

A Securitization-based Model of Shadow Banking with Surplus Extraction and Credit Risk Transfer

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Abstract

The paper provides a theoretical model that supports the search for yield motive of shadow banking and the traditional risk transfer view of securitization. The shadow banking system, which is worth more than \$60 trillion (more than the joint GDP of U.S., E.U. and China) and accounts to almost a third of the U.S. systemic risk, is indeed an important provider of high-yielding AAA-rated asset-backed securities via the underlying securitized credit intermediation process. Investors' sentiment on future macroeconomic conditions affects their reservation prices related to the demand for securitized assets: high-willing payer ("optimistic") investors are attracted to these investment opportunities and offer to intermediaries a rent extraction incentive. When the outside wealth is high enough that securitization occurs, asset-backed securities are used by intermediaries to extract the highest feasible surplus from optimistic investors and to transfer credit risk to them. Shadow banking is pro-cyclical and securitization allows risks to be spread among market participants coherently with their risk attitude.

Keywords: *securitization, shadow banking, credit risk transfer, reservation prices*

JEL classification: *E44, G21, G23*

1 Introduction

During the last four decades we witnessed to fundamental changes in financial techniques and financial regulation that paved the way for the development of innovative financial instruments and the establishment of non-bank financial entities.¹ This wave of financial innovation allowed non-bank financial institutions to compete with traditional banks in performing bank-like activities at

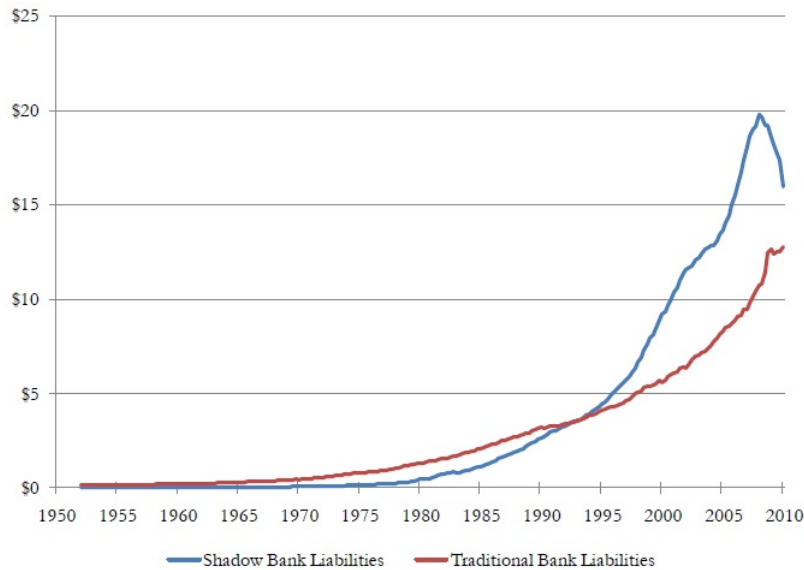
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¹Miller (1986).

low costs and in offering a broad range of high-yield investment opportunities. Such changes have gradually transformed the “originate-to-hold” banking model into a “originate-to-distribute” model based on a *securitized credit intermediation process* that relies upon *i)* securitization techniques, *ii)* securities financing transactions, and *iii)* mutual funds industry.²

The securitized credit intermediation process is the backbone of the modern forms of non-bank financial intermediation that “...take(s) place in an environment where prudential regulatory standards and supervisory oversight are either not applied or are applied to a materially lesser or different degree than is the case for regular banks engaged in similar activities” (FSB 2011), simply known as the *shadow banking system*. Its origin can be traced back to the mid-1900 in the United States, the country that has always been the worldwide leader of the sector. The phenomenon spread to other majors financial systems around the world afterwards: driven by regulatory arbitrage, financial innovation, and the search for high-yield investment opportunities, the boom of shadow banking started in the mid-1990s and lasted until the outbreak of the recent financial crisis.³ An overview of its trend and dimension is provided by Figure 1.

Figure 1: Shadow bank liabilities and traditional bank liabilities in the U.S.



US\$ trillion. Source: Pozsar et al. (2010), Figure 1.

According to the IMF estimates, at the end of 2014 the global shadow banking system was worth \$68 trillion⁴ (more than the joint GDP of U.S., E.U. and China) and accounted to almost a third of the overall U.S. systemic risk.⁵

²Gorton and Metrick (2010, 2012).

³Pozsar et al. (2010), IMF (2014).

⁴FSB (2015a). This is the “broad measure” of shadow banking, consisting of the total assets held by other financial intermediaries (including all financial intermediaries that are not classified as traditional banks, central banks, insurance companies, pension funds, public financial institutions and financial auxiliaries).

⁵IMF (2014).

The purpose of this paper is to provide a theoretical model that captures aspects related to i) securitization involving real credit risk transfer, and to ii) the search for yield motive and the pro-cyclical nature of shadow banking.

Securitization generally involves credit risk transfer by allowing financial intermediaries to put their assets off-balance sheets to a special-purpose vehicle (SPV) according to the “true” sale accounting principle: this is known as the *traditional risk-transfer view* of asset securitization. On the opposite, if the sponsoring financial firm (originator) provides credit enhancements to the SPV or buys back part of the securitized assets (usually junior tranches), the credit risk is totally or partially retained on the sponsor’s balance sheet, according to the *imperfect credit risk-transfer view* (Shin 2009, Acharya et al. 2013).⁶

Instead of being driven by the demand for safe short-term debt collateralized by senior securitized assets (Gennaioli et al. 2013), shadow banking is driven by the demand for securitized assets from outside investors (in particular the high-willing payer ones). The search for principal safety and liquidity motive⁷ is thus replaced by the search for yield motive.

The model lasts two periods $t = 0, 1$ and is featured by two broad categories of agents: a continuum of intermediaries and a continuum of outside investors both normalized to one. Intermediaries are risk-neutral and act both as originators and as special-purpose vehicles. They originate both safe (prime) and risky (sub-prime) loans which are financed by their own equity and by the resources raised through the issuance of riskless debt claims, such as deposits. Risky loans are subject to:

- i)* idiosyncratic risk, i.e. the intermediary-specific credit risk connected to its borrowers;
- ii)* aggregate risk of the economy, connected to the global macroeconomic conditions that may occur at $t = 1$ (growth, downturn or recession).

Following the rationale by Gennaioli et al. (2013), we assume that asset securitization allows intermediaries to diversify and eliminate the idiosyncratic risk only when asset-backed securities (ABS) are traded among themselves. This implies that an intermediary cannot diversify idiosyncratic risk through its own projects but it must buy those of others.

Investors consist of two types, the “pessimistic” and the “optimistic” ones. According to their type, they expect to receive the highest, or the lowest, return on their portfolio of risky assets, associated, respectively, to the realization of the best state (growth) or of the worst state (recession) of the world. Investors act as a sort of programmed agents that suffer of bounded rationality. Their sentiment on future macroeconomic conditions affects the reservation prices related to their demand for financial securities: the optimistic ones are willing to pay higher prices than the pessimistic ones.

Riskless loans are financed for first, but they are supposed to be limited in the economy. When investors’ wealth is low, only riskless debt is issued and the returns from safe loans are sufficient to guarantee repayment of debt. At high levels of wealth, all of the prime borrowers are satisfied and

⁶Acharya et al. (2013) show that the severity of the recent financial crisis laid in the fact that conduits provided little risk transfer, since losses from conduits remained with banks instead of outside investors.

⁷Pozsar (2011).

intermediaries start financing the sub-prime customers (risky loans), and in turn start securitizing their assets. Optimistic investors are attracted to the high-yield opportunity of investing in securitized assets and intermediaries are attracted to the high-willingness to pay of optimistic investors. At this point the returns on safe projects are not longer enough to repay additional units of debt, and intermediaries face an opportunity cost expressed by the giving up of the proceeds related to the sale of ABS in order to issue more units of debt by pledging securitized assets as further collateral. We show that intermediaries prefer to sell ABS to optimistic investors in order to extract their highest feasible surplus. By doing so, intermediaries also transfer the idiosyncratic risk.

Optimistic investors are crucial for our results, since they are basically offering to financial intermediaries a rent-extraction incentive thanks to financial innovation. Their presence allows our model to achieve the following outcomes:

- ABS are intended for sale purposes (supporting the search for yield motive of the shadow banking literature), since optimistic investors are attracted to the high-yield opportunity of investing in ABS, and intermediaries are attracted to high-willing payer optimistic investors and want to extract the largest possible surplus;
- intermediaries transfer the idiosyncratic risk to optimistic investors, and losses, if any, are borne by this type of investors (supporting the risk transfer motive of securitization);
- shadow banking is pro-cyclical and allows credit risk to be distributed among agents coherently with their risk attitude.

Related literature. Our model is mainly motivated by the outcomes in [Gennaioli et al. \(2013\)](#) and contributes to the literature by offering an economic rationale for securitization involving real credit risk transfer and for the search for yield motive of shadow banking. Securitization is not intended as a mere way to diversify the credit risk of the underlying assets pool and to provide safe collateral to investors; rather it is driven by gain purposes, since intermediaries can use securitized assets to extract the highest feasible surplus from high-willing payer investors. The sale of ABS to outside investors, allows our model to support the inherent risk transfer motive of securitization.

