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

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August, 2017

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, which is consistent with the factual background that had characterized the U.S. financial system before the recent crisis. The shadow banking system is indeed an important provider of high-yield asset-backed securities via the underlying securitized credit intermediation process. Investors’ sentiment on future macroeconomic conditions affects the 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 offload credit risk. 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, surplus extraction
JEL classification: E44, G21, G23

1 Introduction

During the last four decades we witnessed to fundamental changes in financial techniques and financial regulation that have gradually transformed the “originate-to-hold” banking model into a “originate-to-distribute” model based on a securitized credit intermediation process relying upon i) securitization techniques, ii) securities financing transactions, and iii) mutual funds industry.1

* Tuscia University in Viterbo, Department of Economics and Engineering. E-mail: morganti@unitus.it. I am most grateful to Giuseppe Garofalo for his continuous guidance and support. I thank Anton Korinek for his valuable suggestions as well as his guidance and support during my visit at the Johns Hopkins University. I am very grateful to Nicola Gennaioli for his valuable comments and suggestions. I am also grateful to Luca Correani for his suggestions, to seminar participants at Sapienza University in Rome, and to participants at the 2016 CREDIT Conference in Venice.

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: 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.\(^2\) In 2007, U.S. total shadow banking liabilities were estimated as $20 trillion against $13 trillion of traditional banking liabilities (Pozzar et al. 2010). A crucial role was played by the securitization market which alone was worth $4600 billion, accounting for more than 60% of the U.S. market for privately issued financial bonds. From 2003Q3 to 2006Q4, total net issuance of asset-backed securities (ABS) increased from nearly $200 billion to $934 billion. Asset-backed securities became very attractive instruments since they provided issuing companies with great liquidity while offering to investors high-yield and less risky investment opportunities. Investors mostly belonged to the asset under management industry, which serves as a major supplier of funds through the wholesale funding market. Money market funds (MMFs) funded the asset-backed commercial paper market (ABCP) while medium- to long-term debt investors, such as securities lenders, hedge funds, pension funds and insurance companies, funded the corporate segment of the ABS market. Hedge funds, in particular, were one of the major holders of highly-risky tranches of asset-backed securities before the crisis, and their involvement in the shadow banking system mainly occurred through the ABS-CDOs market: by June 2007 global hedge funds assets were estimated as $2.2 trillion, with almost $1.4 trillion invested in collateralized-debt obligations.\(^3\)

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 procyclical nature of shadow banking, coherently with the factual background that had characterized the U.S. shadow banking system before the recent financial crisis. At this regard, we analyze a vast bulk of data (mostly collected from the FED Flow of Funds and other institutional sources) of entities, instruments and activities involved in the U.S. market for privately issued ABS, in order to capture the risk-taking behavior that had broadly characterized the pre-crisis period.

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 the traditional risk-transfer view of asset securitization, which is opposed to the imperfect credit risk-transfer view (Shin 2009, Acharya et al. 2013).\(^4\) For the latter, credit risk is totally or partially retained on the sponsor’s balance sheet because the sponsor provides credit enhancements to the SPV or buys back securitized assets (usually junior tranches).

The model lasts two periods \(t = 0, 1\) and is featured by two broad categories of agents: a contin-

\(^2\)Pozzar et al. (2010), IMF (2014).
\(^3\)Goda and Lysandrou (2014), FCIC (2010).
\(^4\)Acharya 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.
uum 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 \( i \) the intermediary-specific credit risk connected to its borrowers, i.e. the idiosyncratic risk, and to \( ii \) the 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 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”, or “risk-taker”, 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 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: the latter are basically offering to financial intermediaries a rent-extraction incentive. At this point the returns on safe projects are no longer enough to repay additional units of debt, and intermediaries face an opportunity cost represented by the proceeds they give up from the sale of ABS in order to issue more units of debt pledged by additional securitized assets as further collateral. We show that intermediaries prefer to sell ABS to optimistic investors, rather than trading them among themselves, in order to extract the highest feasible surplus. By doing so, intermediaries also transfer the idiosyncratic risk. 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 motive is thus replaced by the search for yield motive.

The presence of optimistic investors allows our model to achieve the following outcomes:

- ABS are intended for sale and gain purposes (supporting the search for yield motive of the shadow banking literature);
- intermediaries transfer the idiosyncratic risk, and thus any related loss, to optimistic investors

\(^5\text{Pozsar (2011).}\)
(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.** The paper 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 credit risk for originators 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 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 paper is also related to the literature on behavioral finance that focuses on investors’ sentiment, to the extent that it 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), since 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) to the extent that securitization allows risk to be spread among market participants coherently with their risk attitude. By allocating risks to those investors that are most willing to bear them (Acharya and Schnabl 2010), securitization can improve the efficiency, the safety, and the completeness of financial markets (Cheng 2002). Securitization involving real credit risk transfer 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 is also connected with incentives in trades as in Grossman and Stiglitz (1980), to the extent that 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. In the next Section we reconstruct and explore the factual background of the U.S. shadow banking system from 2000 to 2016, that will serves as a support for the development of our theoretical model. Section 3 describes the model setup and analyzes agents’ optimizing behavior. In Section 4 we investigate agents’ investment choices at $t=0$, while in Section 5 we provide the equilibrium analysis at $t=0$. Section 6 analyzes the outcomes at $t=1$ after the state of the world has occurred. Section 7 concludes.

2 Factual background

Shadow credit intermediation relies on three pillars: 1) asset securitization, 2) wholesale funding, and 3) securities financing transactions, mostly repurchase agreements (repos). Entities, activities and instruments generally involved in shadow credit intermediation are displayed in Figure 1.

In this Section we reconstruct the factual background characterizing the U.S. shadow credit intermediation chain since the beginning of the new century, that we will use to support the theoretical model presented in the next sections. We will focus the attention on the U.S. market for privately issued asset-backed securities trying to capture the risk-taking behavior that had broadly characterized the pre-crisis period. We analyze a vast bulk of market data, mostly collected from the Flow of Funds and other institutional sources, regarding the entities, instruments and activities involved in the supply and in the demand side of the ABS market, and finally at their interactions.

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Source: our elaboration from Puzsar et al. (2010), Exhibit 2.

Note: securitized funding techniques are highlighted in red.
2.1 Supply of asset-backed securities

Information on the supply side can be obtained by looking at the issuers of private asset-backed securities (basically special purpose vehicles - SPVs) in the Flow of Funds data: the liabilities of these shadow entities measure the amount of securitized products supplied in the economy, both commercial paper (short-term, or simply asset-backed commercial paper) and corporate (medium-to long-term, or simply medium-term notes - MTNs). ABS are mostly issued in the form of medium- and long-term securities: as the overall ABS market entered its boom stage in early 2000, corporate liabilities grew more than commercial paper ones accounting for a share of nearly 80% over the total (see Figure 2, right panel). Given their long-term maturity, corporate ABS surely yield an higher return than short-term ABCP.

Figure 2: Liabilities of U.S. ABS issuers (quarters, 2000-2016)

Left panel: levels, $US millions. Right panel: share on total ABS liabilities.

Source: Federal Reserve Flow of Funds data.

This a first stylized fact that the securitized corporate bonds market was manufacturing complex and high-yielding structured financial products, in response to the growing appetite from investors for more remunerative investment opportunities than the existing traditional ones, such as treasuries. ABCP were mostly used by shadow entities as a source of collateral in order to meet their short-term liquidity needs, but also as a more attractive investment opportunity than traditional bank deposits for investors with a low tolerance of risk.

