project has not paid at $t = 1$, as the debt they issued against securitized pools now faces a severe risk

[8] This reduction in investors' own valuation of debt is due to an unanticipated drop in $t = 1$ repayment of $(q_h - q_l)A\, S^{\mathrm{LT}}_{\mathrm{L},j}$ plus a drop in $t = 2$ repayment of $(\pi_d - \pi_r - q_h + q_l)A\, S^{\mathrm{LT}}_{\mathrm{L},j}$.

of default (the fact that only securitized debt claims are subject to default risk is due to our simplifying assumption of a two tiered debt seniority structure).

To see this, consider the securitized assets of a generic late intermediary. The investors that had been pledged up to $\pi_d \cdot A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}$ by the intermediary from these assets, upon observing q_l effectively become owners of the cash flow generated by these assets and value it at the worst case value $\pi_r \cdot A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}$.[9] On the demand side, an early intermediary having some spare liquidity at $t = 1$ has a higher reservation price $\mathrm{E}(\pi_\omega | \omega = l) \cdot A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}$ ($> \pi_r \cdot A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}$) for the cash flow generated by the securitized assets of a late intermediary. To reiterate, there are gains for risk averse investors to sell their risky debt claims on late intermediaries to the risk neutral early intermediaries having some spare liquidity at $t = 1$, and for these intermediaries to purchase this debt. Notwithstanding these gains, the key question is what volume of trade can be sustained at $t = 1$ by the wealth of the q_l early intermediaries confronted with the supply of the securitized (now risky) debt of the remaining $(1 - q_l)$ of late intermediaries.

To determine the equilibrium, denote by V_1 the total market value of this now risky debt at $t = 1$. Even if V_1 is below their valuation, early intermediaries are only able to buy debt to the extent that they have enough resources available. At $t = 1$, the total resources available to early intermediaries to buy debt claims in secondary markets are equal to

$$q_l \cdot [A \cdot (I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}) - (\pi_d - \pi_r) A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}], \tag{21}$$

which consists of the payoff from "early" projects that were not securitized (and thus not pledged to creditors) minus the unexpected drop in the lowest value of the securitized assets pledged to creditors, which must be repaid using the non-pledged resources. Since riskless debt is senior to equity, the intermediary must pledge part of the return from early projects to its creditors, because the pool of risky projects cannot alone ensure that debt is repaid in full.

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[9] For simplicity we are assume that trading occurs before the $t = 1$ debt repayment is made, so that the value of the debt includes the coupon $q_l A \cdot S_{\mathrm{L},j}^{\mathrm{LT}}$.

Using (21) we can then prove the following result:

Proposition 3 If the share of early projects is q_l, the equilibrium at t =1 is as follows:

a) if $\frac{I_{\mathrm{L}}^{\mathrm{LT}}}{S_{\mathrm{L}}^{\mathrm{LT}}} > 1 + (\pi_d - \pi_r) + \frac{(1-q_l)}{q_l}\mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega}|\omega = l)$, then early intermediaries have a lot of spare wealth at t = 1 and thus absorb all of the now risky debt, bidding up its market value to their reservation value $V_1 = (1- q_l)\cdot\mathrm{E}(\pi_{\omega}|\omega=l)\cdot A\cdot S_{\mathrm{L},j}^{\mathrm{LT}}$;

b) if $\frac{I_{\mathrm{L}}^{\mathrm{LT}}}{S_{\mathrm{L}}^{\mathrm{LT}}} \in [\ 1 + (\pi_d - \pi_r) + \frac{(1-q_l)}{q_l}\pi_d,\ 1 + (\pi_d - \pi_r) + \frac{(1-q_l)}{q_l}\mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega}|\omega = l)\ ]$, then early intermediaries have a medium amount of spare wealth at t = 1. They still absorb all of the now risky debt but now the market value of debt is $V_1 = q_l\cdot[A\cdot(I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}) - (\pi_d - \pi_r)A\cdot S_{\mathrm{L},j}^{\mathrm{LT}}]$, which is lower than intermediaries' reservation price;

c) if $\frac{I_{\mathrm{L}}^{\mathrm{LT}}}{S_{\mathrm{L}}^{\mathrm{LT}}} < 1 + (\pi_d - \pi_r) + \frac{(1-q_l)}{q_l}\pi_d$, then early intermediaries have little spare wealth at t = 1. Now they cannot absorb all of the now risky debt, whose equilibrium price stays at investors' reservation value $V_1 = (1- q_l)\cdot\pi_r\cdot A\cdot S_{\mathrm{L},j}^{\mathrm{LT}}$.

In cases a)-c) The ratio $I_{\mathrm{L}}^{\mathrm{LT}} / S_{\mathrm{L}}^{\mathrm{LT}}$ and the difference $I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}$ fall with investors' wealth w.