The [IMF \(2014\)](#) has recently provided empirical evidence that the search for high-yield opportunities contributes to the growth of the shadow banking system. The shadow banking system is, indeed, an important provider of structured finance instruments via the securitized credit intermediation process. Such instruments, that satisfy a large range of risk/return preferences, are very attractive to outside investors because they are mostly in the form of high-yielding AAA-rated securities (such as ABS or CDOs) that are perceived to be as safe as other similar non-securitized fixed income instruments ([Coval et al. 2009](#), [Jackson 2013](#)). The seek for these high-yield instruments is usually encouraged by a context of relatively low interest rates that shrinks the demand for treasury or corporate bonds, as it actually happened (in particular in the U.S.) before the outbreak of the recent financial crisis ([Goda et al. 2013](#), [Goda and Lysandrou 2014](#)).

The model is related to the literature on behavioral finance that focuses on investors' sentiment. Investors' sentiment represents a candidate explanation for different asset valuations across investors.

Investors' evaluation of asset characteristics is usually non-rational and mostly dependent on their feelings (sentiment) on past and future macroeconomic conditions ([Barberis et al. 1998](#), [Barberis and Thaler 2003](#), [Lee et al. 1991](#)).

The model supports the pro-cyclical nature of shadow banking ([Adrian and Shin 2009, 2010](#), [FSB 2011, 2012](#)): it amplifies benefits and risks of the financial industry in “good” and in “bad” times, respectively. The model also supports the idea that shadow banking can positively affect the whole financial system ([Pozsar et al. 2010](#)): securitization allows risk to be spread among market participants coherently with their risk attitude. This, in turn, allows to improve the safety of the financial system by allocating the financial risks to investors that are best able to hold risks ([Acharya and Schnabl 2010](#)). Securitization can increase the efficiency and completeness of the financial markets ([Cheng 2002](#)). When securitization involves real credit risk transfer (achieved through the “true sale of an asset”) is, indeed, an important way for the originator to limit its exposure to certain borrowers, loan types and geographies on its balance sheet. Furthermore, securitization can increase the availability of credit to the real economy and diversifies risks through converting non-marketable financial assets into securities that are traded by a wide range of investors. The restructuring of the original pool of assets into different tranches allows credit risk to be tailored according to investors appetites ([FSB 2015b](#)).

The model is related to the traditional financial innovation literature. [Allen and Gale \(1988\)](#) show that securities are manufactured to be targeted at specific types of investors according to their marginal valuations: in equilibrium, securities are held by the type of investor that values them most. From this standpoint, the model also captures aspects connected with incentives in trades as in [Grossman and Stiglitz \(1980\)](#): the incentives to trade arise primarily from differences in tastes (risk aversions), endowments, or beliefs.

The model also captures rent-extraction implications related to financial innovation. [Korinek \(2015\)](#) explores the hypothesis that financial innovation is intended to extract rents from the public sector, and shows that financial innovation allows more efficient rent extraction.

The paper is organized as follows.

Section 2 describes the model setup, highlighting its main features and analyzing agents' behavior. In Section 3 we investigate agents' investment choices at $t = 0$, while in Section 4 the equilibrium analysis at $t = 0$. Section 5 analyzes the outcomes at $t = 1$ after the state of the world has occurred. Section 6 concludes.

2 Model setup

The model has the following main features:

- two dates $t = 0, 1$;
- a measure one of risk-neutral intermediaries;
- a measure one of investors;

- the whole economy is subject to the aggregate risk connected to the global macroeconomic conditions (growth, downturn or recession) that may occur at $t = 1$.

The timing of the model works as follows.

At $t = 0$, agents makes their optimal investment decisions and trade securities among them. At $t = 1$ the state of the world ω is revealed and learned by everybody; the output from projects is produced and distributed to agents.⁸ The world ends.

Three possible final states may occur at $t = 1$, such that $\Omega_1 \equiv \{g, d, r\}$: g captures a “growth” state in which most investments succeed, d a less productive “downturn”, and r an even less productive “recession”. At $t = 0$, it is known that state $\omega \in \Omega_1$ may occur with probability $\varphi_\omega \in [0, 1]$, with $\sum_\omega \varphi_\omega = 1$. φ_ω captures the aggregate risk to which the whole economy is subject to.

2.1 Intermediaries

The representative risk-neutral intermediary j is indifferent between consuming at $t = 0, 1$, and at $t = 0$ it receives an endowment $w_{int} \in (0, 1)$.

At $t = 0$, the behavior of each intermediary can be described as consisting of three stages:

- 1) raises funds through the issuance of D_j units of a riskless debt security promising to repay rD_j at $t = 1$, with $r \geq 1$;
- 2) uses its own wealth w_{int} and the resources raised to finance two projects:
 - a riskless project H, which yields the sure amount $R \cdot I_{H,j}$ at $t = 1$, but which is limited in supply (formally $\int_j I_{H,j} dj \leq 1$) according to the principle of the marginal efficiency of capital;
 - a risky project L, whose pay-off at $t = 1$ is given by:

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

with $\omega \in \Omega_1 \equiv \{g, d, r\}$;

- 3) sells (securitizes) $S_{H,j}$ and $S_{L,j}$ units of riskless and risky projects, respectively, and then may buy $T_{H,j}$ and $T_{L,j}$ units from other intermediaries.⁹

$I_{H,j}$ and $I_{L,j}$ denote the units invested in each project. We can think to these investments opportunities as the loan origination stage for the intermediary, where the two projects denote respectively *prime loans* and *sub-prime loans*. There are no storage opportunities.

⁸At $t = 1$, intermediaries can neither raise new funds nor re-trade existing securitized projects, and investors cannot re-optimize their consumption decisions.

⁹Without loss of generality we consider the originator and the SPV as the same entity, and securitization is thus represented by the true sale of assets to a third party, either outside investors or intermediaries.

The return on the risky project is *i.i.d.* across intermediaries, and $\pi_\omega \in [0, 1]$ captures the idiosyncratic risk connected to such projects, i.e. the share of risky investments that might succeed in ω , or simply the share of potentially succeeding intermediaries in ω . Such a risk denotes the default risk of the underlying borrowers, and it can be diversified through asset securitization. At $t = 0$ the expected return on risky projects is given by $E_\omega(\pi_\omega)A$.

Following [Gennaioli et al. \(2013\)](#), we assume that:

Assumption 1. *An intermediary cannot diversify idiosyncratic risk through its own, but it must buy securitized assets of other intermediaries. Securitization is thus supposed to fully eliminate the idiosyncratic risk when securitized assets are traded among intermediaries.*¹⁰

Here follows other assumptions on probabilities and returns.

Assumption 2. *$R > E_\omega(\pi_\omega)A$, so that intermediaries strictly prefer to invest in the riskless project rather than in the risky one.*¹¹

Assumption 3. *$E_\omega(\pi_\omega)A > 1$, so that investment in the risky project is expected to be strictly profitable for intermediaries.*

Assumption 4. *$\pi_d A < 1$, which implies that if either the state of downturn or recession will occur, the risky project will yield a return smaller than its cost of investment.*

Assumption 5. *$\pi_g A > \pi_d A > \pi_r A$, meaning that the probability of success is higher in better states of the world.*

Besides the two investment projects available to intermediaries, there are two marketable financial instruments in the economy: riskless debt claims and asset-backed securities.

Riskless debt is a safe security that must be pledged only by safe cash flows collateral, which in the economy are represented by the return on riskless projects H and by the return on the senior tranche of ABS (formally $\pi_r A$, i.e. the return in the worst state of the world). Riskless debt is a pure fund-raising instrument and can be thought as a deposit claim through which investors temporarily park their savings into banks.

At $t = 0$, intermediaries can securitize their assets. The representative intermediary receives the price p_H or p_L for each unit of projects H or L he securitizes. The resulting asset-backed securities can be sold either to investors or to other intermediaries.

¹⁰Intermediaries are meant to be multi-seller conduits which, in reality, are considered less risky than other conduit types.

¹¹According to the traditional risk-return relationship, risky investments should yield higher returns than riskless ones. However, we suppose that activity L is a marginal risky investment that intermediaries wish to undertake only after better investment opportunities are exhausted, i.e. once all of the prime customers have been satisfied ([Gennaioli et al. 2013](#)). This rationale is backed by the principle of the marginal efficiency of capital, and it is formalized through the assumption that the safe activity H is limited supply.

Following [Gennaioli et al. \(2013\)](#), at $t = 0$ the representative intermediary j maximizes its expected profits¹²

$$\begin{aligned} \max_{\{I_H, T_H, S_H, D, I_L, T_L, S_L\}} \Pi_{int} = & [R \cdot (I_H + T_H - S_H) + p_H \cdot (S_H - T_H)] \\ & + [E_\omega(\pi_w)A \cdot (I_L - S_L) + E_\omega(\pi_w)A \cdot T_L + p_L \cdot (S_L - T_L)] \\ & + D \cdot (1 - r) + w_{int} - I_H - I_L \end{aligned} \quad (2)$$

subject to the following constraints

$$w_{int} + D + p_H S_H + p_L S_L \geq I_H + I_L + p_H T_H + p_L T_L \quad (3)$$

$$R \cdot (I_H + T_H - S_H) + \pi_r \cdot A \cdot T_L \geq rD \quad (4)$$

$$I_H \geq S_H \quad (5)$$

$$I_L \geq S_L \quad (6)$$

$$\int_j I_{H,j} dj \leq 1 \quad (7)$$

taking prices (r, p_H, p_L) as given.

We brief explain the previous expressions, starting from the expected profits.