In 2003:Q1, asset-backed securities accounted for nearly $2200 billion, while in 2007:Q3 their amount was more than doubled reaching a peak of $4600 billion (Figure 2, left panel). The events of the financial crisis dramatically reduced the amount of ABS issued in the economy by restoring

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6 Asset-backed commercial paper issuance by U.S.-chartered commercial banks is counted separately from total liabilities of ABS issuers: we do not include this series because its negligible amount.

7 Corporate asset-backed securities are measured as net liabilities, i.e. ABS issued minus ABS purchased by the same conduits.
During the first decade of the new century, U.S. private issuance of asset-backed securities was the prominent segment in the market for private bonds issued by the overall U.S. domestic financial sector (Figure 3). Starting from 2002, both short and long-term securitized securities accounted for more than 50% of the total domestic financial bonds issuance, with a peak of more than 60% in 2007 at the eve of the financial crisis.\(^8\)

Figure 4 shows the quarterly net issuance of asset-backed securities from 2000 to 2016 by maturity short-term (commercial paper) and medium/long term (corporate and foreign bonds). From 2003:Q3 to 2006:Q4, total net issuance increased from nearly $200 billion to $934 billion. This remarkable upward trend was suddenly interrupted in 2007:Q2 with a sharply decline in net issuance: from $670 billion to minus $88 billion in 2007:Q4, and finally to minus $671 in 2009:Q3.

By aggregating quarterly data from securitization reports of SIFMA and AFME it emerges that before the crisis almost the 50% of the reported asset-backed securities issuance was not rated at all (Figure 5). Unfortunately, data are available only from 2007:Q1, but it is reasonable to suppose that the share of ABS with no rating was prominent even before to this date, during the boom of the securitization market. This has to be interpreted as a signal of the low quality environment that has characterized securitization techniques.

In a securitized banking system, securitization opens up to new sources of funding and new investment opportunities: as balance sheets expand, new creditors and borrowers must be found.\(^9\)

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\(^8\)Shares of ABS liabilities remain prominent even considering total domestic private bonds issuance (i.e. by including non-financial bonds): long-term ABS are between 30 to 40%, while ABCP over 50%.

\(^9\)As pointed out by Shin (2009), p. 310, in benign financial market conditions (i.e. with low systemic aggregate risk), financial intermediaries expand balance sheets as they increase leverage in a way consistent with the limits set by regulatory capital requirements, creditors (for instance, on pledgeable collateral) or self-imposed risk constraints. Unexpected shocks may let aggregate risk to fluctuate, and so indebtedness as well. When all prime borrowers have been satisfied then banks have to lower their lending standards in order to further expand balance sheets.
Figure 4: ABS net issuance in the U.S. (quarterly flows, 2000-2016)


Figure 5: U.S. asset-backed securities issuance by rating (quarters, 2007-2016)

Percentages on total issuance. Source: AFME and SIFMA, securitization quarterly reports.
These new creditors, those who buy mortgage-backed securities (MBSs), collateralised debt obligations (CDOs), and asset-backed commercial paper, mostly belong to the asset management industry, i.e. mutual funds, hedge funds, pension funds and insurance companies, as well as foreign investors. Before ending up in the mutual funds industry, securitized securities and funds are usually intermediated by broker-dealers through securities financing transactions (SFTs), mostly repos. As far as we are concerned to securitized credit intermediation, ABS intermediation and repo financing are usually managed and conducted by brokers and dealers. Dealers, in particular, are key suppliers of market liquidity and price makers for the financial products they manage. Apart from maximizing the bid-ask spread, the main function of dealers is to keep markets liquid by maintaining the continuity of market prices, i.e. by buying (when there is excess selling pressure) and selling (when there is excess buying pressure) without moving the market price much, but rather by changing their inventories of cash and securities. Real world dealers typically rely on leverage, and they move as close as they can to an ideal balance sheet mostly composed by reverse repos (assets side) and repos (liabilities side): they take advantage of outside agents holding inventories of security and cash.

The left panel of Figure 6 plots the amount of security repurchase agreements held in the balance sheet of U.S. brokers-dealers. It emerges that brokers and dealers are mostly engaged in the strategy of borrowing money against collateral rather than in lending money against collateral. Figure 6, right panel, shows the net flows of repos (flows of repos minus flows of reverse repos) which basically provide us a measure for the financial account of broker-dealers expressed in terms of repo net positions. Up to 2007-Q3 brokers-dealers acted as net borrowers while then they became net lenders: this might be due to a remarkable decrease in borrowing money against collateral, because

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10See Mehring et al. (2013).
11Ibidem.
of i) the scarcity of such collateral (reduced supply of securitized products, Figure 4) - and of ii) not rolling over repo positions at maturity (mostly overnight).

Asset-backed securities (in particular ABCP) were one of the greatest source of collateral used by broker-dealers in repo transactions before the crisis. The Federal Reserve provides data on the type of ABCP placement: from 2000 to 2016, more than 80% of outstanding ABCP has been placed by dealers, except in the aftermath of the crisis (mid-2009 to mid-2013) where dealers placement fell to 20-30% due to the decline in total ABCP outstanding (see Figure 7).

Before the crisis, the supply side of the securitization market was thus characterized by:

- prominent weight of ABS on total privately-issued domestic bonds, with the large majority having medium- to long-term maturities;
- large increases in supply for securitized securities (both ABCP and corporate ABS);
- most of securitized products had not a rating;
- the crucial role of brokers-dealers (behaving as net borrowers in repo transactions) in channeling securitized instruments (mostly ABCP) to the demand side of the shadow banking system.

2.2 Demand of asset-backed securities

The creditors of the shadow banking system mostly belong to the mutual funds industry. By connecting ultimate lenders (mostly households) to the rest of the financial system, the mutual funds industry serves as a major supplier of funds and demander of securities through the wholesale

\footnote{See, among all, Pozsar et al. (2010), Gorton and Metrick (2012).}
Wholesale funds are usually raised i) on a short-term rollover basis with money market instruments (such as large-denomination certificates of deposits, brokered deposits, repos, and ABCP) that serve to maintaining liquidity in the shadow banking system, and ii) through the issuance of medium-term notes (MTNs) to longer-term debt investors such as securities lenders, hedge funds, pension funds and insurance companies.

Figure 8: U.S. money market funds holdings of repos and commercial paper (quarters, 2000-2016)

The demand for commercial paper and repos from MMFs sharply increased from, respectively, $400 billion and $250 billion in 2004 to almost $700 billion and $600 billion at the end of 2007: CP and repos together accounted for more than 40% of total MMFs assets (Figure 8). Starting from 2008 there was a decline in the holdings of both instruments, but while the demand for repos was restored in 2012, the holdings of commercial paper dramatically fell to $300 billion at the end of 2012 (just more than 10% of total assets) and then to $100 billion at the end of 2016 (nearly 4% of total assets). The sharp contraction in commercial paper demand is thus strictly related to the contraction in supply of ABCP as displayed in Figure 4. The collapse of Lehman Brothers on September 2008, disrupted the ability of CP issuers to roll over their maturing short-term liabilities, and thus triggered an unprecedented “flight to quality” from high-yielding to Treasury-only money market funds. Given that ABCP accounted for nearly the 60% of the overall U.S. financial commercial paper market (see Figure 3), it is reasonable to draw the conclusion, in line with the shadow banking

13 The term “wholesale funding” generally refers to the way whereby financial institutions raise funds in addition to core demand deposits; the funding of any financial institution through the sale of money market and longer-term debt instruments is called wholesale funding, and the instruments involved are called wholesale funding instruments (Pozsar et al. 2010).