Proposition 3 shows that securitization creates financial fragility not only by exposing unsuccessful intermediaries to unexpected aggregate shocks as we saw in Section 4.2, but also by draining out market liquidity after the unexpected shock has occurred. When a large share of investment is securitized (i.e., $I_{\mathrm{L},j}^{\mathrm{LT}} - S_{\mathrm{L},j}^{\mathrm{LT}}$ is low), even intermediaries with "early" projects are illiquid when the unexpected shock occurs, because they had sold part of their successful projects to other intermediaries and they increased their leverage. This implies that, even if the un-securitized part of the portfolio is sufficiently large to allow "early" intermediaries to repay their own creditors, these intermediaries are unable to provide

liquidity backstop to other creditors by purchasing the distressed debt claims of the "late" intermediaries. Once more, initial investor wealth is critical in creating financial fragility, for it is precisely when investors' wealth is high that securitization and leverage are extensive, causing secondary debt markets to be fragile.[10]

In Shleifer and Vishny (2010) and GSV (2011), market liquidity is scarce because the investment gains reaped by intermediaries induce them to commit all of their wealth at $t = 0$. In our model, in contrast, the insurance mechanism provided by securitization boosts fragility *not only* by inducing intermediaries to commit their wealth ex-ante, but also and most distinctively by rendering the "spare wealth" conditions of different intermediaries highly correlated. In fact, the model in GSV can be viewed as a special case of this model in the range where securitization is full so that idiosyncratic risk is fully removed.

The case with partial securitization thus highlights the distinctive mechanism through which insurance creates fragility. In that case, it is still true that some unsuccessful intermediaries experience financial distress because, as in Shleifer-Vishny (2010) and GSV (2011), they have committed all of their wealth to investment. However, there are also other successful intermediaries with unencumbered balance sheets willing and able to provide liquidity support. These intermediaries have also committed all of their wealth ex-ante, but the limited amount of securitization leaves them with some spare capacity to rescue the unsuccessful intermediaries thanks to the bonanza of early successful projects. There is market liquidity in the sense of Shleifer and Vishny (1992) and Brunnermeier and Pedersen (2009). The problem, however, is that when securitization is sufficiently extensive, the spare capacity of successful intermediaries is small, making them unable to provide significant backstop insurance to the unsuccessful intermediaries. By creating a correlation in the performance of different intermediaries through an endogenously-created network of

[10] Rather than re-trading risky debt in secondary debt markets, a better risk allocation at $t = 1$ could be achieved by additional financial innovation (tranching) at $t = 1$ whereby investors carve out the risky portion of debt repayment and sell it to intermediaries while keeping the safe portion for themselves.

relationships, securitization creates market illiquidity. This correlation can be naturally viewed as a source of the counter party risk created by the interlinkages typical of insurance arrangements, generating systemic risk in the sense of Giglio (2010).

5.2 Risky debt and risk premia

The previous analysis shows how trading and liquidity of riskless debt is shaped by securitization after the realization of neglected risks, but does not meaningfully explain changes in risk premia since risk averse investors do not hold risky securities. In our model, securitization and its link to financial fragility also have implications for risk premia.

To begin, note that the presence of "early" projects may allow intermediaries to expand debt capacity by issuing risky debt to investors. So far we have only considered the issuance of riskless debt claims pledging the lowest support of the risky pool $\pi_d \cdot A \cdot S^{\text{LT}}_{\text{L},j}$ (on top of the riskless return $RI^{\text{LT}}_{\text{H},j}$). However, the intermediary could issue a (risky) debt security that pledges the entire cash flow from the pool, or equivalently it pledges the risky pool as collateral, effectively using securitization not only as pooling but also as a ring fencing device. Crucially, investors are willing to lend up to $p_1 \cdot S^{\text{LT}}_{\text{L},j}$ for this security, where p_1 is the market value of risky collateralized debt at $t = 1$ in the event tree of Figure 5 that agents are thinking about. If investors expect to resell the pool at $t = 1$ at a price $p_1 > \pi_d \cdot A$, pledging the entire pool as collateral allows intermediaries to increase the shadow value of securitization in terms of relaxing the riskless debt constraint (5), which becomes $rD_j \leq R \cdot I^{\text{LT}}_{\text{H},j} + p_1 \cdot S^{\text{LT}}_{\text{L},j}$. Debt capacity is indeed larger than in (20) precisely when $p_1 > \pi_d \cdot A$. If instead investors expect a market price for risky collateral of $p_1 = \pi_d \cdot A$, then posting risky collateral entails no expansion in debt capacity relative to purely riskless debt.

The possibility of market trading explains why it might indeed be the case that in

equilibrium $p_1 > \pi_d{\cdot}A$: intermediaries holding "early" projects are willing to pay more than $\pi_d{\cdot}A$ for each unit of the pool because – being risk neutral – they also value the pool's upside. Once again, the question is whether early intermediaries are sufficiently wealthy at $t = 1$ to sustain a high market price $p_1 > \pi_d{\cdot}A$. In the remainder of this section, we sketch the analysis of an equilibrium where $p_1 > \pi_d{\cdot}A$. The goal of our analysis here is not to fully characterize the equilibrium set, but to identify circumstances in which the very mechanism permitting the issuance of risky debt at $t = 0$ to investors – the expectation of ex-post market liquidity – evaporates when neglected risks materialize, creating fragility.