The term in the first square brackets is the (sure) return that the intermediary will earn at $t = 1$ on its portfolio of riskless projects H (for the net amount $I_H + T_H - S_H$), plus the net proceeds at $t = 0$ deriving from the trade of securitized riskless projects¹³ $(S_H - T_H)$ at the price p_H . The term in the second square brackets captures the payoff for risky projects, with the key remark that the expected return on the portfolio of risky investment $E_\omega \pi_w A \cdot (I_L - S_L)$ is kept distinct from the return on securitized risky projects¹⁴ bought in the market, $E_\omega \pi_w A \cdot T_L$. From the standpoint of the risk-neutral intermediary, $(I_L - S_L)$ and T_L yield the same average return but have different risk profiles. The intermediary's own investment $(I_L - S_L)$ is subject to both aggregate and idiosyncratic risk: in state ω it yields A with probability π_ω and zero otherwise. In contrast, the holdings of securitized risky projects are subject only to aggregate risk: T_L include part of each intermediary's investment project, whose expected return $\pi_\omega A$ is not affected by idiosyncratic risk. The second row's term also includes the net proceeds at $t = 0$ deriving from the trade of risky ABS. Please note that the securitization of riskless projects creates no benefit to intermediaries since these securities yield the same sure return R as riskless projects H. In contrast, the securitization of risky projects may allow intermediaries to diversify idiosyncratic risk in their balance sheets, and creates other investment opportunities to investors. The last row of equation (2) denotes the intermediary's net position from

¹²We drop the subscript j to ease the notation. Later we will use the subscript *int* to identify variables related to intermediaries. A more technical and rigorous presentation of the intermediary's optimization problem is given in the Mathematical Appendix, which is available from the author on request.

¹³Also securitized prime loans.

¹⁴Also securitized sub-prime loans.

debt issuance and repayment plus the intermediary's equity, and minus the outflow of prime and sub-prime loans originated at $t = 0$.

Let us analyze the constraints.

Resource constraint. Constraint (3) tells us that the intermediary's resources at $t = 0$, given by its own and borrowed funds plus the revenue from the sale of its own projects, must be greater or equal than the total amount of loans originated plus the expenditure for the purchase of securitized securities from other intermediaries.

Debt constraint. At $t = 1$, the intermediary must be able to repay principal and interest to its debt holders. This implies that the 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. The intermediary can pledge to its creditors the following resources:

- i) the sure return on its net holdings of prime loans $R \cdot (I_H + T_H - S_H)$;
- ii) the return from its holdings of idiosyncratic risk-free ABS¹⁵ evaluated at the worst possible state of the world, i.e. $\pi_r \cdot A \cdot T_L$.¹⁶

Neither the return on non-securitized risky projects $(I_L - S_L)$,¹⁷ nor the upper-side return of securitized risky projects (i.e., $\pi_g - \pi_r$) can be used as further collateral for debt payments: if so, riskless debt would not be "riskless" anymore.

Feasibility constraints. Constraints (5) and (6) concern about the feasibility of securitization: intermediaries cannot securitize more than the amount of the loans originated.¹⁸

Limited supply of riskless projects. The final constraint denotes that prime customers are limited in the economy.

2.2 Investors

There is a continuum of outside investors i of total mass equal to one. $\alpha \in [0, 1]$ and $(1 - \alpha)$ denote, respectively, the shares of investors belonging to the "pessimistic" and to the "optimistic" type. Investors save by buying the following financial claims from intermediaries:

- i) riskless debt, promising a sure return $r \geq 1$ at $t = 1$;¹⁹
- ii) securitized riskless projects, which yield at $t = 1$, the same sure return R on riskless projects;
- iii) securitized risky projects, whose expected return is $E_\omega(\pi_\omega)A$.

¹⁵If the intermediary holds risky ABS on its balance sheet, it means that he has bought such securities from other intermediaries, thus allowing idiosyncratic risk to be diversified according to Assumption 1.

¹⁶Such idiosyncratic risk-free ABS can be interpreted as a senior tranche that pays out for sure at least $\pi_r A$.

¹⁷Non-securitized risky projects are vulnerable to the idiosyncratic risk of yielding zero, and thus they cannot support riskless debt issuance.

¹⁸Intermediaries do not re-securitize portions of the acquired pool T_L since it is already diversified and there is no benefit from doing so. Formally, the model does not allow for further stages of securitization, such as the creation of collateralized debt obligations (CDOs).

¹⁹We assume that investors cannot supply riskless debt, formally $D_i \geq 0$.

Investors' aggregate endowment is assumed to be large enough to meet all funding needs of intermediaries.

The generic consumption streams of the representative investor i are given by:

$$C_{0,i} = w - D_i - p_H T_{H,i} - p_L T_{L,i} \quad (8)$$

$$C_{1,i} = rD_i + RT_{H,i} + E_\omega(\pi_\omega)AT_{L,i} \quad (9)$$

where D_i , $T_{H,i}$, and $T_{L,i}$ denote, respectively, the demand for riskless debt, riskless and risky securitized projects from the representative investor i . The $t = 1$ consumption stream is state contingent: uncertainty is attached to the portfolio of securitized risky projects, whose return is subject to both idiosyncratic and aggregate risks. If investors hold securitized risky assets, it implies that intermediaries have transferred to investors the credit risk related to underlying sub-prime borrowers.

We shape investors' behavior in the same way as in [Gennaioli et al. \(2013\)](#)²⁰: investors act as “programmed agents” who expect to receive, at $t = 0$, a specific payoff on their portfolio of risky assets. Investors α are “pessimistic” in the sense that, ex-ante, they value future stochastic consumption streams at their worst-case scenario, thus obtaining the lowest payoff associated with the regression state, while “optimistic” investors $(1 - \alpha)$ value consumption streams at their best-case scenario, thus obtaining the highest payoff associated with the growth state. The labels “pessimistic” and “optimistic” allow us to capture the behavior that market participants usually have in real financial markets, which is mainly driven by their sentiment on future macroeconomic conditions.²¹ The idea is that investors sentiment affects their investment decision at $t = 0$ by determining the reservation prices related to the demand of securitized risky assets. We suppose that optimistic investors are perfectly aware of the risk they may potentially bear and of the losses they may incur to at $t = 1$.

According to its type, at $t = 0$ the representative investor maximizes its expected payoff with respect to D_i , $T_{H,i}$ and $T_{L,i}$. Markets for debt and securitized securities clear at given competitive prices r , p_H , and p_L .

At $t = 0$, the representative pessimistic investor expect to receive the following payoff:²²

$$\Pi_\alpha = w - D_\alpha - p_H T_{H,\alpha} - p_L T_{L,\alpha} + rD_\alpha + RT_{H,\alpha} + \pi_r AT_{L,\alpha} \quad (10)$$

where the true expected value on risky ABS is replaced by the return associated with the realization of the worst state of the world, i.e. $\omega \equiv r$.²³

²⁰The model of [Gennaioli et al. \(2013\)](#) does not include optimistic investors. The authors only analyze the behavior of pessimistic investors, to which they refer as “infinitely risk-averse” ones. We follow their rationale in order to shape the opposite behavior of optimistic investors.

²¹This is what actually happened before the recent financial crisis, where almost no one was expecting that an extremely severe event would have occurred in the short-term. Agents had neglected the so-called tail risk, see [Gennaioli et al. \(2012, 2013\)](#).

²²Henceforth we will drop the subscript i to ease the notation.

²³Pessimistic investors expect to suffer the maximum aggregate risk. They essentially set $\varphi_r = 1$ and thus their expected return on risky projects collapses to $\pi_r A$.

At $t = 0$, the representative optimistic investor expect to receive the following payoff:

$$\Pi_{1-\alpha} = w - D_{1-\alpha} - p_H T_{H,1-\alpha} - p_L T_{L,1-\alpha} + r D_{1-\alpha} + R T_{H,1-\alpha} + \pi_g A T_{L,1-\alpha} \quad (11)$$

where the true expected value on risky ABS is replaced by the return associated with the realization of the best state of the world, i.e. $\omega \equiv g$.²⁴

According to the available supply, investors' payoff is maximized for an infinite amount of each financial instrument.²⁵

3 Investment choices at $t = 0$

In this Section we investigate the determination of the investment decision for every agent according to their reservation prices and to the financial products available in the economy.

Intermediaries choose i) whether to invest first in the riskless project or in the risky one, ii) whether to securitize or not assets, and iii) whether to buy or not asset-backed securities. Investors choose whether to buy riskless debt securities or ABS.

According to Assumption [2] we already know that intermediaries strictly prefer to finance prime loans rather than sub-prime loans.

Riskless debt and securitized assets are the instruments whereby intermediaries can raise funds from investors. However, ABS can be issued only if some prime (project H) or sub-prime (project L) loan has been already financed by intermediaries. Intermediaries will, therefore, initially raise funds from investors only through riskless debt issuance; the amount of riskless debt issued by intermediaries will be determined later in Section 4.

Securitized riskless projects. Intermediaries are indifferent between securitizing or not projects H, since the marginal benefits related to the sale and the purchase of these securities are equal. We thus focus on equilibria where riskless projects are not securitized, i.e. with $S_H = T_H = 0$. The result can be also obtained logically: riskless projects bear no risk, and since securitization works in order to eliminate the idiosyncratic risk, there is no need to securitize prime loans. The only securitized securities available in the economy are the risky ones. Henceforth, when using the term asset-backed securities we will refer to securitized risky (sub-prime) assets.

Securitized risky projects. According to Assumption [3], intermediaries wish to invest in activity L, since the cost of one investment unit is one.

Let us suppose that $I_L = S_L > 0$, that is, intermediaries invest in risky projects and securitize all of them. Without loss of generality, we suppose that the securitization of risky (sub-prime) loans is always beneficial to intermediaries: apart from the fact that ABS can be sold to investors or not, intermediaries can trade ABS among themselves and thus benefit from risk diversification. It would be irrational for risk-neutral intermediaries to keep sub-prime loans on their balance sheets.