14 Exposure to Lehman forced the Reserve Primary Fund to break the buck on September 16 and, as a result, money market investors reallocated their funds from prime to government money market funds. This reallocation unleashed a tidal wave of redemption demands that overwhelmed the funds’ immediate liquid reserves. As a consequence, money market mutual funds were reluctant, and in some cases unable, to purchase commercial paper (Adrian et al. 2011).
that most of such ABCP were purchased by MMFs, both directly and mostly through brokers-dealers.

Figure 9 plots the series of MMFs’ net purchases of commercial paper and ABCP net issuance as displayed in Figure 4: except for some discontinuities during the crisis, the two series share a similar trend implying the existence of a positive correlation between MMFs demand and supply flows of ABCP. It also emerges an additional interesting evidence: since the outbreak of the crisis and up to the restore of the commercial paper market flows in supply anticipated flows in demand, while the opposite did occur outside this time frame.

While MMFs played a key role in financing the ABCP segment of the shadow banking system, the investors in the segment for privately issued corporate ABS were medium- to longer-term investors. At this regard, Flow of Funds data do not provide specific data for investments in corporate ABS, in particular for what concerns the asset under management industry. The holdings of privately issued corporate ABS are shown separately only for the following sectors: U.S. chartered depository institutions, credit unions, property-casualty insurance companies, life insurance companies, government-sponsored enterprises, and rest of the world (see Figure 10). Before the crisis, these sectors held together almost the 50% of total ABS, while in the recent years their holding share tend to almost 100% (mainly due to the contraction in supply of securitized products). We end up that the discrepancy between total corporate ABS liabilities and the total amounts of ABS held as assets by the previous covered entities, corresponds to the amount of medium- and long-term ABS that was reasonably held by other shadow entities such as mutual funds other than MMFs, closed-end

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15 See, among all, Pozsar et al. (2010), Gorton and Metrick (2012), Adrian et al. (2011)
16 Mostly realized through the FED’s Commercial Paper Funding Facility (Adrian et al. 2011).
17 Please remind that Flow of Funds data considers ABS issuers’ net liabilities, i.e. net of assets.
Particular attention must be paid to hedge funds, who were key actors in ABS intermediation (see Figure 1). As reported by Pozsar et al. (2010), FCIC (2010), Goda and Lysandrou (2014) their involvement in shadow banking system mainly occurred through the ABS-CDOs market: hedge funds were one of the major holders of higher-risky tranches of asset-backed securities before the crisis. They often use the prime brokerage services of broker-dealers: as of year-end 2006, the top three prime brokers-dealers, Morgan Stanley, Bear Stearns and Goldman Sachs serviced 58% of the hedge fund accounts. The top ten brokers-dealers had over 80% of the market, implying a very large exposure to the hedge fund industry, and a concentration of counterparty credit risk for the hedge funds to the brokers.\footnote{FCIC (2010).} Hedge funds are also major trading partners with the large commercial banks and investment banks. For example, many hedge funds borrow cash from these financial institutions in repo transactions with the hedge funds posting their securities as collateral. Also, as already noted, several of the large banks control very substantial hedge funds. Together, these linkages through prime brokerage, as counterparties to broker-dealers, and through ownership, helped spread the crisis throughout the shadow banking system and to the traditional banking sector as well.\footnote{Ibidem.}

Being exempt from SEC registration, hedge funds are not generally subject to direct oversight by any federal or state agency and their leverage is not capped by regulatory requirements. This qualifies hedge funds as a particular type of risk-taker investors that are extremely able to take advantage from regulatory arbitrage opportunities through complex strategies (typically are not open to mutual fund managers) that involve, for example, heavy use of finance structured products and short sales. As reported by a report of J.P. Morgan (2009), hedge funds aimed to produce positive returns by
having little market risk and lots of idiosyncratic risk and investors experienced losses mainly related to a lack of diversification. Securitization was hailed as a panacea, providing tremendous liquidity to issuing companies while offering higher returns and less risk to investors. The diversification benefits that were expected from investments in higher returning illiquid markets never materialized.

Hedge funds mainly served high-net worth individuals (HNWI)\(^{20}\), whose large demand for high yield investment opportunities was met through the ABS-CDOs market: by June 2007 global hedge funds assets were estimated as $2.2 trillion, with almost $1.4 trillion invested in CDOs.\(^{21}\) In contrast to institutional asset managers, which had to severely restrict the amounts of the high risk and unrated CDO equity tranches they bought in order to comply with prudential and regulatory constraints, hedge funds faced no such constraints in their involvement in the CDO market. This meant that they could go long on the risky equity tranches thus enabling them to take advantage of their high yields while at the same time controlling for risk through the use of credit default swaps and put options. Hedge funds may have been the conduit through which the demand pressure for yield was transmitted through to the CDO creators but the ultimate source of that pressure were the clients of the hedge funds, and chief amongst these clients were HNWIs.\(^{22}\)

Before the crisis, the demand side of asset securitization was thus characterized by:

- money market funds (low risk profile) were the main providers of short-term funding through wholesale funding instruments such as CP, ABCP and repo;
- other mutual funds (higher risk profile than MMFs), pension funds and insurance companies were the main providers of medium- to longer-term funding through investments in corporate ABS;
- hedge funds (highest risk profile) served as key intermediaries in channeling the wealth of HNWI to the shadow banking system through the ABS-CDOs market.

### 2.3 Interactions between demand and supply

Let us retrieve some information on ABS prices and yields, as a result of the continuous interactions between supply and demand. For the corporate bond market we refer to the BoFA Merrill Lynch US High Yield Total Return Index Value and to BoFA Merrill Lynch US High Yield Effective Yield, both taken from the Federal Reserve Bank of St. Louis (see Figure 11). These series represent, respectively, the values and effective yields of the BoFA Merrill Lynch US High Yield Master II Index, which tracks the performance of US dollar denominated below investment grade rated corporate debt (based on an average of Moody’s, S&P, and Fitch) issued in the US domestic market with more than one year of remaining maturity.

\(^{20}\) Typically, those individuals holding financial assets (excluding their primary residence) with a value greater than $US1 million. According to Credit Suisse (2016), in 2016 HNWI accounts for the 0.7% of the global population and they hold the 45.6% of global wealth.