Consider an equilibrium in which the price at $t = 1$ is equal to intermediaries' reservation value, namely $p_1 = \mathrm{E}_\omega(\pi_\omega|\omega{=}l){\cdot}A$. To see under what condition this equilibrium is sustainable, note that along the expected path of events at $t = 1$ there is no default on debt, so that the liquid resources of intermediaries are equal to $q_h A{\cdot}(I^{\mathrm{LT}}_{\mathrm{L},j} - S^{\mathrm{LT}}_{\mathrm{L},j})$. That is, intermediaries' resources are equal to the non-securitized (and thus non-pledged) return of the early projects in h. On the other hand, early intermediaries must absorb the market value of the totality of risky debt at their reservation price, which amounts to $\mathrm{E}_\omega(\pi_\omega|\omega{=}l)A\, S^{\mathrm{LT}}_{\mathrm{L},j}$. The liquid resources of intermediaries are enough to absorb this amount when:

$$\frac{I^{\mathrm{LT}}_{\mathrm{L}}}{S^{\mathrm{LT}}_{\mathrm{L}}} > 1 + \frac{\mathrm{E}^{\mathrm{LT}}_{\omega}(\pi_\omega|\omega = h)}{q_h}. \tag{22}$$

When this equilibrium is sustained, i.e. (22) holds, intermediaries' debt capacity is $R{\cdot}I^{\mathrm{LT}}_{\mathrm{H},j} +$ $\mathrm{E}_\omega(\pi_\omega|\omega{=}h){\cdot}A{\cdot}S^{\mathrm{LT}}_{\mathrm{L},j}$. For any value of $S^{\mathrm{LT}}_{\mathrm{L},j}$, this is above their debt capacity with riskless debt in Equation (20). Note that higher debt capacity does not boost aggregate borrowing because the aggregate resources available to intermediaries at $t = 1$ are fixed. The main feature of this arrangement is that the same amount of borrowing can be carried out using less securitization. Due to the presence of a liquid secondary market, each unit of securitization is more valuable to investors.

Since the left hand side $I_{L,j}^{LT}/S_{L,j}^{LT}$ of Equation (22) falls with investors' wealth w, from subcase c) in Proposition 1 it follows that there exists a threshold $\tilde{w}$ such that Equation (22) holds for $w \in (R/\,E_\omega(\pi_\omega|\omega=h)\cdot A,\ \tilde{w})$. Intuitively, for a secondary market to operate at $t = 1$, investors' wealth must be sufficiently large [$w > R/E_\omega(\pi_\omega|\omega=h)\cdot A$] that some assets are securitized. On the other hand, if investor wealth is too large, securitization is so extensive that early intermediaries are illiquid even in good times, making it impossible for them to buy all risky claims at their reservation price. Hence, we must have $w < \tilde{w}$.

In terms of the $t = 0$ equilibrium, note that when $w \in (R/E_\omega(\pi_\omega)\cdot A, \tilde{w})$ securitization is partial, otherwise (22) would not hold, and thus $r = E_\omega(\pi_\omega|\omega=h)A$, just as in subcase c) of Proposition 1. In this equilibrium, at $t = 0$ risk averse investors buy risky debt at the equilibrium interest rate valuing the underlying risky collateral at $E_\omega(\pi_\omega|\omega=h)A$, which is precisely the intermediaries' reservation price. In this precise sense, at $t = 0$ the risk premium on risky debt is equal to zero. Intuitively, even if investors dislike risk, they value collateral at its risk neutral value because they believe that tomorrow they can sell their debt in a liquid market dominated by risk neutral investors.[11]

Once more, however, this arrangement is very sensitive to neglected risk. When at $t = 1$ market participants observe a low share of "early" projects q_l, they immediately realize that, in the most optimistic scenario, they are only able to sell at the average price $E_\omega(\pi_\omega|\omega=l)A$, which is less than what they expected to obtain at $t = 0$. The unexpected bad state reduces intermediaries' valuation at t = 1, exposing investors to resale risk. Most important, however, even if intermediaries' valuation does not change much, in the sense that $E_\omega(\pi_\omega|\omega=l) \approx E_\omega(\pi_\omega|\omega=h)$, investors are also exposed to the possibility that a bad realization of a neglected risk may cause liquidity at $t = 1$ to evaporate. This effect can be so strong as to drive the price of

[11] Although this mechanism works though the trading of long term debt, the same intuition can be developed in the context of riskless debt in terms of the expectation of debt rollover at $t = 1$. Another possibility to implement the same equilibrium is for investors rather than intermediaries to buy the securitized pools at the outset.

risky debt at $t = 1$ down to investors' ex-post valuation, which has become equal to $\pi_r \cdot A$. In this case, the risk premium jumps from zero at $t = 0$ to $[E_\omega(\pi_\omega|\omega=l) - \pi_r]A$ at $t = 1$.