²⁴Optimistic investors expect not to suffer the aggregate risk at all. They essentially set $\varphi_g = 1$ and thus their expected return on risky projects collapses to $\pi_g A$.

²⁵A more technical and rigorous presentation of investors' behavior is given in the Mathematical Appendix.

Formally, if $I_L > 0$ we have $I_L = S_L$. This lead us to state that intermediaries strictly prefer to follow the “originate-to-distribute” strategy rather than the “originate-to-hold” one.

Securitized risky projects are supplied by intermediaries and they can be potentially demanded by every agent of the economy. Pessimistic investors are willing to demand only the safest tranche, i.e. the one whose return is guaranteed even in the worst state of the world ($\pi_r A$), while optimistic investors and intermediaries have no particular preferences with this regard.

The investment decisions are determined by analyzing the reservation prices of every agent.²⁶ Intermediaries are the unique supplier of ABS, and they can also demand them. In order to issue ABS, intermediaries must finance some risky projects for first, securitize them, and finally sell them to potential buyers, either intermediaries or outside investors.

The intermediaries’ sale reservation price is given by:

$$p_L \geq \frac{E_\omega(\pi_\omega)A + \Theta_L}{r(1 + \gamma)} = p_{L,int}^S \geq 1 \quad (12)$$

which is the lowest price at which intermediaries are willing to sell (securitize) risky projects. This price must not be smaller than one, otherwise intermediaries would not securitize risky projects at all.

Please pay attention to the role of Θ_L inside (12): as well as being the marginal benefit for intermediaries to securitize risky loans²⁷, it also represents a sort of “markup” that intermediaries apply to their sale reservation price in order to extract the largest possible surplus from potential buyers. It essentially denotes the bargaining power of intermediaries: the higher Θ_L , the higher their sale reservation price. Solving condition (12) w.r.t. Θ_L we find that intermediaries set the markup according to the following rule:

$$\Theta_L \leq p_L r(1 + \gamma) - E_\omega(\pi_\omega)A \quad (13)$$

i.e., intermediaries can apply a markup up to the level fixed by (13). Note that this markup “rule” depends positively from the interest rate r : the higher the interest rate, the higher the cost for intermediaries to issue debt, and thus the higher the markup they would like to apply. The markup level depends crucially on the reservation price of the potential buyers: if intermediaries want to sell ABS, the lowest feasible purchase reservation price among all the potential buyers denotes the upper limit to which intermediaries can apply their markup (provided that this price is at least equal to the sale reservation price). If condition (13) does not hold, then the markup would be so high that the demand and the supply of ABS would not meet in the market.

On the demand side, we have three potential buyers of ABS, each one with three different purchase reservation prices:

²⁶Reservation prices are obtained by comparing the net marginal benefits of the investment opportunities. Their determination is shown in the Mathematical Appendix.

²⁷Formally, it is the attached multiplier to the feasibility constraint (6) and it denotes how a marginal change of the constraint affects the representative intermediary’s objective function. If we are assuming $I_L = S_L$ then it must be that $\Theta_L > 0$.

- intermediaries, with a reservation price given by

$$p_{L,int}^P = \frac{E_\omega(\pi_\omega)A + \gamma\pi_r A}{r(1 + \gamma)} \quad (14)$$

- pessimistic investors α , with a reservation price given by

$$p_{L,inv_\alpha} = \frac{\pi_r A}{r} \quad (15)$$

- optimistic investors $(1 - \alpha)$, whose reservation price is

$$p_{L,inv_{1-\alpha}} = \frac{\pi_g A}{r}. \quad (16)$$

For the trade to occur, the purchase reservation price of at least one potential buyer must be greater than, or equal to, the sale reservation price of the supplier.

Intermediaries do not trade ABS with pessimistic investors or, puts differently, pessimistic investors do not demand risky securitized projects, since $p_{L,int}^S > p_{L,inv_\alpha}$.

The trade of ABS is feasible with:

- optimistic investors, for

$$p_{L,inv_{1-\alpha}} \geq p_{L,int}^S \Leftrightarrow \Theta_L \leq [\pi_g A - E_\omega(\pi_\omega)A] + \gamma\pi_g A;^{28} \quad (17)$$

- other intermediaries, for $p_{L,int}^P = p_{L,int}^S$.²⁹

Comparing the purchase reservation prices between optimistic investors and intermediaries it emerges that:

$$p_{L,inv_{1-\alpha}} > p_{L,int}^P. \quad (18)$$

Conditions (17) and (18) provide us the first important outcomes of the model:

- condition (17) implies that i) the trade of ABS between intermediaries and optimistic investors is feasible, and that ii) optimistic investors prefer to purchase securitized risky projects rather than riskless debt because their high-willingness to pay let ABS to be an attractive high-yield investment opportunity;
- condition (18) implies that optimistic investors are willing to pay an higher price for the purchase of ABS than intermediaries; therefore intermediaries strictly prefer to sell ABS, if any in the economy, to optimistic investors rather than trading them among themselves.

Given that the potential buyers of ABS can be optimistic investors and/or intermediaries, the following cases may arise in the model:

²⁸When respecting this markup rule, the supply from intermediaries meets the demand from optimistic investors.

²⁹In this case the value of Θ_L is basically irrelevant since intermediaries are just exchanging ABS among themselves. Intermediaries act a sort of “last resort” buyers in order to clear the ABS market.

- 1) intermediaries trade ABS among themselves, thus the equilibrium price is univocally determined by $p_L = p_{L,int}^S = p_{L,int}^P$, with Θ_L irrelevant, but formally equal to $\gamma\pi_r A$,³⁰
- 2) intermediaries trade ABS only with optimistic investors, thus the equilibrium price can range between $p_{L,int}^S \leq p_L \leq p_{L,inv_{1-\alpha}}$, meaning that $p_{L,int}^S$ can be increased up to $\pi_g A/r$ according to the markup $\Theta_L \leq [\pi_g A - E_\omega(\pi_\omega)A] + \gamma\pi_g A$ as expressed by condition (17); intermediaries can maximize the surplus extraction acting as a sort of monopolists in the market;
- 3) intermediaries trade ABS both with other intermediaries and with optimistic investors, thus the equilibrium price must be again $p_L = p_{L,int}^S = p_{L,int}^P$ since the lowest purchase reservation price among the potential buyers is that of intermediaries; we have $\Theta_L = \gamma\pi_r A$, and intermediaries are not able to extract any surplus from investors. Optimistic investors, on the opposite, maximize their surplus.

The outcome of case 1) is the same as that of [Gennaioli et al. \(2013\)](#): the supply of ABS is entirely absorbed by intermediaries themselves. Formally, their marginal benefits of selling and purchasing ABS are equal.³¹

The presence of optimistic investors allows cases 2) and 3) to arise: intermediaries trade ABS not only among themselves, but also, or solely, with optimistic investors. Intermediaries strictly prefer to sell ABS to optimistic investors in order to gain the proceeds from the trade and extract the highest surplus: Θ_L can be raised up to $[\pi_g A - E_\omega(\pi_\omega)A] + \gamma\pi_g A$. Intermediaries are able to practice the highest feasible bargaining power, by pushing up their sale reservation price according to optimistic investors' high-willingness to pay ABS. The sale of ABS to optimistic investors represents an high yield investment opportunity for intermediaries (backing the search for yield motive of shadow banking), whose yield is given by the sure proceeds from the sale, and furthermore it involves the credit risk transfer according to Assumption [1].

If optimistic investors are alone unable to fulfill the whole supply of ABS, then intermediaries clear the market by buying the residual securities (case 3). This require intermediaries (acting both as suppliers and demanders of ABS) to set their reservation prices at the same level, forcing them to give up to the extraction of investors' surplus. Optimistic investors, on the opposite, maximize their surplus purchasing ABS at the lowest feasible market price. Therefore it is always beneficial for intermediaries to securitize risky (sub-prime) loans: when they trade with investors $(1 - \alpha)$ they obtain the proceeds from the sale of ABS, while when they buy ABS from other intermediaries they benefit from holding idiosyncratic risk-free securities on their balance sheets.

When selling ABS, intermediaries apply a mark-up coherent with the following condition:

$$\Theta_L \in [0, \pi_g A - E_\omega(\pi_\omega)A] + \gamma\pi_g A \quad (19)$$

Since Θ_L may change according to (19), Assumption [2] alone would not be sufficient to guarantee that investment in H is strictly preferred to that in L, thus we introduce the following assumption.³²

³⁰Gains from trade are zero, since intermediaries buy and sell ABS at the same price.

³¹This can also be obtained by solving $p_{L,int}^S = p_{L,int}^P$ w.r.t. Θ_L .

³²See the Mathematical Appendix. We exclude the opposite scenario, i.e. L to be preferred to H, because it

Assumption 6. $R \geq \pi_g A$.

According to Assumption [6], intermediaries invest first in the riskless project as long as it is available in the economy; once exhausted, any unit of resources in excess goes to finance risky projects. Puts differently, intermediaries finance prime loans for first as long as prime borrowers are available in the economy, and then start financing sub-prime customers by lowering lending standards.