\(^{22}\) Goda and Lysandrou (2014).
Figure 11: U.S. high yield corporate bonds performance and effective yield (months, 2000-2017)

The performance of the U.S. high yield corporate bonds was remarkable in the pre-crisis period (the total return index grew from nearly 350 points to more than 600 points in the first half of 2008) but the recovery after the sharp decline during the crisis was even more: the index reached 1200 points in the early 2017, thus trebling the value registered at the end of 2008. By denoting the performance of particular basket of securities, this Index allows us to obtain representative information on prices for risky corporate bonds and specifically, given their prominence in the corporate bonds market, for risky high-yield asset-backed securities: higher values of the index implies higher prices of the securities included in the index, most reasonably due to a growing appetite and demand for such securities, in order to fill the growing supply as already reported in Figure 4. This fact is confirmed by looking at the effective yields of such U.S. high yield bonds, which basically follow a specular trend to the total return Index: before the crisis risky securitized securities were bullish, prices went up and interest rate went down, while during the crisis they were bearish, prices went down and interest rates went up. In the right panel of Figure 11 we also plot the secondary market rate for 5-year Treasuries with constant maturities and the spread between high-yield bonds and Treasuries. Two important comments arise. First, risky corporate bonds were obviously higher return instruments than Treasuries and thus more attractive to investors with a great risk tolerance and in search for high-yield investment opportunities. Second, these high yield instruments were not only preferred to traditional treasury securities but they were also perceived as nearly safe as those securities, since just before the crisis (from mid-2004 to mid-2007) the spread was below 5%, with a lower bound of 266 basis points in February 2007.23

Figure 12 plots the interest rate on 90-day AA ABCP and the spread with the 3-months T-Bills rate. Before the crisis interest rates sharply rose from about 1% to 5% in less than two years, implying  

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23Series of highly-rated U.S. private corporate bonds tend to overlap the trend of Treasury securities, in particular during the pre-crisis period.
that the costs of issuing ABCP rose as well. Once the crisis burst, interest rates dramatically fell below 3% at end-2007/early-2008 (the spread jumped from 50bp to more than 200bp), and after a slight recovery during the third quarter of 2008, they fell below 1% at the end of 2008. These two downturns in interest rates correspond to two distinct discontinuities in interest rates and market prices: given that most of ABCP was placed by dealers (see Figure 7), it implies that dealers were not able to maintain the market liquid because they incurred to shortages of inventories (cash and securities) on their balance sheets. As reported on the Figure Given that ABCP rates are calculated by the FED from the supply side, i.e. on CP sold directly or indirectly (by dealers) to investors, then an increase in interest rates is related to an increase in the supply of ABCP (confirmed by evidence on Figures 4 and 7) that in turn led to a decrease in prices.

Figure 12: 90-day AA ABCP and 3-months T-Bills interest rates (months, 2001-2017)

Percentages. Shaded areas denote discontinuities. Source: Federal Reserve of St. Louis.

3 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 make their optimal investment decisions and trade securities among them. At $t = 1$ the state of the world $\omega$ is revealed and learned by everybody; the output from projects
is produced and distributed to agents. At $t = 1$, intermediaries can neither raise new funds nor re-trade existing securitized projects, and investors cannot re-optimize their consumption decisions. 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 $\sum_\omega \varphi_\omega = 1$. $\varphi_\omega$ captures the aggregate risk to which the whole economy is subject to.

### 3.1 Intermediaries

We shape the behavior of intermediaries as in Gennaioli et al. (2013). 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) raising funds through the issuance of $D_j$ units of a riskless debt security promising to repay $rD_j$ at $t = 1$, with $r \geq 1$;\footnote{This condition guarantees that lending to intermediaries makes investors weakly better off than autarky.}

2) investing its own wealth $w_{int}$ and the resources raised in:
   - a riskless project $H$ that 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:
     \[
     f(I_{L,j}) = \begin{cases} 
     A \cdot I_{L,j}, & \text{with probability } \pi_\omega \\
     0, & \text{with probability } (1 - \pi_\omega)
     \end{cases}
     \] (1)
   with $I_{H,j}$ and $I_{L,j}$ denoting the units invested in each project, and $\omega \in \Omega_1 \equiv \{g, d, r\}$;

3) selling (securitize) $S_{H,j}$ and $S_{L,j}$ units of riskless and risky projects, respectively, and then buying $T_{H,j}$ and $T_{L,j}$ units from other intermediaries.

The two investments opportunities can be interpreted as the loan origination stage for the intermediary, with $I_H$ and $I_L$ denoting, respectively, prime loans and sub-prime loans. There are no storage opportunities. 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 $\omega$, or simply the share of potentially succeeding intermediaries in $\omega$. Such a risk denotes the default risk of the underlying borrowers which can be diversified by intermediaries through a simple pass-through securitization structure involving traditional banks and multi-seller.
SPVs conduits: without loss of generality the originator and the SPV are considered as the same entity. Following Gemnioli et al. (2013), we adopt the crucial assumption:

**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.

At \( t = 0 \) the expected return on risky projects is given by \( E_\omega(\pi_\omega)A \). 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.  

**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.** \( \pi_dA < 1 \), 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.** \( \pi_gA > \pi_dA > \pi_rA \), 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 \( \pi_rA \), i.e. the return associated to 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.

At \( t = 0 \) the representative intermediary \( j \) maximizes its expected profits:

\[
\max_{\{I_H, T_H, S_H, D, I_L, T_L, S_L\}} \Pi_{int} = \left[ R \cdot (I_H + T_H - S_H) + p_H \cdot (S_H - T_H) \right] \\
+ \left[ E_\omega(\pi_\omega)A \cdot (I_L - S_L) + E_\omega(\pi_\omega)A \cdot T_L + p_L \cdot (S_L - T_L) \right] \\
+ D \cdot (1 - r) + w_{int} - I_H - I_L
\]  

Securitization is thus represented by the true sale of an asset to a third party, either outside investors or intermediaries.

According 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 (Gemnioli et al. 2013, Shin 2009). 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.

We 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.
subject to the following constraints

\[ w_{int} + D + p_H S_H + p_L S_L \geq I_H + I_L + p_H T_H + p_L T_L \]  
\[ R \cdot (I_H + T_H - S_H) + \pi_r \cdot A \cdot T_L \geq rD \]  
\[ I_H \geq S_H \]  
\[ I_L \geq S_L \]  
\[ \int_j I_{H,j} d_j \leq 1 \] 

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

Here follows a brief explanation of the previous expressions.

**Expected profits** (2). 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 projects\(^\text{28}\) \((S_H - T_H)\) 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 projects\(^\text{29}\) 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 \(\omega\) it yields \(A\) with probability \(\pi_\omega\) 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 deriving from the trade of risky ABS at \(t = 0\).

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 debt issuance and repayment plus the intermediary’s equity, and minus the outflow of prime and sub-prime loans originated at \(t = 0\).

**Resource constraint** (3). At \(t = 0\), the resources of an intermediary, 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** (4). At \(t = 1\), the intermediary must repay principal and interest to its debt holders. This implies that the debt issuance at \(t = 0\) must be such that the intermediary will be able to repay riskless debt in the worst possible state of its balance sheet. The intermediary can pledge to its creditors the following resources:

\(^{28}\) Also securitized prime loans.

\(^{29}\) Also securitized sub-prime loans.
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 ABS\(^{30}\) evaluated at the worst possible state of the world, i.e. \( \pi_r \cdot A \cdot T_L \).\(^{31}\)

Neither the return on non-securitized risky projects \((I_L - S_L)\),\(^{32}\) nor the upper-side return of securitized risky projects (i.e., \( \pi_g - \pi_r \))\(^{33}\) can be used as further collateral for debt payments: if so, riskless debt would not be “riskless” anymore.

**Feasibility constraints** (5) and (6). Intermediaries cannot securitize more than the amount of the loans originated.\(^{34}\)

**Limited supply of riskless projects** (7). The final constraint denotes that prime borrowers are limited in the economy.