We now identify the conditions leading to this case, which illustrates in the starkest manner the mechanism for fragility under risky debt. This case arises when $q_l A \cdot (I_{L,j}^{LT} - S_{L,j}^{LT})$, the liquid resources of intermediaries at $t = 1$, are insufficient to absorb all risky debt at investors' reservation price. This occurs provided:

$$\frac{I_L^{LT}}{S_L^{LT}} < 1 + \frac{\pi_r}{q_l}, \tag{23}$$

which holds when the non-securitized portion of the investment by successful intermediaries is sufficiently small. Conditions (22) and (23) are mutually consistent provided:

$$\frac{q_l}{q_h} < \frac{\pi_r}{E_\omega(\pi_\omega|q_h)}. \tag{24}$$

When (24) holds, there is a range of investors' wealth levels for which intermediaries expand debt capacity by selling risky debt to investors. This debt is sold without a risk premium at $t = 0$, but its the risk premium becomes very large when neglected risks materialize.

Securitization causes the boom and bust in the value of debt and the fluctuation in risk premia. In good times, securitization reduces risk premia by creating a relatively safe and liquid form of collateral. After all, the investor thinks, if the intermediary is hit by an adverse idiosyncratic shock, he can always sell its debt in the market and reduce his downside risk. This effect sustains ex-ante leverage. In bad times, however, securitization creates a strong correlation in the returns of intermediaries, which renders secondary markets very illiquid upon the realization of adverse aggregate shocks. This is what drives risk premia up as neglected risks materialize. The problem here is that the local thinking investor neglects the possibility that the intermediary whose debt he owns may go under precisely when many other debtors go under as well. In these neglected states, the very securitization that had

created the illusion of safety causes liquidity to collapse. As a consequence, the risk averse investor is stuck with risky debt, which causes the risk premium to rise.

6. Conclusion.

An important gap in our understanding of the financial crisis is the failure of the "originate and distribute" model, which resulted in the retention of massive amounts of systematic risk by banks. One explanation of such retention is the "too big to fail" argument, according to which intermediaries intentionally took massive risks counting on a government rescue. Another explanation refers to moral hazard problems resulting from poorly designed compensation arrangements for traders, which encouraged them to take risks unbeknownst to the top management (Rajan 2005, UBS Shareholder Report 2008). In this paper, we presented a third explanation, which focuses on the reluctance of large pools of outside capital to bear any risk, leading to the concentration of risk in banks and the correspondingly large impacts when neglected risks surface. This explanation accounts for the failure to distribute risks, but also for many other aspects of the crisis.

Specifically, our model of shadow banking describes securitization without any risk transfer outside the core banks. Securitization allows banks to diversify idiosyncratic risk while concentrating their exposure to systematic risk. This process enables them to expand their balance sheets by essentially funding carry trades with riskless debt. When all risks are recognized ex ante, this market efficiently allocates them to risk-neutral financial intermediaries, and expands opportunities for insurance and intertemporal trade. When tail risks are neglected, however, the shadow banking system is extremely fragile. The trouble is not the realization of neglected risks per se, but the increase in the total amount of risk-taking that securitization facilitates. Securitization magnifies exposure to unrecognized aggregate risks through contracts between intermediaries that, absent neglect, would improve welfare.

One might ask how this mechanism differs from the more basic proposition that banks often finance risky projects, such as mortgages, and occasionally face huge losses when such financing turns sour. After all, banks from Japan in the 1980s to Spain and Ireland in the 2000's became insolvent or nearly insolvent financing speculative investments in real estate that turned out badly even without much securitization. Bank runs are also not a new phenomenon. What is new about securitization is that it enables intermediaries to access enormous pools of short-term capital seeking riskless returns even without government deposit guarantees. By identifying activities in which investors misperceive risks, perhaps because these investors pay too much attention to recent history, financial intermediaries through securitization can finance a lot more risk than they could without it. The cost, of course, is that they bear the residual risk themselves. It is precisely the process of risk control through diversification and securitization that leads to the exposure of all intermediaries to common risks, and generates aggregate instability in excess of what would occur if each bank speculated on its own. Moreover, because the availability of short-term finance is tied directly to the perceived safety of publicly traded securities held by many banks, bank runs quickly turn system-wide. Insurance contracts intended to be risk-reducing end up being risk-enhancing, especially from a systemic point of view.

The risks neglected by market participants tend to be subtle and constantly evolving. For this reason, it is optimistic to expect market regulators to identify these risks when investors and even intermediaries fail to do so. Still, some policy interventions might make the system more stable. The most obvious, if crude, instrument is capital requirements, which can successfully reduce the ability of intermediaries to expand their risky activities even when risks are neglected. Alternatively, regulators might raise a red flag when they see increasing exposure of intermediaries to a particular sector, such as real estate, especially when accompanied by securitization and collateralized borrowing. Regulators might also be

wary of financial innovations such as prime money market funds whose appeal consists of offering higher returns with allegedly no risk. Knowledge of which risks are neglected may not be essential to recognizing the signs of such neglect in the financial system.