According to the outcomes obtained so far, we write the following Lemma.³³

Lemma 1. *Intermediaries strictly prefer to invest in the riskless investment H . For any given investment profile (I_H, I_L) , intermediaries are indifferent between securitizing or not riskless projects. We, thus, focus on equilibria where riskless projects are not securitized, i.e. with $S_H = T_H = \Theta_H = 0$. Two financial instruments are available in the economy: riskless debt and securitized risky projects (ABS).*

- *Pessimistic investors invest their wealth in the riskless debt securities; formally $D_\alpha \rightarrow +\infty$ and $T_{L,\alpha} = 0$*
- *Optimistic investors strictly prefer to invest their wealth in securitized risky projects rather than in riskless debt securities (according to condition (19)); formally $T_{L,1-\alpha} \rightarrow +\infty$ when $S_L > 0$ and $D_{1-\alpha} \rightarrow +\infty$ when $S_L = 0$*
- *If $I_L > 0$, intermediaries securitize all of their risky projects, i.e. $I_L = S_L$, fulfilling the demand from optimistic investors for first and buying residual ABS among themselves (in the latter case intermediaries benefit from risk diversification)*
- *When selling ABS, intermediaries apply a markup according to condition (19).*

4 Equilibrium at $t = 0$

This Section determines the levels of investment and the consumption patterns at $t = 0$, as well as the expected consumption streams at $t = 1$. The amount of the total wealth available in the economy (i.e. $w + w_{int}$) is crucial for the equilibrium analysis. We consider two macro scenarios:

1. for $w + w_{int} \leq 1$;
2. for $w + w_{int} > 1$.

would have no logical foundation: i) H would be cut off from the economy, since investment in L is unlimited, ii) intermediaries would not be able to raise any resources from investors, since no riskless projects would exist, iii) riskless debt issuance could be pledged only by the senior tranche of ABS (i.e. $\pi_r AT_{L,int}$); but intermediaries could not securitize risky loans if no risky loans would have been financed yet since no fund-raising instrument (i.e. debt, the only available in the economy) would have been issued yet.

³³The proof of Lemma 1 is provided in the Mathematical Appendix.

4.1 Scenario 1

When the total wealth in the economy is lesser than one only riskless projects are financed and intermediaries absorb the wealth of outside investors using riskless debt. Even if intermediaries are aware that there are two types of investors, they cannot benefit from the sale of ABS to the optimistic ones since they cannot raise enough wealth to finance risky projects. In equilibrium we have $R \geq r > 1$, with $R > r > 1$ for $w = 1 - w_{int}$: the economic interpretation is that, *ceteris paribus*, as w grows and better investment opportunities are exhausted, the equilibrium interest rate r must fall below R in order to guarantee the repayment of the debt.

The consumption patterns are shown in Table 1.³⁴

Table 1: Consumption patterns of representative agents for $w + w_{int} \leq 1$

| Time | Consumption patterns | | |
|------|----------------------|--------------------------|---------------------------------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | 0 | 0 | 0 |
| 1 | rw (Rw) | rw (Rw) | $Rw_{int} + (R - r)w$ (Rw_{int}) |

Note: last row terms in brackets denote $t = 1$ consumption streams for $R = r$.

At $t = 0$, investors invest all of their wealth in the riskless debt and consume nothing: they are simply “parking” their wealth to intermediaries. At maturity, they receive the interest rate r on the purchased units of debt.³⁵ Each investor’s type receive the same payoff $\Pi_\alpha = \Pi_{1-\alpha}$.

The intermediary’s profits correspond to its payoff at $t = 1$, i.e. the return on its equity Rw_{int} plus the component $(R - r)w$ if positive.

4.2 Scenario 2

The total wealth in the economy is now higher than one, $w > 1 - w_{int}$, implying that:

- i) riskless projects are exhausted, formally $I_H = 1$;
- ii) $I_L > 0$, but no statement can be made yet on its amount;
- iii) $R > r$.

According to the riskless debt constraint (4), the threshold R/r denotes the maximum amount of riskless debt that intermediaries can repay only with the return on riskless projects H, without pledging any additional collateral.

Since investment H is preferred to investment L, we might reasonably suppose that riskless debt is the preferred fund-raising instrument as long as its repayment is guaranteed only by the return

³⁴The $t = 1$ payoffs have no uncertainty and thus correspond to the real payoffs.

³⁵They basically get principal and interest back.

on the riskless project. This would mean that for $w \leq R/r$, intermediaries would absorb investors' wealth only through riskless debt issuance and not through the sale of ABS.

Assumption 7. For $w \in (1 - w_{int}, R/r]$ we set $D = w$, i.e. the representative intermediary absorbs the wealth of the representative outside investor only through riskless debt securities, even if some risky projects are financed.

For $w > R/r$, the only way for intermediaries to issue more debt would be to pledge additional safe collateral.³⁶ To do so, intermediaries must: *i*) finance some risky projects, $I_L > 0$, *ii*) securitize them, $S_L > 0$, and finally *iii*) trade them with other intermediaries, $T_{L,int} > 0$. The senior tranche (identified by the one which yield at least $\pi_r A$) of the resulting idiosyncratic risk-free ABS, can be used as additional collateral to issue more debt.

The high willingness to pay of optimistic investors, however, creates an opportunity cost to intermediaries: in order to issue more units of D , intermediaries would give up the proceeds from the sale of ABS to optimistic investors, because they should use the same securities as collateral for debt. According to Lemma 1, optimistic investors are attracted to the high-yield opportunity of investing in ABS, and intermediaries are eager to exploit the benefits from selling ABS (in this case intended as pure investment instruments) to investors in order to extract the largest part of their surplus. Because of their way of thinking, optimistic investors are basically offering to intermediaries a rent extraction incentive. In the real world, the search for yield motive is a key factor in driving shadow banking activities: according to their risk attitude, outside investors look for high-yielding assets that are often supplied by the shadow banking system.³⁷ Shadow banks and investors are strongly attracted to the high-yield opportunities provided by the securitized credit intermediation channel.

Condition (18) formally proves that it is definitely beneficial to intermediaries to sell ABS, if any in the economy, to investors $(1 - \alpha)$. We thus reasonably suppose that the maximum riskless debt issuance is fixed at $D = R/r$.

Assumption 8. For $w > R/r$, the intermediary sets $D = R/r$, and the difference $(w - R/r)$ denotes the excess of wealth of the representative investor which is not absorbed through riskless debt.

This means that for $w > R/r$ banks stop issuing debt and start selling securitized risky projects to optimistic investors in order to exploit the gains from the sale. If intermediaries set $D = w$ even for $w > R/r$, then the outside wealth would be exhausted only with riskless debt and no ABS could be sold to optimistic investors.

³⁶We remind that the sources of safe collateral in the economy are the return on riskless projects and the lowest return on the senior tranche of those ABS traded among intermediaries.

³⁷IMF (2014), Jackson (2013), Coval et al. (2009). For instance, before the 2007, the strong attraction for these high-yielding, and low risk perceived, AAA-rated ABS or CDOs was also encouraged by the context of relatively low interest rates (in particular in the U.S. market) which, in turn, shrank the demand for treasury and corporate bonds (Goda et al. 2013, Goda and Lysandrou 2014).

At high level of outside wealth, intermediaries move from a “conservative” deposit-based behavior to an “aggressive” speculative-based behavior. By doing so, the nature of ABS changes too: securitization does not occur for the purpose to generate safe collateral and increase leverage for intermediaries, but it does for the purpose to obtain capital gains. As investors’ wealth grows beyond R/r the model achieves different equilibria.

At $t = 0$, the funds effectively raised by intermediaries are given by:

$$D + w_{int} > 1 \Rightarrow \begin{cases} I_H = 1 \\ I_L = D + w_{int} - 1 \end{cases}$$

which go to finance riskless and risky projects, respectively. Securitized risky projects are issued only if some risky projects I_L are financed.³⁸ $I_L = D + w_{int} - 1$ denotes the “actual level” of risky investment. We can also define a “potential level” of risky investment $I_L^P = w + w_{int} - 1$, which represents the maximum feasible level of risky investment given the total wealth in the economy. The difference $I_L - I_L^P = D - w$ denotes the *risky investment gap*, which is the opposite of the excess of wealth, as defined in Assumption [8]. According to Assumption [7], for $w \leq R/r$ this gap is always zero since $D = w$. For $w > R/r$ this gap becomes negative and it grows as the level of wealth grows. This gap might be interpreted as a sort of financial fragility index: when positive and large it denotes an high level of fragility since the actual exposure to sub-prime lending is higher than its potential level. In this model the index is negative meaning that intermediaries are more concentrated to exploit the benefits from selling securitized assets to investors rather than raise more wealth to increase the investments of risky projects: securitization reduces the exposure to sub-prime lending.

When investors’ wealth belongs to $w \in (1 - w_{int}, R/r)$ we have that:

- investors’ wealth is completely absorbed through riskless debt, i.e. $w = D$;
- some risky projects are financed, for the amount $I_L = w + w_{int} - 1$, with $I_L = I_L^P$;
- the return on riskless projects (i.e. prime loans) is alone sufficient to repay riskless debt;
- risky projects are securitized and traded among intermediaries, formally $I_L = S_L = T_{L,int}$, because the outside wealth is exhausted.
- there is no need for intermediaries to use securitized securities as additional collateral for riskless debt repayment.

The mark-up is irrelevant since ABS are traded among intermediaries: we are in case 1) of page 13. Intermediaries’ reservation prices of purchase and sale must be the same and thus the equilibrium price is univocally determined by $p_L = p_{L,int}^S = p_{L,int}^P = 1$, since $R > E_\omega(\pi_\omega)A = r > 1$.

Consumption patterns are displayed in Table 2.

³⁸Securitized risky projects can be sold to investors (and used for speculative purposes) only if there is some outside wealth not yet absorbed through riskless debt, otherwise ABS could be sold solely to other intermediaries. The logical sequence is the following: raise resources with debt, finance riskless and then risky projects, securitize risky projects, and finally sell ABS to potential buyers.