### 3.2 Investors

There is a continuum of outside investors \( i \) of total mass equal to one endowed with \( w \) units of wealth. \( \alpha \in [0,1] \) and \((1-\alpha)\) denote, respectively, the shares of investors belonging to the “pessimistic” and to the “optimistic”, or “risk-taker”, type. Investors save by buying the following financial claims from intermediaries:

i) riskless debt, promising a sure return \( r \geq 1 \) at \( t = 1 \);\(^{35}\)

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 \( E_\omega(\pi_\omega)A_T \).

The aggregate endowment belonging to outside investors 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:

\[
C_{0,i} = w - D_i - p_H T_{H,i} - p_L T_{L,i} \\
C_{1,i} = rD_i + RT_{H,i} + E_\omega(\pi_\omega)AT_{L,i}
\]

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

\(^{30}\)If 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.

\(^{31}\)Such idiosyncratic risk-free ABS can be interpreted as a senior tranche that pays out for sure at least \( \pi_r A \).

\(^{32}\)Non-securitized risky projects are vulnerable to the idiosyncratic risk of yielding zero, and thus they cannot support riskless debt issuance.

\(^{33}\)This can be interpreted as a non-senior, or non-investment grade, tranche of ABS.

\(^{34}\)Intermediaries do not re-securitize portions of the acquired pool \( T_L \) since it is already diversified and there is no benefit from doing so.

\(^{35}\)We assume that investors cannot supply riskless debt, formally \( D_i \geq 0 \).
idiosyncratic and aggregate risks. By holding securitized risky assets, investors bear the credit risk related to underlying sub-prime borrowers which has been transferred from intermediaries.

We shape investors’ behavior in the same way as in Gennaioli et al. (2013):36 investors act as “programmed agents” who expect to receive, at \( t = 0 \), a specific payoff on their portfolio of risky assets. Investors \( \alpha \) 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”, or “risk-taker”, 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.37 This is coherent with the pre-crisis context where euphoria and optimism on general financial and macroeconomic conditions increased investors’ appetite for higher-yield investment opportunities than those provided by traditional financial channels. Such increase in demand was filled by shadow banking entities that manufactured complex, and often low quality, structured securities (many of them being not rated at all, see Figure 5). The optimism in the financial markets induced agents to neglect the so-called tail risk (Gennaioli et al. 2012, 2013), since almost no one was expecting that an extremely severe event would have occurred in the short-term. As reported in Section 2, the creditors of the shadow banking system mostly belonged to the asset under management industry: short-term and less risky funding was mostly provided by money market funds while the supply of medium- to long-term ABS was funded by investors with higher risk tolerance, mainly hedge funds that channeled the wealth of high-net worth individuals to the securitized banking system through the ABS-CDOs market.

By affecting the expected return at \( t = 0 \), investors sentiment also affects the investment decisions by determining the reservation prices related to the demand of securitized assets. 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:38

\[
\Pi_\alpha = w - D_\alpha - p_H T_{H,\alpha} - p_L T_{L,\alpha} + rD_\alpha + RT_{H,\alpha} + \pi r A T_{L,\alpha}
\] (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. \( \omega \equiv r \).39

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36 The 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 “ininitely risk-averse” ones. We follow their rationale in order to shape the opposite behavior of optimistic investors.

37 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).

38 Henceforth we will drop the subscript \( i \) to ease the notation.

39 Pessimistic 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:

$$H_{1-\alpha} = w - D_{1-\alpha} - p_H T_{H,1-\alpha} - p_L T_{L,1-\alpha} + r D_{1-\alpha} + R T_{H,1-\alpha} + \pi_g A T_{L,1-\alpha}$$

(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. $\omega \equiv g$.\(^{40}\)

According to the available supply, investors’ payoff is maximized for an infinite amount of each financial instrument.\(^{41}\)

4 Investment choices at $t = 0$

Agents make their investment decision according to their reservation prices of the financial products available in the economy. Intermediaries choose i) whether to securitize or not assets, and ii) whether to buy or not asset-backed securities. Investors choose whether to buy riskless debt securities or ABS. We are going to adopt the same approach as in Section 2, by first analyzing the supply and the demand side of the ABS market and then looking at their interactions.

4.1 Supply of asset-backed securities

Asset-backed securities and riskless debt are supplied by intermediaries.\(^{42}\) 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 through riskless debt issuance\(^{43}\) and then, according to Assumption [2], they will start to finance prime loans; once prime borrowers have been exhausted, intermediaries will start engage in sub-prime lending.

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.\(^{44}\)

Securitized risky projects. According to Assumption [3], intermediaries wish to invest in activity L, since the cost of an investment unit is one. We suppose that for $I_L > 0 \Rightarrow I_L = S_L$, i.e. intermediaries securitize their whole portfolio of risky assets: it would be irrational for risk-neutral intermediaries to keep sub-prime loans on their balance sheets, while they could gain the benefit

\(^{40}\)Optimistic 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 $\pi_g A$.

\(^{41}\)A more technical and rigorous presentation of investors’ behavior is given in the Mathematical Appendix.

\(^{42}\)Please remind that the model does not allow financial instruments to be re-traded at $t = 1$.

\(^{43}\)The amount of riskless debt issued by intermediaries will be determined later in Section 5 when considering the equilibrium analysis at $t = 0$.

\(^{44}\)Henceforth, when using the term asset-backed securities we will refer to securitized risky (sub-prime) assets.
from risk diversification in trading ABS among themselves.\textsuperscript{45}

Since we are considering a pure pass-through securitization structure, with the intermediary acting both as the originator and as the SPV conduit, assets securitization is simply represented by the sale of those assets. The intermediaries’ sale reservation price of asset-backed securities is thus given by:\textsuperscript{46}

\begin{equation}
\begin{aligned}
p_L \geq \frac{E_\omega(\pi_\omega)A + \Theta_L}{r(1 + \gamma)} = p_{L,\text{int}}^S \geq 1
\end{aligned}
\end{equation}

which is the lowest price at which intermediaries are willing to sell (securitize) risky projects. This reservation price is supposed not to be smaller than one, otherwise intermediaries would not securitize risky projects at all.\textsuperscript{47}

The supply curve of ABS is depicted in Figure 13: the supply is zero for equilibrium prices below the sale reservation price of intermediaries, while it is equal to the amount of risky projects that has been financed in the economy for any $p_L \geq p_{L,\text{int}}$. An increase (decrease) in $I_L$ will move the upper vertical segment rightward (leftward), causing and increase (decrease) in the supply of ABS.

Please pay attention to the role of $\Theta_L$ inside expression (12): as well as being the marginal benefit for intermediaries to securitize risky loans\textsuperscript{48}, it also represents a measure for the ability of intermediaries to extract surplus from potential buyers, or similarly, a measure for the bargaining power of intermediaries: the higher $\Theta_L$, the higher is the sale reservation price and thus the lower

\textsuperscript{45}Without loss of generality, we suppose that the securitization of risky loans is always beneficial to intermediaries: no matter whether ABS are sold to investors or not, intermediaries can trade ABS among themselves and thus benefit from risk diversification. This is coherent with a “originate-to-distribute” strategy.

\textsuperscript{46}Reservation prices are obtained by comparing the net marginal benefits of the investment opportunities. Their determination is shown in the Mathematical Appendix.

\textsuperscript{47}A negative sale reservation price could be feasible with a situation of fire sales experienced during a financial crisis.