7. Proofs

At $t = 0$, a generic intermediary j solves the optimization problem:

$$\max_{(D,I_H,I_L,S_H,S_L,T_H,T_L)} \quad [R\cdot(I_\mathrm{H}+T_\mathrm{H}-S_\mathrm{H})+p_\mathrm{H}(S_\mathrm{H}-T_\mathrm{H})]+$$

$$+[\mathrm{E}_\omega(\pi_\omega)\cdot A\cdot(I_\mathrm{L}-S_\mathrm{L})+\mathrm{E}_\omega(\pi_\omega)\cdot A\cdot T_\mathrm{L}+p_\mathrm{L}(S_\mathrm{L}-T_\mathrm{L})]- \tag{A.1}$$

$$+D-I_\mathrm{H}-I_\mathrm{L}+w_{int}-rD,$$

Subject to:

$$w_{int}+D-I_\mathrm{H}-I_\mathrm{L}-p_\mathrm{H}(T_\mathrm{H}-S_\mathrm{H})-p_\mathrm{L}(T_\mathrm{L}-S_\mathrm{L})\geq 0, \tag{A.2}$$

$$R\cdot(I_\mathrm{H}+T_\mathrm{H}-S_\mathrm{H})+\pi_r\cdot A\cdot T_\mathrm{L}-rD\geq 0, \tag{A.3}$$

$$I_\mathrm{H}-S_\mathrm{H}\geq 0, \tag{A.4}$$

$$I_\mathrm{L}-S_\mathrm{L}\geq 0, \tag{A.5}$$

where we drop subscript j for ease of notation. Denote by μ the multiplier attached to the resource constraint (A.2), by γ the multiplier attached to the riskless debt constraint (A.3), by θ_H and θ_L the multipliers attached to the securitization constraints (A.4) and (A.5), respectively. We also denote by v the multiplier attached to the aggregate constraint $1 - \int_j I_{\mathrm{H},j}\mathrm{d}j \geq 0$, which must be considered by the intermediary when investing the last unit of H. The first derivatives of the Lagrangian with respect to the choice variables are then equal to:

$$I_\mathrm{H}: \quad R-1-\mu+\gamma R-v+\theta_\mathrm{H}, \tag{A.6}$$

$$T_\mathrm{H}: \quad R-p_\mathrm{H}-\mu\, p_\mathrm{H}+\gamma R, \tag{A.7}$$

$$S_\mathrm{H}: \quad -R+p_\mathrm{H}+\mu\, p_\mathrm{H}-\gamma R-\theta_\mathrm{H}, \tag{A.8}$$

$$D: \quad 1-r+\mu-\gamma r, \tag{A.9}$$

$$I_\mathrm{L}: \quad \mathrm{E}_\omega(\pi_\omega)\cdot A-1-\mu+\theta_\mathrm{L}, \tag{A.10}$$

$$T_\mathrm{L}: \quad \mathrm{E}_\omega(\pi_\omega)\cdot A-p_\mathrm{L}-\mu\, p_\mathrm{L}+\gamma\,\pi_r\cdot A, \tag{A.11}$$

$$S_\mathrm{L}: \quad -\mathrm{E}_\omega(\pi_\omega)\cdot A+p_\mathrm{L}+\mu\, p_\mathrm{L}-\theta_\mathrm{L}. \tag{A.12}$$

Together with investor optimization, (A.2) to (A.12) yield the model's equilibrium. The conditions determining investors' optimal consumption-saving problem are easy. Given

investors' preferences [Equation (1)], the marginal benefit for an investor i of lending D_i, purchasing $T_{H,i}$ riskless projects and $T_{L,i}$ pools of risky projects are respectively equal to:

$$D_i: \qquad -1 + r, \tag{A.13}$$

$$T_{H,i}: \qquad -p_H + R, \tag{A.14}$$

$$T_{L,i}: \qquad -p_L + \pi_r \cdot A, \tag{A.15}$$

Consider now what (A.2) to (A.15) imply for the model's equilibrium. First, note that (A.9) and (A.13) imply that in equilibrium $r \geq 1$, otherwise no investor is willing to lend. Thus, the only feasible lending pattern is for investors to lend resources to intermediaries who have productive projects and can therefore afford to pay $r \geq 1$.

Proof of Lemma 1 Consider first how intermediaries optimally finance a riskless investment $I_H > 0$ using borrowing and securitization. With respect to capital suppliers, investors (or lending intermediaries) prefer securitization $T_{H,i}$ when it yields a higher return than bonds D_i, i.e. when $R/p_H > r$. The reverse occurs when $R/p_H < r$. When $R/p_H = r$, capital suppliers are indifferent. On the demand side, if $R/p_H > r$, then by (A.8) and (A.9) intermediaries prefer debt D_j to securitization $S_{H,j}$, if $R/p_H < r$, the reverse is true. In equilibrium it must be that:

$$R/p_H = r, \tag{A.16}$$

namely bonds and securitization should yield the same return. From Equations (A.8) and (A.9) one can also see that when (A.16) holds, the shadow cost of securitizing riskless projects is weakly higher than that of issuing bonds because $\theta_H \geq 0$. We thus focus on equilibria where riskless projects are not securitized, namely $S_H = T_H = 0$ (and $\theta_H = 0$).