Table 2: Consumption patterns of representative agents for $w \in (1 - w_{int}, R/r)$

| Time | Consumption patterns | | |
|------|----------------------|--------------------------|----------------------------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | 0 | 0 | 0 |
| 1 | rw | rw | $R + \pi_\omega AT_{L,int} - rw$ |

Investors receive the same payoff as in Scenario 1 and the same economic interpretation holds, but here the interest rate r is exactly equal to $E_\omega(\pi_\omega)A$. The drop of the interest rate enables intermediaries to issue more riskless debt than in the previous case, as long as $w < R/r$. The intermediary’s payoff corresponds to the riskless debt constraint. We point out that intermediaries earn nothing from the trade of ABS among themselves at $t = 0$: their payoff is related to the expected return on their portfolio of ABS. Please note that the component $\pi_\omega AT_{L,int}$ represents the expected return on the portfolio of idiosyncratic risk-free ABS (such a risk has been diversified because of the trade of ABS among intermediaries): such ABS bear only the aggregate risk of the economy, and formally they do not incur to the risk of yielding zero at $t = 1$.³⁹ Intermediaries start enjoying the benefits of financial innovation: securitizing assets allows them to obtain an extra-return related to their portfolio of ABS. The investors’ wealth “parked” to intermediaries (via riskless debt) is not only used for loans origination, but it also *re-used* to manufacture structured financial products.

When $w = R/r$ riskless debt issuance is exactly $D = R/r$. The equilibrium has the same features as for $w \in (1 - w_{int}, R/r)$ with the unique difference that the representative intermediary’s payoff is now only given by the expected return on ABS, since $R = rw$ (see Table 3).

Table 3: Consumption patterns of representative agents for $w = R/r$

| Time | Consumption patterns | | |
|------|----------------------|--------------------------|-------------------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | 0 | 0 | 0 |
| 1 | rw | rw | $\pi_\omega AT_{L,int}$ |

For $w > R/r$ issuing additional units of debt would be “costly” to intermediaries. The presence of optimistic investors allows intermediaries to benefit from a better investment opportunity, i.e. the sale of ABS to this type of investors. Intermediaries prefer to absorb the wealth in excess through the sale of securitized risky projects rather than through the issuance of riskless debt. This strategy affects only optimistic investors: the pessimistic ones keep and consume their wealth in excess since they do not demand securitized projects.

³⁹On the opposite, the expected return $E_\omega(\pi_\omega)A$ involves both idiosyncratic (i.e. of yielding zero at $t = 1$) and aggregate (connected to the state of the world) risks.

The investment profile for intermediaries is given by:

$$w + w_{int} > 1 \Rightarrow \begin{cases} I_H = 1 \\ I_L = \frac{R}{r} + w_{int} - 1 \\ \text{excess of wealth} = w - \frac{R}{r} \end{cases} \quad (20)$$

implying $I_L < I_L^P$, i.e. the risky investment is below its maximum feasible level, and R/r is the amount of wealth actually raised from investors. There are some resources available in the economy that could be invested in the risky project L if raised through riskless debt securities. But securitization is basically hindering the risky investment to reach its maximum feasible level, because intermediaries prefer to exploit the gains from the sale of ABS: this is an interesting outcome of the model. Economically speaking, banks could increase their sub-prime lending but they do not, since they prefer to sell their already existing portfolio of ABS to high willing potential buyers rather than using it as additional collateral. Instead of increasing their risk exposure, intermediaries off-load the existing credit risk to optimistic investors.

The potential demand for ABS from risky investors is:

$$T_{L,1-\alpha} = \frac{1}{p_L} \left[w - \frac{R}{r} \right] \quad (21)$$

which can be rearranged to $p_L T_{L,1-\alpha} = w - R/r$, i.e. total expenditure for ABS must equal the wealth in excess.⁴⁰ Note that $T_{L,1-\alpha} > 0$ because $w > R/r$, meaning that risky investors have enough money to purchase, at least, one unit of securitized risky projects.

Since the supply of ABS is upper-bounded by the feasibility constraint (6), intermediaries are able to fulfill the whole demand from investors $(1 - \alpha)$ only if investors' wealth does not exceed the following threshold:⁴¹

$$w^* \equiv \frac{R}{r} + p_L \left(\frac{R}{r} - 1 \right) + p_L w_{int} \quad (22)$$

with $w^* > R/r$ since $(R/r - 1) > 0$. Thus $R/r < w \leq w^*$. For $w \in (R/r, w^*]$ the securitization constraint is satisfied and intermediaries are able to fulfill the entire demand for ABS from investors $1 - \alpha$, given the level of risky investment $I_L = R/r + w_{int} - 1$. In other words, there are enough risky projects to be securitized and used to absorb the wealth in excess of optimistic investors.

The ABS market clears for:

$$S_L = T_{L,int} + T_{L,1-\alpha} \quad (23)$$

where it cannot be that $S_L = T_{L,int}$, since $T_{L,1-\alpha} > 0$.

According to Lemma 1, intermediaries securitize their whole portfolio of risky loans regardless the demand from optimistic investors, since they strictly prefer the “originate-to-distribute” strategy as shown by Lemma 1.

⁴⁰Solving expression (21) w.r.t. the price we obtain the inverse demand function for risky securitized projects.

⁴¹The supply of ABS is limited by the fixed amount of risky projects financed and, in turn, by the fixed amount of resources raised: according to Assumption [8], $D = R/r$ implies the level of I_L to be fixed as well.

⁴²Please remind that the demand for ABS from pessimistic investors is zero, i.e. $T_{L,\alpha} = 0$.

The equilibrium analysis leads to different outcomes whether $w \in (R/r, w^*)$ (thus implying $T_{L,int} > 0$) or $w = w^*$ (thus implying $T_{L,int} = 0$).

In the first case investors do not have enough wealth to purchase the whole supply of ABS, since $I_L = S_L > T_{L,1-\alpha}$: the market is cleared by intermediaries, who buy residual ABS and benefit from risk diversification. We are exactly in case 3) of page 13, where intermediaries act as a sort of “last reserve” buyers. In reality, this might be the case when intermediaries buy back tranches of ABS not placed among investors (usually mezzanine or junior tranches) or provide credit or liquidity guarantees. The equilibrium price is univocally determined and given by $p_L = p_{L,int}^P = p_{L,int}^S = E_\omega(\pi_\omega)A > 1$ since $R > E_\omega(\pi_\omega)A > r = 1$. The mark-up Θ_L is irrelevant since intermediaries are both suppliers and demanders of ABS: they cannot exercise their bargaining power to pushing up the sale reservation price, because they are “forced” to clear the market by trading ABS among themselves. Even if optimistic investors are willing to purchase ABS at an higher price than intermediaries, the fact that intermediaries purchase some ABS “lowers” the equilibrium price to $p_L = p_{L,int}^P = p_{L,int}^S$. This is a benefit to optimistic investors, since they buy ABS at a lower price than they would pay if they were the unique demanders in the market. If their expectations will be fulfilled (i.e. the growth state will occur at $t = 1$), optimistic investors will obtain a capital gain and they will maximize their surplus. Consumption patterns are displayed in Table 4.

Table 4: Consumption patterns of representative agents for $w \in (R/r, w^*)$

| Time | Consumption patterns | | |
|------|----------------------|------------------------------|--------------------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | $w - R$ | 0 | $p_L T_{L,1-\alpha}$ |
| 1 | R | $R + \pi_g A T_{L,1-\alpha}$ | $\pi_\omega A T_{L,int}$ |

It emerges that:

- at $t = 0$, the pessimistic investor consumes the wealth in excess $w - R$, and its payoff at $t = 1$ is equal to return on riskless projects;
- the optimistic type consumes nothing at $t = 0$, since its wealth is completely allocated between riskless debt and ABS;⁴³
- the representative intermediary has two sources of profits, i) the proceeds deriving from the sale of ABS to optimistic investors, and ii) the expected return on its portfolio of diversified ABS purchased from other intermediaries (subject to aggregate risk only);
- when selling ABS to investors, the intermediary transfers the idiosyncratic risk to them;
- securitized risky projects bought from investors $(1 - \alpha)$ bear both aggregate and idiosyncratic risk.

⁴³Formally, their payoff is given by $w - R - p_L T_{L,1-\alpha} = 0$.

The overall payoff of the representative investor α corresponds to its initial endowment because the interest rate on debt is equal to one: the net payoff of its investment is zero. This type of investor plays a conservative strategy since he temporarily parks (deposits) its wealth into a depository institution, earning a return close to zero.⁴⁴

The total expected payoff of optimistic investors is equal to that expected at $t = 1$, which is given by the repayment of debt securities (corresponding to the return on riskless projects) plus the return on ABS evaluated at the best state of the world, according to their programmed preferences (but the “true” expected return on ABS is state contingent).⁴⁵ We stress the point that the asset-backed securities held by investors bear both aggregate and idiosyncratic risk: according to Assumption [1], the idiosyncratic risk is eliminated only when ABS are traded among intermediaries. Even if the optimistic investor might incur to losses at $t = 1$ on its portfolio of ABS (because of having failed its prediction), having invested some wealth in the riskless projects provides him some protection (insurance) against the ABS investment.