\textsuperscript{48}Formally, 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 $\Theta_L > 0$. 

\textbf{Figure 13: Supply of ABS from intermediaries}
is the ability for intermediaries to extract surplus from buyers. Solving condition (12) w.r.t. $\Theta_L$ we obtain that:

$$\Theta_L \leq p_L r (1 + \gamma) - E_\omega (\pi_\omega) A$$  \hspace{1cm} (13)$$
i.e., intermediaries’ ability to extract surplus is determined by rule (13). The lower bound for this condition is reached for $p_L = p_L^S$, with $\Theta_L = 0$. If intermediaries want to sell ABS among all the potential buyers, the lowest purchase reservation price denotes the upper limit to which intermediaries can exert their bargaining power (provided that this price is not smaller than the sale reservation price). If condition (13) does not hold, then demand and supply of securitized assets never meet.

4.2 Demand of asset-backed securities

The market for securitized assets has three potential buyers:

- intermediaries, with a reservation price
  $$p_P^{L, \text{int}} = \frac{E_\omega (\pi_\omega) A + \gamma \pi_r A}{r (1 + \gamma)}$$  \hspace{1cm} (14)$$
- pessimistic investors, with a reservation price
  $$p_{L, \alpha} = \frac{\pi_r A}{r}$$  \hspace{1cm} (15)$$
- optimistic investors, whose reservation price is
  $$p_{L, 1-\alpha} = \frac{\pi_g A}{r}$$  \hspace{1cm} (16)$$

Comparing the purchase reservation prices it emerges that:

$$p_{L, 1-\alpha} > p_P^{L, \text{int}} > p_{L, \alpha}$$  \hspace{1cm} (17)$$

implying that optimistic investors are willing to pay the highest price to purchase ABS, because of their positive expectation on the future state of the world, followed by intermediaries and finally by pessimistic investors. Condition (17) implies that intermediaries would strictly prefer to sell securitized assets, if any in the economy, to optimistic investors rather than trading ABS among themselves, since they would be offered a rent extraction incentive that would increase the proceeds deriving from the sale of ABS.

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 intermediaries. As an immediate result, it emerges that ABS are not traded between intermediaries and pessimistic investors since $p_P^{L, \text{int}} > p_{L, \alpha}$: the supply from intermediaries does not meet the demand from this type of investor, and investors $\alpha$ are thus willing to demand only riskless debt.

49 An increase in the sale reservation price implies that the intermediary is now willing to sell the same amount of securities at an higher price; ceteris paribus, the intermediary is now obtaining a smaller revenue.

50 Pessimistic investors would prefer senior ABS to debt only if $p_L \leq \pi_r A/r$ which is unfeasible given that $p_L \geq 1$. 

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Figure 14: Demand for ABS from pessimistic investors

Figure 15: Demand for ABS from optimistic investors

- optimistic investors, as long as
  \[ p_{L,inv_1-\alpha} \geq p_{L,int}^S \iff \Theta_L \leq [\pi_g A - E_\omega(\pi_\omega)A] + \gamma \pi_g A; \] \hspace{1cm} (18)

- other intermediaries, for \( p_{L,int}^P \geq p_{L,int}^S \iff \Theta_L \leq \gamma \pi_r A. \] \hspace{1cm} (52)

Condition (18) implies that the trade of ABS between intermediaries and optimistic investors is feasible since the high-willingness to pay of the latter let securitized assets to be a more attractive investment opportunity than riskless debt. Investors \((1 - \alpha)\) prefer ABS, if any in the economy, to debt as long as \( p_L \leq \pi_g A/r \) holds: they will invest in riskless debt securities only when the supply of securitized assets is cleared, if there is some wealth left. No demand for ABS exists for \( p_L > \pi_g A/r. \)

\hspace{1cm} 51When respecting this rule, the supply from intermediaries meets the demand from optimistic investors.

\hspace{1cm} 52In this case intermediaries clear the ABS market thus acting a sort of “last resort” buyers.
we can thus define the upper bound for condition (13), given by $\Theta_L = [\pi g A - E_\omega(\pi_\omega)A] + \gamma \pi g A$, which denotes the maximum level of $\Theta_L$ that allows the trade of ABS to be still feasible. When the equilibrium price is equal to investors’ reservation prices, the demand for securitized assets is given, respectively, by $T_{L,1-\alpha}$ and $T_{L,1-\alpha}$, supposing $D = 0$. From Figure 14 it emerges that the demand curve of pessimistic investors lies below the sale reservation price of intermediaries, while the opposite occurs for optimistic investors as depicted in Figure 15. As the equilibrium price $p_L$ falls below $p_{L,1-\alpha}$, the demand for ABS increases up to the level $T_{L,1-\alpha} = w \cdot [(1 + \gamma) r]/[E_\omega(\pi_\omega)A + \Theta_L]$ which correspond to $p_L = p_{L,\text{int}}^S$. An increase (decrease) in investors’ wealth will move the demand curves rightward (leftward).

### 4.3 Equilibrium in the ABS market

The following equilibria may arise in the model:

1) intermediaries trade ABS among themselves, thus the equilibrium price can range between $p_{L,\text{int}}^S \leq p_L \leq p_{L,\text{int}}^P$, with $\Theta_L \leq \gamma \pi r A$;

2) intermediaries trade ABS only with optimistic investors, thus the equilibrium price can range between $p_{L,\text{int}}^S \leq p_L \leq p_{L,1-\alpha}$; intermediaries act as a sort of monopolists in the ABS market and their profits will depend on their bargaining power as expressed by the rule $\Theta_L \leq [\pi g A - E_\omega(\pi_\omega)A] + \gamma \pi g A$;

3) intermediaries trade ABS with optimistic investors and among themselves, thus the equilibrium price range again between $p_{L,\text{int}}^S \leq p_L \leq p_{L,\text{int}}^P$, with $\Theta_L \leq \gamma \pi r A$, since the lowest purchase reservation price among the potential buyers is that of intermediaries.

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, and their net gains are zero because they buy and sell securitized assets at the same equilibrium price.\textsuperscript{53}

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 feasible surplus. The sale of ABS to optimistic investors represents a more attractive and safe way for intermediaries to raise funds in addition to core demand deposits (i.e. riskless debt): by securitizing and selling ABS to investors, intermediaries obtain the sure proceeds from the sale and, furthermore, they transfer credit risk outside their balance sheets (according to Assumption [1]). Both risk-taker investors and intermediaries are thus motivated by the search for yield motive of shadow banking.

An example of the equilibrium in the ABS market is depicted in Figure 16, with $p_E$ denoting the equilibrium price.

\textsuperscript{53}This can also be obtained by solving $p_{L,\text{int}}^S = p_{L,\text{int}}^P$ w.r.t. $\Theta_L$. 

26
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). Intermediaries act both as suppliers and demanders of ABS, and this requires the equilibrium price to range between $p_{L,int}^S \leq p_L \leq p_{L,int}^P$. Optimistic investors benefit from this situation, since the highest equilibrium price at which they could buy ABS would be $p_{L,int}^P$ and as a consequence their unit surplus would be given at least by $p_{L,1-\alpha} - p_{L,int}^P$.

When selling ABS, intermediaries must take into account that their bargaining power (or surplus extraction’s ability) can change according to the following condition:

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

(19)

lower values of $\Theta_L$ implies a lower sale reservation price, which in turn increases the chances for intermediaries to obtain larger profits by extracting a higher surplus from investors.