Next, consider the securitization of risky projects. Suppose that intermediaries engage in risky investment $I_L > 0$ and securitize $S_L > 0$ of it. Investors buy securitized claims if they yield them more than riskless bonds, i.e. if $\pi_r A/p_L \geq r = R/p_H$. By plugging this condition into Equation (A.11), one finds that if investors demand securitized risky claims $T_{L,i}$, then

intermediaries demand an infinite amount of them, which cannot occur in equilibrium. Formally, if $\pi_r A/p_L \geq r = R/p_H$ the benefit of increasing $T_{L,j}$ is positive, because it is larger than that of increasing $T_{H,j}$ (and the latter benefit must be equal to zero, for riskless projects are not securitized). But then, in equilibrium it must be that $\pi_r A/p_L < r$ and the available securitized risky claims are traded among intermediaries, namely $T_{L,j} = S_{L,j}$. Equations (A.11) and (A.12) show that starting from a no securitization situation (i.e. $\theta_L = 0$), purchasing securitized projects is strictly beneficial (and so $T_{L,j} = S_{L,j} > 0$) if the debt constraint (A.3) is binding, namely when $\gamma > 0$.

Proof of Proposition 1 Since $R \geq E_\omega(\pi_\omega)\cdot A$, investment in H is preferred to that in L if H is available, i.e. when $v = 0$ in (A.6). In this case, the marginal benefit of I_H in (A.6) is larger than that of I_L in (A.10) provided:

$$R - E_\omega(\pi_\omega)\cdot A \geq \theta_L - \theta_H - \gamma R. \qquad \text{(A.17)}$$

Since riskless projects are not securitized ($\theta_H = 0$), Equation (A.17) is satisfied if $\gamma R \geq \theta_L$, i.e. if the riskless project boosts leverage more than securitization. This is true if securitization does not occur (i.e. $\theta_L = 0$) but also if it does. In the latter case, the fact that risky projects are only traded among intermediaries, i.e. $T_{L,j} = S_{L,j}$, calls for (A. 11) to be equal to minus (A.12). This requires $\gamma\pi_r A = \theta_L$ and thus implies $\gamma R \geq \theta_L$. Hence, intermediaries invest in H until investment in such activity is equal to 1. Beyond that limit, intermediaries invest also in L.

Consider the equilibrium when $w_{int} + w \leq 1$. Here $v = 0$ and all wealth goes to finance H and financial constraints are not binding ($\gamma = 0$) since H is self-financing. By plugging $r = 1 + \mu$ from (A.9) into (A.6), we find that $r = R$. Thus, equilibrium prices are ($r = R$, $p_H = 1$, p_L) where $\pi_r\cdot A/R \leq p_L \leq 1$ and quantities are ($D = w$, $I_H = w_{int} + w$, $I_L = 0$, $S_H = S_L = T_H = T_L = 0$). Investors lend their wealth at $t = 0$ by purchasing riskless bonds that promise R at $t = 2$. No lending or trading occurs at $t = 1$, because after ω is learned investors and intermediaries

have the same preferences and value all assets equally. The consumption patterns of intermediaries is $C_0 = C_1 = 0$, $C_2 = Rw_{\text{int}}$, that of investors is $C_0 = 0$, $C_1 = 0$, $C_2 = Rw$.

Consider the equilibrium when $w_{int} + w > 1$. Now activity H is exhausted, i.e. $v > 0$. There are two cases to consider, depending on whether $E_\omega(\pi_\omega)\cdot A$ is higher or lower than one.

1) If $E_\omega(\pi_\omega)\cdot A \leq 1$, then intermediaries do not invest in L. To see this: by Equation (A.10), $I_L > 0$ can only be optimal if securitization is valuable, i.e. if $\theta_L > 0$. For this to be the case, the resale price of the project must be higher than the investment cost, i.e. $p_L \geq 1$. No intermediary is willing to buy at $p_L \geq 1$, as the project yields less than 1. Thus, if $E_\omega(\pi_\omega)\cdot A <$ 1 we have $S_L = T_L = I_L = 0$. In this equilibrium it must be that $r = 1$. If $r > 1$ investors lend all of their wealth w and intermediaries' budget constraint becomes slack ($\mu = 0$) because $w_{int} + w > I_H = 1$. But then equation (A.9) implies $\gamma < 0$, which is impossible. Thus, in equilibrium $r = 1$ and intermediaries' debt can take any value $D \in (1 - w_{int}, \min(w, R))$ by the riskless debt constraint (A.3). For a given D, the consumption of intermediaries is $C_0 = w_{int} + D - 1$, $C_1 = 0$, $C_2 = R - D$, that of investors is $C_0 = w - D$, $C_1 = 0$, $C_2 = D$. Once more, there is neither trading nor lending at $t = 1$.