At $t = 0$, the intermediary consumes the proceeds deriving from the sale of ABS to optimistic investors and at $t = 1$ he will receive the return on its portfolio of ABS according to the state of the world occurred. The total expected profits of a representative intermediary can be rewritten as follows:

$$\Pi_{0,int} = p_L S_L + T_{L,int}(\pi_\omega A - p_L) > 0 \quad (23)$$

where $I_L = S_L$ and the price $p_L = E_\omega(\pi_\omega)A$ is fixed and does not involve any uncertainty since it is the equilibrium price for ABS. The expected profits are strictly positive since $I_L = S_L > T_{L,int}$. At first sight, the first term corresponds to the expected return on the portfolio of non-securitized risky loans, but actually it does not: this term has no uncertainty because it denotes the total revenues collected from the securitization of the entire sub-prime loans portfolio. The risk-neutral intermediary is basically insuring itself against the risks in the economy: at $t = 0$ he takes part into an insurance contract which guarantees the true expected return $E_\omega(\pi_\omega)A$ on its risky loans I_L . Uncertainty appears only in the term $\pi_\omega A$ which denotes the aggregate risk borne by the representative intermediary: the term in brackets identifies the contingent capital gain (or loss) on the portfolio of ABS. This will be analyzed in the next section.

It emerges that securitization allows risks to be distributed among agents coherently with their risk attitude: everyone in the economy bears the risk which is willing to carry. Pessimistic investors bear no risk. Risk-neutral intermediaries bear only the aggregate risk which is appropriately evaluated at its expected value. Optimistic investors end up bearing both aggregate and idiosyncratic risk and they are aware they might incur to considerable capital losses. One of the advantage of securitization is that through the process of redistributing risk to those investors most willing to bear it, it increases the efficiency and completeness of the financial markets: each tranche is structured so as to maximize the optimal allocation of scarce capital to investors according to their specific risk-return preferences.⁴⁶

⁴⁴The riskless debt market can also be interpreted as a repo market, whose source of collateral is the riskless project.

⁴⁵The payoffs at $t = 1$, once the state of the world has occurred, will be analyzed in Section 5.

⁴⁶Cheng (2002).

When $w = w^*$, we have $I_L = S_L = T_{L,1-\alpha}$, meaning that optimistic investors have enough wealth in excess to purchase the entire portfolio of securitized risky assets from intermediaries. The market clears for $S_L = T_{L,1-\alpha}$ and intermediaries do not purchase ABS, i.e. $T_{L,int} = 0$. ABS are demanded only by optimistic investors. We are in case 2) of page 13. As an important consequence, intermediaries can apply a markup up to the limit of $\Theta_L = \pi_g A - E_\omega(\pi_\omega)A$. The equilibrium price ranges between $E_\omega(\pi_\omega)A + \Theta_L \leq p_L \leq \pi_g A$, since we have $R > E_\omega(\pi_\omega)A > r = 1$.

Contrary to the previous case, the fact that intermediaries sell ABS only to optimistic investors, allows intermediaries to exercise their whole bargaining power by raising their sale reservation price and thus to extract the largest feasible surplus from optimistic investors. For instance, if $\Theta_L = \pi_g A - E_\omega(\pi_\omega)A$, the equilibrium price would be exactly equal to $p_{L,inv_{1-\alpha}}$ and intermediaries would extract the entire surplus from optimistic investors: intermediaries act as a sort of monopolist of the ABS market.

The consumption patterns are displayed in Table 5.

Table 5: Consumption patterns of representative agents for $w = w^*$

| Time | Consumption patterns | | |
|------|----------------------|--------------------------|----------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | $w - R$ | 0 | $p_L S_L$ |
| 1 | R | $R + \pi_g A S_L$ | 0 |

Payoffs and reflections are the same as for $w \in (R/r, w^*)$, except for:

- the $t = 1$ payoff of the optimistic type is now referred to the entire supply of ABS, since $S_L = T_{L,1-\alpha}$;
- the payoff of the representative intermediary is entirely given by the proceeds from the sale of ABS to investors $(1 - \alpha)$.

By selling its whole portfolio of risky loans, the intermediary eliminates any kind of risk from its balance sheet. Securitization involves credit risk transfer to outside investors. Risks are spread among agents coherently with their risk attitude.

For $w > w^*$ the investment profile (I_H, I_L) of intermediaries does not change; the difference $w - w^*$ denotes the amount of investors' wealth not absorbed by intermediaries.⁴⁷ The supply of ABS is fixed and upper-bounded by the fixed amount of risky projects already financed in the economy which, in turn, are limited by the fixed amount of resources raised through riskless debt: please remind that markets play no role after $t = 0$, thus intermediaries can neither raise new funds nor re-trade existing securitized projects, and investors cannot re-optimize their consumption

⁴⁷We will focus on optimistic investors, since the pessimistic ones consume any amount of wealth that is not invested in riskless debt, i.e. any amount exceeding the level R/r .

decisions. When $w > w^*$, the wealth belonging to investors is so high that the potential demand for ABS from the optimistic type is higher than the available “fixed” supply in the economy. Since the supply is already at its maximum feasible amount, the only way to re-establish the equilibrium in the ABS market would be to work on the demand side, by raising the equilibrium price so that to reduce the purchasing power of investors. However, for the trade to occur between intermediaries and optimistic investors, the equilibrium price must be smaller or equal than the reservation price of the latter.

As long as the equilibrium price has not yet reached $p_{L,inv_{1-\alpha}}$, an increase in the price can re-establish the market clearing condition $S_L = T_{L,1-\alpha}$ ⁴⁸ and the equilibrium features, as well as the consumption patterns, are the same as for $w = w^*$.

When it is required $p_L > p_{L,inv_{1-\alpha}}$ in order to re-establish the market equilibrium, then investors do not demand asset-backed securities any more. A logical solution would be that intermediaries would clear the market by buying ABS among themselves (in this case the mark-up would be irrelevant for them), but this would not be feasible with the current hypothesis and assumptions of the model since the purchase reservation price of intermediaries is smaller than that of optimistic investors, i.e. $p_{L,inv_{1-\alpha}} > p_{L,int}$ (*supra* condition (18)), and in turn smaller than the equilibrium price.⁴⁹ Furthermore, if $p_L > p_{L,inv_{1-\alpha}} > p_{L,int}$ no one would demand ABS.

The economy is jammed and the unique solution is that the wealth in excess $w - w^*$ is consumed by investors. The equilibrium features are the same as for $w = w^*$, but with $p_L = p_{L,inv_{1-\alpha}}$.⁵⁰ Table 6 shows the consumption patterns.

Table 6: Consumption patterns of representative agents for $w > w^*$

| Time | Consumption patterns | | |
|------|----------------------|--------------------------|----------------|
| | Investors α | Investors $(1 - \alpha)$ | Intermediaries |
| 0 | $w - R$ | $w - w^*$ | $p_L S_L$ |
| 1 | R | $R + \pi_g A S_L$ | 0 |

We can summarize the results in the following proposition.⁵¹

Proposition 1. *The $t = 0$ allocation fulfills:*

- a) *if $w \leq 1 - w_{int}$, investors’ wealth is so low that only the safe project is financed and securitization does not occur. Formally, $I_H = w + w_{int}$, $I_L = S_L = T_L = 0$. In equilibrium we have $R \geq r > 1$. Consumption patterns are displayed on Table 1;*
- b) *if $w \in (1 - w_{int}, R/r]$ the riskless investment is exhausted and investors’ wealth is still absorbed only through riskless debt, i.e. $D = w$. The wealth is sufficiently high that some risky projects*

⁴⁸This condition holds when the securitization constraint is re-established.

⁴⁹We are not considering any hypothesis on price discrimination.

⁵⁰Intermediaries apply the highest feasible mark-up and extract the highest feasible surplus from optimistic investors related to the trade of ABS.

⁵¹The proof of Proposition 1 is shown in the Mathematical Appendix.

are financed, but the return on safe investments is enough to repay all debt. Intermediaries securitize risky projects and buy securitized risky projects among themselves in order to eliminate the idiosyncratic risk. Formally, $I_H = 1$, $I_L = w + w_{int}1$, and $I_L = S_L = T_{L,int}$. In equilibrium we have $R > E_\omega(\pi_\omega)A = r > 1$ and $p_L = 1$. Consumption patterns are displayed on Table 2 for $w \in (1 - w_{int}, R/r)$, and on Table 3 for $w = R/r$;

- c) if $w \in (R/r, w^*)$ intermediaries set $D = R/r$ and absorb the wealth in excess $w - R/r$ by selling securitized risky projects to optimistic investors. Formally, the resources actually raised are given by $D + w_{int}$, thus $I_H = 1$ and $I_L = D + w_{int} - 1$. Intermediaries securitize their whole portfolio of risky projects, i.e. $I_L = S_L$, satisfy the demand from optimistic investors and buy among themselves any securitized risky project left unsold, thus $T_{L,int} = S_L - T_{L,1-\alpha}$. In equilibrium we have $R > E_\omega(\pi_\omega)A > r = 1$ and the equilibrium price is given by $p_L = E_\omega(\pi_\omega)A$. Consumption patterns are displayed on Table 4;
- d) if $w = w^*$, $I_L = S_L = T_{L,1-\alpha}$, riskless debt is still fixed at R/r , and investors' wealth is high enough to purchase all of the securitized risky projects available in the economy. Formally, $I_H = 1$ and $I_L = D + w_{int} - 1$. In equilibrium we have $R > E_\omega(\pi_\omega)A > r = 1$, and the equilibrium price ranges between $E_\omega(\pi_\omega)A + \Theta_L \leq p_L \leq \pi_g A$. Intermediaries are able to extract the highest feasible surplus from optimistic investors by applying a mark-up $\Theta_L \in (0, \pi_g A - E_\omega(\pi_\omega)A]$. Consumption patterns are displayed on Table 5.
- e) if $w > w^*$, given the investment profile $I_H = 1$ and $I_L = R/r + w_{int} - 1$, there is an excess of demand in the ABS market that can be cleared only by increasing the equilibrium price up to $p_L = p_{L,inv1-\alpha}$ (if not yet reached). The equilibrium has the same features as for $w = w^*$, and the wealth in excess $w - w^*$ is consumed by investors. Consumption patterns are shown in Table 6.