According to the outcomes obtained so far, we write the following Lemma.\textsuperscript{54}

**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 $D_\alpha \longrightarrow +\infty$ and $T_{L,\alpha} = 0$

\textsuperscript{54}Proof is provided in the Mathematical Appendix.
• Optimistic investors strictly prefer to invest their wealth in securitized risky projects rather than in riskless debt securities; 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, if needed, buying residual ABS among themselves; in the first case credit risk is transferred to investors while in the latter case credit risk is diversified.

• When selling ABS, intermediaries have a bargaining power (or surplus extraction’s ability) that may change according to condition (19).

5 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, $w + w_{int}$, is crucial for the equilibrium analysis. We consider two macro scenarios:

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

5.1 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.\textsuperscript{55}

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Investors $\alpha$</th>
<th>Investors $(1-\alpha)$</th>
<th>Intermediaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>$rw$ $(Rw)$</td>
<td>$rw$ $(Rw)$</td>
<td>$Rw_{int} + (R-r)w$ $(Rw_{int})$</td>
</tr>
</tbody>
</table>

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

\textsuperscript{55}The $t = 1$ payoffs have no uncertainty and thus correspond to the real payoffs.

28
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 units of debt purchased.\textsuperscript{56} The intermediary’s profits correspond to its payoff at $t=1$, i.e. the return on its equity $Rw_{\text{int}}$ plus the component $(R-r)w$ if positive. This equilibrium is consistent with an early stage of development of financial systems where intermediaries conduct the basic credit intermediation activity with no need for finance to generate additional value and more profitable investment opportunities.

5.2 Scenario 2

The total wealth in the economy is now higher than one, $w > 1 - w_{\text{int}}$, 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 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 6.** For $w \in (1 - w_{\text{int}}, R/r]$ 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.\textsuperscript{57} 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, $T_{L,\text{int}} > 0$. 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: by issuing more units of $D$, intermediaries would give up the proceeds from the sale of securitized assets to optimistic investors, because they should use the senior tranche of ABS 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

\textsuperscript{56}They basically get principal and interest back.

\textsuperscript{57}We 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.
ABS (in this case intended as pure investment instruments) to investors in order to extract the largest part of their surplus. Optimistic investors are basically offering to intermediaries a rent extraction incentive because they are sure to receive the highest yield at $t = 1$. 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. This is confirmed by the pre-crisis factual background provided in Section 2, where shadow banks and investors were strongly attracted to the high-yield opportunities provided by the securitized credit intermediation channel.

Condition (17) 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 7.** 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.

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:

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

which go to finance riskless and risky projects, respectively. Securitized risky projects are issued only if some risky projects $I_L$ are financed. $I_L = D + w_{\text{int}} - 1$ denotes the “actual level” of risky investment. We can also define a “potential level” of risky investment $I_L^P = w + w_{\text{int}} - 1$, 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

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58 IMF (2014), Jackson (2013), Coval et al. (2009). 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).

59 Securitized 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.
excess of wealth, as defined in Assumption [7]. According to Assumption [6], 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.

We are in case 1) of page 26, where the equilibrium price can range between \( p_{L,int}^S \leq p_L \leq p_{L,int}^P \), with \( \Theta_L \leq \gamma \pi \omega A \) and \( R > E_{\omega}(\pi_\omega)A = r > 1 \).

Consumption patterns are displayed in Table 2.

<table>
<thead>
<tr>
<th>Time</th>
<th>Investors</th>
<th>Intermediaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>( rw )</td>
<td>( R + \pi_\omega AT_{L,int} - rw )</td>
</tr>
</tbody>
</table>

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

Consumption patterns are displayed in Table 2.

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 \( t = 1 \). Intermediaries start enjoying the

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60 On 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.
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 \( w \in (1 - w_{\text{int}}, R/r) \) 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 \( w = R/r \)

<table>
<thead>
<tr>
<th>Time</th>
<th>Investors ( \alpha )</th>
<th>Investors ((1 - \alpha))</th>
<th>Intermediaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>( rw )</td>
<td>( rw )</td>
<td>( \pi_{w}AT_{L,\text{int}} )</td>
</tr>
</tbody>
</table>

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.

The investment profile for intermediaries is given by:

\[
\begin{align*}
    w + w_{\text{int}} > 1 &\Rightarrow
    \begin{cases}
        I_{H} = 1 \\
        I_{L} = \frac{R}{r} + w_{\text{int}} - 1
    \end{cases}
    \text{excess of wealth } = w - \frac{R}{r}
\end{align*}
\]

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:

\[
T_{L,1-\alpha} = \frac{1}{p_{L}} \left[ w - \frac{R}{r} \right]
\]
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.\(^{61}\) 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:\(^{62}\)

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

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:

\[
S_L = T_{L,int} + T_{L,1-\alpha} \tag{63}
\]

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.

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 26, where intermediaries act both as suppliers and demanders of securitized assets. 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 can range between \( p_{L,int}^R \leq p_L \leq p_{L,int}^P \), with \( \Theta_L \leq \gamma \pi_L A \), and \( R > E_\omega(\pi_L) A > r = 1 \). Even if optimistic investors are willing to purchase ABS at an higher price than intermediaries, the fact that intermediaries purchase some ABS pushes down the equilibrium price. 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.

 Consumption patterns are displayed in Table 4.

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;

\(^{61}\)Solving expression (21) w.r.t. the price we obtain the inverse demand function for risky securitized projects.

\(^{62}\)The 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 [7], \( D = R/r \) implies the level of \( I_L \) to be fixed as well.

\(^{63}\)Please remind that the demand for ABS from pessimistic investors is zero, i.e. \( T_{L,\alpha} = 0 \).
Table 4: Consumption patterns of representative agents for $w \in (R/r, w^*)$

<table>
<thead>
<tr>
<th>Time</th>
<th>Investors $\alpha$</th>
<th>Investors $(1 - \alpha)$</th>
<th>Intermediaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$w - R$</td>
<td>0</td>
<td>$p_L T_{L,1-\alpha}$</td>
</tr>
<tr>
<td>1</td>
<td>$R$</td>
<td>$R + \pi g AT_{L,1-\alpha}$</td>
<td>$\pi \omega AT_{L,int}$</td>
</tr>
</tbody>
</table>

- the optimistic type consumes nothing at $t = 0$, since its wealth is completely allocated between riskless debt and ABS.\(^{64}\)
- 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 risk-taker investors, the intermediary transfers the idiosyncratic risk to them;
- securitized risky projects bought from investors $(1 - \alpha)$ bear both aggregate and idiosyncratic risk.

The overall payoff of the representative investor $\alpha$ 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.\(^{65}\)

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).\(^{66}\) 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:

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

\(^{64}\)Formally, their payoff is given by $w - R - p_L T_{L,1-\alpha} = 0$.

\(^{65}\)The riskless debt market can also be interpreted as a repo market, whose source of collateral is the riskless project.