2) If $E_\omega(\pi_\omega)\cdot A > 1$, intermediaries wish to invest in L. There are three cases.

2.1) If w is sufficiently low, intermediaries finance L with a slack debt constraint, i.e. $\gamma = 0$, and without securitization, so that $\theta_L = 0$ and $S_L = T_L = 0$. In this case, (A.9) and (A.10) imply $r = E_\omega(\pi_\omega)\cdot A > 1$. As a consequence, investors lend all of their wealth and $D = w$ and $I_L = w + w_{int} - 1$. The riskless debt constraint (A.3) is slack for $R \geq E_\omega(\pi_\omega)\cdot A\cdot w$, so this allocation is an equilibrium for $w \in (1 - w_{int}, R/E_\omega(\pi_\omega)\cdot A]$.

2.2) If w increases further, intermediaries start to securitize risky projects, so that $S_L = T_L > 0$, but not yet to the full amount of investment, i.e. $\theta_L = 0$. In this case because of $\theta_L = \gamma\, \pi_r\, A$ by (A.11) and (A.12), the debt constraint holds with equality even though there is no shadow cost (i.e. $\gamma = 0$), so that it is still the case that $r = E_\omega(\pi_\omega)\cdot A > 1$ by (A.9) and (A.10).

Investors lend w to intermediaries and the equilibrium level of securitization is determined along the debt constraint (A.3) as follows:

$$E_{\omega}(\pi_{\omega})\cdot A\cdot w = R + \pi_r\cdot A\cdot S_{\mathrm{L}}, \tag{A.18}$$

which implicitly identifies the level of securitization S_{L} increasing in w. This allocation constitutes an equilibrium (thus satisfying $\theta_{\mathrm{L}}= 0$) only if $S_{\mathrm{L}} < \mathrm{I_L} = w + w_{int} - 1$, which corresponds to the condition:

$$w \leq w^* \equiv \frac{R/A + \pi_r(w_{\mathrm{int}} - 1)}{\mathrm{E}_{\omega}(\pi_{\omega}) - \pi_r}. \tag{A.19}$$

Condition (A.19) implies that this configuration is an equilibrium for $w \in (R/\mathrm{E}_{\omega}(\pi_{\omega})\cdot A, w^*]$.

2.3) If w increases beyond w^*, securitization hits the constraint $S_{\mathrm{L}} = I_{\mathrm{L}}$, i.e. $\theta_{\mathrm{L}}> 0$. In this case the debt constraint is binding, i.e. $\gamma > 0$, and the interest rate drops to $r < \mathrm{E}_{\omega}(\pi_{\omega})\cdot A$ by (A.9) and (A.10). As long as $r \geq 1$, investors lend w to intermediaries and the equilibrium interest rate is implicitly determined along the debt constraint (A.3) as follows:

$$r\cdot w = R + \pi_r\cdot A\cdot(w + w_{int} - 1), \tag{A.20}$$

which implicitly identifies a function $r(w)$ that monotonically decreases in w and approaches $r = \pi_r\cdot A$ as $w \to +\infty$. Due to A.1, since $\pi_r\cdot A < 1$ there is a threshold level of wealth w^{**} such that $r(w^{**}) = 1$. Obviously then, intermediaries cannot absorb investors' wealth beyond w^{**}.

Once more, in all equilibria 2.1) – 2.3) nothing happens to lending and trading at t = 1. It is straightforward to derive agents' consumption patterns.

Proof of Proposition 2 The construction of the equilibrium is identical to the one discussed in the proof of proposition 1, except the now we replace π_r with π_d in the debt constraint (A.3) and investors' return $\mathrm{E}_{\omega}(\pi_{\omega})$ on $\mathrm{T_{L,j}}$ in (A.15) with $\mathrm{E}_{\omega}^{\mathrm{LT}}(\pi_{\omega})$ in the intermediary's objective. Compare now the extent of securitization under local thinking and under rational expectations. Clearly, we have that $S_{\mathrm{L}}^{\mathrm{LT}} > S_{\mathrm{L}}$ for all w provided $w^{*\mathrm{LT}} < w^*$ because in this case

local thinking intermediaries max out securitization for lower values of w. Since at these values the level of investment is the same under LT and RE, securitization is higher in the former regime. After some algebra, one can find that $w^{*LT} < w^*$ for all $w_{int} \leq 1$ provided:

$$\mathrm{E}_{\omega}^{LT}(\pi_{\omega}) - \pi_d > \mathrm{E}_{\omega}(\pi_{\omega}) - \pi_r \Leftrightarrow \varphi_g \varphi_r (\pi_g - \pi_d) > (\varphi_g + \varphi_d)^2 (\pi_d - \pi_r),$$

which is fulfilled provided the expectational error $(\pi_d - \pi_r)$ is small. If the condition above is not met, it might be that $w^{*LT} > w^*$. In such a case, for w on the left neighbourhood of $R/\mathrm{E}_{\omega}(\pi_{\omega}| t = 0)\cdot A$ securitization is higher under LT (there is no securitization under RE yet). For w above w^{**}, investment and securitization are also higher under LT. However for w intermediate securitization might be higher under RE.