5 The outcome at $t = 1$ after ω is learned

At $t = 1$ everyone learns the aggregate state of the world $\omega \in \Omega_1 \equiv \{g, d, r\}$. Everyone knows the return on risky assets and in particular the probability of default for sub-prime loans. Output from projects is produced and distributed to agents. The world ends.

Given the investment and securitization patterns $(I_{H,j}, I_{L,j}, S_{L,j})$ at $t = 0$, we analyze what happens once ω is learned.

According to the results obtained in the previous Section, risks are distributed among agents as follows:

- aggregate risk is borne by those agents that hold risky projects (sub-prime loans) or securitized risky projects, i.e. optimistic investors and intermediaries;
- idiosyncratic risk is borne only by optimistic investors who have bought securitized risky projects.

By definition, riskless debt securities are not affected by aggregate risk. Pessimistic investors are thus completely immune from any risk.

According to Assumption [1], the idiosyncratic risk is eliminated only when ABS are traded among intermediaries. This is not the case when ABS are sold to optimistic investors: in such a case, the default risk of sub-prime loans is transferred to investors $(1 - \alpha)$, who ultimately bear the risk.⁵²

We now check what happens at $t = 1$ to the payoffs and consumption streams of intermediaries and optimistic investors once the state of the world has occurred. We exclude Scenario 1 from the analysis since no risky projects is financed and no uncertainty appears.

5.1 Intermediaries payoffs

According to Assumption 1 and to Lemma 1, intermediaries are exposed only to the aggregate risk since they always find beneficial to securitize all of their portfolio of risky loans.

The intermediary's payoff related to securitized risky projects is given by:

$$p_L T_{L,inv_{1-\alpha}} + \pi_\omega A T_{L,int} \quad (24)$$

i.e., the proceeds at $t = 0$ deriving from the sale of ABS to investors $(1 - \alpha)$ plus the expected return on its idiosyncratic risk-free portfolio of ABS bought from other intermediaries.⁵³ For $w \in (1 - w_{int}, R/r]$, its payoffs are positive and higher as better states of the world occur (*Supra* Tables 2 and 3).

For $w \in (R/r, w^*)$ ⁵⁴, the representative intermediary's state contingent payoffs are displayed on Table 7.

Table 7: State contingent payoffs of intermediaries for $w \in (R/r, w^*)$

| States of the world | Overall payoffs for $w \in (R/r, w^*)$ |
|---------------------|--|
| r | $p_L S_L + T_{L,int}(\pi_r A - p_L) > 0$ |
| d | $p_L S_L + T_{L,int}(\pi_d A - p_L) > 0$ |
| g | $p_L S_L + T_{L,int}(\pi_g A - p_L) > 0$ |

As shown by expression (23), the overall expected profits are always positive and higher as better states of the world occurs. Please pay attention to the second component of the overall payoff, i.e. the one related to the portfolio of ABS held by the intermediary: it is positive only if the growth

⁵²ABS are thus conceived as mere pass-through securities: the originator transfers, through the SPV, the assets cash flows to the buyer of the ABS without any form of credit enhancement.

⁵³The expected return is simply $\pi_\omega A$ instead of $E_\omega(\pi_\omega)A$, since there is no chance for idiosyncratic risk-free ABS to default, i.e. to be unsuccessful and yield a zero return at $t = 1$.

⁵⁴*Supra* Table 4. For $w = w^*$ the intermediary's payoff is not state contingent because it is entirely given by the proceeds from the sale of ABS at $t = 0$ (see Table 5).

state occurs, and negative otherwise.⁵⁵ This means that intermediaries might incur to a capital loss on their ABS portfolio if either the state of downturn or recession occur. In “bad” times aggregate risk turns to be systemic in the sense that lead to large scale losses to the holders of structured financial products. Shadow banking, through asset securitization, is pro-cyclical: it inflates payoffs when good times occur while it amplifies losses during bad times.

5.2 Optimistic investors payoffs

The payoffs of optimistic investors are state contingent only for $w > R/r$: we focus on the case for $w \in (R/r, w^*]$.

As well as the aggregate risk, the portfolio of securitized assets held by optimistic investors also bears the idiosyncratic risk connected to the default of the underlying sub-prime borrowers. At $t = 1$, for any $\omega \in \Omega_1 \equiv \{g, d, r\}$, there are two classes of optimistic investors:

- the *successful* ones, whose ABS pay out;
- the *unsuccessful* ones, whose ABS do not pay out, since the underlying sub-prime loans have defaulted.

The *successful* investors enjoy a positive payoff which is only undermined by the aggregate risk. At $t = 0$ they expect to receive the highest payoff from their ABS holdings (associated with the growth state) but their true payoff is actually state contingent and given by:

$$\Pi_{1-\alpha} = R + \pi_\omega AT_{L,1-\alpha} > 0 \quad \text{with } \omega \in \Omega_1 \equiv \{g, d, r\}. \quad (25)$$

If the growth state occurs, the believes of optimistic investors are fulfilled and their true payoff is the same as they expected at $t = 0$. Otherwise, if either the state of downturn or recession occur their true payoff will be lower than that expected at $t = 0$. The overall expected payoff of the representative optimistic investor can be rearranged as follows:

$$\Pi_{1-\alpha} = w + T_{L,1-\alpha}(\pi_g A - p_L) \quad (26)$$

which denotes the same payoff as in (25) but it isolates the component related to the investment in ABS. If the growth state does not occur, optimistic investors lose the amount $(p_L - \pi_\omega A)$, with $\omega \in \{d, r\}$, on each unit of ABS purchased.⁵⁶ Shadow banking is pro-cyclical.

The *unsuccessful* optimistic investors are those ones whose ABS do not pay out since the underlying risky loans have defaulted. No recourse can be made to intermediaries (the originators) since the risky loans have been put off-balance sheets according to the true sale principle. Regardless the state of the world occurred at $t = 1$, the unsuccessful optimistic investors lose the wealth invested in ABS, since the ultimate borrowers are unable to pay their debt to intermediaries. Their payoff is given by:

$$\Pi_{1-\alpha} = w + T_{L,1-\alpha}(0 - p_L) = w - p_L T_{L,inv_{1-\alpha}} = w - (w - R) = R \quad \text{with } \omega \in \{g, d, r\}$$

⁵⁵Because of Assumption 4.

⁵⁶Please remind that in this case the equilibrium price is $p_L = E_\omega(\pi_\omega)A > 1$.

Both successful and unsuccessful investors will receive at least the return on riskless debt claims at $t = 1$. However, the successful ones will obtain a higher payoff than the unsuccessful ones whatever the state of the world will be, since the component $\pi_\omega AT_{L,1-\alpha}$ is strictly positive.

Summing up:

- optimistic investors and intermediaries experience losses in connection with the aggregate risk of their asset-backed securities if either the state of downturn or recession occur;
- a part of optimistic investors, the unsuccessful ones, might lose all of the wealth invested in asset-backed securities if the underlying risky projects fail.

The idiosyncratic risk is totally transferred, via securitization, to optimistic investors: these investors become the actual bearers of the default risk connected to risky projects. The aggregate risk is inherently rooted in the economy and therefore it cannot be diversified: those agents that holds risky securities are exposed to it. Securitization allows risks to be distributed among market participants coherently with their risk appetite.

6 Conclusions

Our theoretical model provides an economic rationale for securitization involving real credit risk transfer and for the search for yield motive of shadow banking.

Securitization is not intended as a mere way to diversify the credit risk of the underlying assets pool and to provide safe collateral to investors, rather the market of asset-backed securities is driven by gain purposes. Optimistic investors are attracted to the high-yield investment opportunities offered by the ABS market, while intermediaries are attracted to the high willingness to pay of optimistic investors. Investors' sentiment on future macroeconomic conditions affects, indeed, their reservation prices related to the demand for securitized assets: the optimistic ones are willing to pay higher prices than other market participants.

Optimistic investors are therefore crucial for our results, since they are basically offering to financial intermediaries a rent-extraction incentive. When investors' wealth is high enough that securitization occurs, intermediaries move from a "conservative" deposit-based behavior to an "aggressive" speculative-based behavior. Instead of trading ABS among themselves and issuing debt claims collateralized by the safest tranches of securitized assets, intermediaries prefer to sell ABS to optimistic investors in order to extract the highest feasible surplus. As a consequence, the idiosyncratic risk of the underlying asset pool is transferred from intermediaries to optimistic investors.

Shadow banking, via asset securitization, is pro-cyclical: it inflates agents' payoffs in "good" times while it leads to large scale losses in "bad" times. In particular it emerges that securitization spills over positively to the rest of the financial system by allowing risks to be spread among market participants coherently with their risk attitude, and by enhancing the quality of credit in the economy. By redistributing risk to those investors most willing to bear it, securitization increases the efficiency and completeness of the financial markets. Furthermore, securitization reduces the

incentive for intermediaries to engage in sub-prime lending: rather than using ABS as additional collateral to raise more debt and expand the origination of risky loans, intermediaries exploit the gains from the sale of ABS to optimistic investors, thus obtaining an immediate cash inflow instead of holding risky assets till maturity.

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