\(^{66}\)The payoffs at $t = 1$, once the state of the world has occurred, will be analyzed in Section 6.
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, risk-taker, investors end up bearing both aggregate and idiosyncratic risk and they are aware they might incur to considerable capital losses. Think about hedge funds before the crisis, as reported in Section 2.2: they were aware of the potential high risk connected to their investment strategies but they did not expected that a very bad state of the world (such a financial crisis) would have occurred at least in the short-run. 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.\footnote{Cheng (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 26. Intermediaries act as a monopolists in the ABS market and their profits depend on their bargaining power as expressed by $\Theta_L \leq \pi_\omega A - E_\omega(\pi_\omega)A$ according to condition (18). The equilibrium price ranges between $E_\omega(\pi_\omega)A + \Theta_L \leq p_L \leq \pi_\omega A$, 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 in order to extract the largest feasible surplus from optimistic investors. Lower values of $\Theta_L$ implies a higher chances for intermediaries to obtain larger profits by extracting an higher surplus from investors. For instance, if $\Theta_L = \pi_\omega A - E_\omega(\pi_\omega)A$, the sale reservation price would be exactly equal to $p_{L,1-\alpha}$ and intermediaries would not be able extract any surplus from optimistic investors.

The consumption patterns are displayed in Table 5.

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

\footnote{Cheng (2002).}
Table 5: Consumption patterns of representative agents for $w = w^*$

<table>
<thead>
<tr>
<th>Time</th>
<th>Investors $\alpha$</th>
<th>Investors $(1 - \alpha)$</th>
<th>Intermediaries</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>$w - R$</td>
<td>0</td>
<td>$p_L S_L$</td>
</tr>
<tr>
<td>1</td>
<td>$R$</td>
<td>$R + \pi_s A S_L$</td>
<td>0</td>
</tr>
</tbody>
</table>

- 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.

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. 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 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 $p_{L,1-\alpha}$, an increase in the price can re-establish the market clearing condition $S_L = T_{L,1-\alpha}$ and the equilibrium features, as well as the consumption patterns, are the same as for $w = w^*$.

When it is required $p_L > p_{L,1-\alpha}$ 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, 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. $p_{L,1-\alpha} > p_{L,\text{int}}$ (supra condition (17)), and in turn

\[68\text{We will focus on optimistic investors, since the pessimistic ones consume any amount of wealth that is not invested in riskless debt, i.e. any amount exceeding the level } R/r.\]

\[69\text{This condition holds when the securitization constraint is re-established.}\]
smaller than the equilibrium price. Furthermore, if $p_L > p_{L,1-\alpha} > p_{L,\text{int}}$ 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 $p_L = p_{L,1-\alpha}$. Table 6 shows the consumption patterns.

We can summarize the results in the following proposition.

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

a) if $w \leq 1 - w_{\text{int}}$, investors’ wealth is so low that only the safe project is financed and securitization does not occur. Formally, $I_H = w + w_{\text{int}}, I_L = S_L = T_L = 0$. In equilibrium we have $R \geq r > 1$. Consumption patterns are displayed on Table 1;

b) if $w \in (1 - w_{\text{int}}, R/r]$ 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 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, $I_H = 1, I_L = w + w_{\text{int}}1$, and $I_L = S_L = T_L,\text{int}$. In equilibrium we have $R > E_\omega(\pi_\omega)A = r > 1$ and $p_L = 1$. Consumption patterns are displayed on Table 2 for $w \in (1 - w_{\text{int}}, R/r)$, 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 $D + w_{\text{int}}$, thus $I_H = 1$ and $I_L = D + w_{\text{int}} - 1$. 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 $T_L,\text{int} = S_L - T_L,1-\alpha$. 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 $I_L = D + w_{\text{int}} - 1$. In equilibrium we have $R > E_\omega(\pi_\omega)A > r = 1$, and the equilibrium price ranges between $E_\omega(\pi_\omega)A + \Theta_L \leq p_L \leq \pi_\omega A$. Intermediaries have a bargaining

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We are not considering any hypothesis on price discrimination.

The proof of Proposition 1 is shown in the Mathematical Appendix.
power which is feasible with \( \Theta_L \in (0, \pi g A - E_{\omega}(\pi_\omega)A] \). Consumption patterns are displayed on Table 5.

e) if \( w > w^* \), given the investment profile \( I_H = 1 \) and \( I_L = R/r + w_{\text{int}} - 1 \), there is an excess of demand in the ABS market that can be cleared only by increasing the equilibrium price up to \( p_L = p_{L,1-\alpha} \) (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.

6 The outcome at \( t = 1 \) after \( \omega \) 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 \((I_{H,j}, I_{L,j}, S_{L,j})\) determined at \( t = 0 \), we analyze what happens once \( \omega \) 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, thus 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.

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 are financed and no uncertainty appears.

6.1 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:

\[
p_L T_{L,1-\alpha} + \pi_\omega A T_{L,\text{int}}
\] (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.\footnote{The 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 $t = 1$.} For $w \in (1 - \omega_{\text{int}}, R/r]$, its payoffs are positive and higher as better states of the world occur (Supra Tables 2 and 3).

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

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

<table>
<thead>
<tr>
<th>States of the world</th>
<th>Overall payoffs for $w \in (R/r, w^*)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r$</td>
<td>$p_LS_L + T_{L, \text{int}}(\pi_r A - p_L) &gt; 0$</td>
</tr>
<tr>
<td>$d$</td>
<td>$p_LS_L + T_{L, \text{int}}(\pi_d A - p_L) &gt; 0$</td>
</tr>
<tr>
<td>$g$</td>
<td>$p_LS_L + T_{L, \text{int}}(\pi_g A - p_L) &gt; 0$</td>
</tr>
</tbody>
</table>

As shown by expression (23), the overall expected profits are always positive and higher as better states of the world occur. 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 state occurs, and negative otherwise.\footnote{Because of Assumption 4.} 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.

6.2 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:

\[ \Pi_{1-\alpha} = R + \pi_\omega A T_{L,1-\alpha} > 0 \quad \text{with} \quad \omega \in \Omega_1 \equiv \{g, d, r\}. \]  

(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:

\[ \Pi_{1-\alpha} = w + T_{L,1-\alpha}(\pi_g A - p_L) \]  

(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.\(^{75}\) 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 repay their debt to intermediaries. Their payoff is given by:

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

Both successful and unsuccessful investors will receive at least the return on riskless debt claims at \( t = 1 \), if they have bought any. However, the successful ones will obtain an higher payoff than the unsuccessful ones whatever the state of the world will be, since the component \( \pi_\omega A T_{L,1-\alpha} \) 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;
- some 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 holding securitized risky assets are exposed to such a risk. Furthermore, it emerges that securitization allows risks to be distributed among market participants coherently with their risk appetite.

\(^{75}\)Please remind that in this case the equilibrium price is \( p_L = E_\omega(\pi_\omega)A > 1. \)
7 Conclusions

Our theoretical model provide economic rationales for securitization involving real credit risk transfer and for the search for yield motive of shadow banking, which are consistent with the factual background that had characterized the U.S. financial system before the crisis. It emerges that securitization is not only intended as a mere way to diversify credit risk and to provide safe collateral to investors. Rather, demand and supply of asset-backed securities are driven by gain purposes: during the boom of the shadow banking system, from early 2000 to mid-2007, ABS provided issuing companies with great liquidity while offering higher returns and less risk to investors. Optimistic risk-taker investors are attracted to the high-yield investment opportunities manufactured 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, the reservation prices related to the demand for securitized assets: investors with “optimistic” expectations 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 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. It also 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, by obtaining an immediate cash inflow instead of holding risky assets till maturity.

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