Consider now the interest rate. When $w^{*LT} > w^*$ it is obvious that $r^{LT} \geq r$, but even if $w^{*LT} < w^*$ it is easy to see that $r^{LT} > r$. To see that, consider the interest rate prevailing under local thinking when $w = w^*$. Indeed, if $r^{LT} < r$ *at any* wealth level, then it must be that $r^{LT} < r$ also at $w = w^*$. It is easy to see that the fact that $(\pi_d - \pi_r) > 0$ implies that at $w = w^*$ we always have $r^{LT} > r$ confirming that the interest rate is weakly higher under local thinking.

Finally, consider leverage D. It is immediate to see that until wealth level w^{**} leverage and investment are the same under LT and RE (i.e. D = w), but that for $w > w^{**}$ leverage and investment are strictly higher under LT, confirming that $D^{LT} \geq D$. Indeed, since $\pi_r \cdot A < 1$ we have that $w^{**} = [R - \pi_r \cdot A(1 - w_{int})]/(1 - \pi_r \cdot A)$, which increases in π_r, implying that $w^{**} < w^{**LT}$.

Proof of Proposition 3 We again focus on the case where $\mathrm{E}_{\omega}(\pi_{\omega}| t = 0)\cdot A > 1$. From the proof of Proposition 1 we know that for $w \leq R/\mathrm{E}_{\omega}(\pi_{\omega}| t = 0)\cdot A$ there is no securitization and thus fragility does not arise [i.e. we are in cases a) and b)]. For $w \geq w^{*,LT} \equiv \dfrac{R/A + \pi_d (w_{int} - 1)}{\mathrm{E}_{\omega}^{LT}(\pi_{\omega} | t = 0) - \pi_d}$ we know that securitization is maximal, namely $I_H^{LT} = S_L^{LT}$. We are in case d), in which

intermediaries have no spare resources at t = 1. In this case, intermediaries cannot buy back any of the debt claims from investors, and in equilibrium $V_1 = (1-q_l)\pi_r \cdot A \cdot S^{LT}_{L,j}$, which is investors' reservation value. Plugging equilibrium values, we find that in this case:

$$V_1 = (1-q_l)\cdot\pi_r\cdot A\cdot(w_{int} + \min(w, w^{**,LT}) - 1)$$

where $w^{**,LT} = [R - \pi_d \cdot A\cdot(1 - w_{int})]/(1 - \pi_d \cdot A)$.

The most interesting case arises when w lies in $(R/\mathrm{E}_\omega(\pi_\omega | t = 0), w^{*,LT})$. In this range, securitization is pinned down by condition $\mathrm{E}_\omega(\pi_\omega | t = 0)\cdot A\cdot w = R + \pi_d \cdot A\cdot S^{LT}_{L,j}$, which implies:

$$I^{LT}_{L,j} - S^{LT}_{L,j} = \frac{R/A}{\pi_d} - (1 - w_{int}) - (\varphi_g + \varphi_r)\left(\frac{\pi_g}{\pi_r} - 1\right)w,$$

which decreases in investors' wealth, attaining a maximum value in the relevant wealth interval of $I^{LT}_{L,j} = w_{int} + R/\mathrm{E}_\omega(\pi_\omega | t = 0) - 1$ and reaching a minimum of 0 at $w^{*,LT}$.

Since the wealth available to intermediaries at any w is equal to $q_l \cdot [A\cdot(I^{LT}_{L,j} - S^{LT}_{L,j}) - (\pi_d - \pi_r)A\, S^{LT}_{L,j}]$, the equilibrium value of risky debt V_1 as a function of $(I^{LT}_{L,j} - S^{LT}_{L,j})$ can be in one of the following configurations. If $q_l \cdot [A\cdot(I^{LT}_{L,j} - S^{LT}_{L,j}) - (\pi_d - \pi_r)A\, S^{LT}_{L,j}] > (1-q_l)\mathrm{E}(\pi_\omega | q_l)\cdot A\cdot S^{LT}_{L,j}$, then the market value of risky debt is equal to intermediaries' reservation value $(1-q_l)\mathrm{E}(\pi_\omega | q_l)\cdot A\cdot S^{LT}_{L,j}$. If $q_l \cdot [A\cdot(I^{LT}_{L,j} - S^{LT}_{L,j}) - (\pi_d - \pi_r)A\, S^{LT}_{L,j}] < (1-q_l)\pi_r \cdot A\cdot S^{LT}_{L,j}$, then the market value of risky debt is equal to investors' reservation value. Otherwise, the market value of risky debt is equal to intermediaries' wealth $q_l \cdot [A\cdot(I^{LT}_{L,j} - S^{LT}_{L,j}) + (\pi_d - \pi_r)A\, S^{LT}_{L,j}]$.

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