Market Discipline and Securitization*

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Abstract

In this paper, I ask whether securitization really contributes to better risk-sharing. To do this, I first propose an outcome-based formalization of the concept of *market discipline.* Then, I compare securitization, which consist of the transfer of risk from *existing* loans, with other mechanisms that differ in the *timing* of risk-transfer. I find that, for securitization to be an efficient risk-sharing mechanism, market discipline has to be strong, that is the securitization market outcome should be better than other mechanisms at rewarding diligent loan origination, and adverse selection has to be mild, which seems to seriously restrict the set of assets that should be securitized for risk-sharing motive.

Additionally, I show how *ex-ante* leverage may mitigate *interim* adverse selection in securitization markets and therefore enhance *ex-post* risk-sharing. This is interesting because high leverage is usually associated with "excessive" risk-taking.

1 Introduction

Securitization has been widely blamed for the 2007-2009 financial crisis. Still, it is commonly believed that it is a powerful mechanism to spread and share risk in the

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economy. In this paper, I challenge such conventional wisdom and show that securitization is an efficient risk-sharing mechanism under strong conditions only. It might therefore apply to a very restricted class of assets.

Securitization consist of the sale of existing loans (mortgage, industrial, credit card receivable, etc.). Because transaction costs and asymmetry of information make such loans individually illiquid, the securitization process generally includes their pooling and tranching. It is indeed well understood that adequate security design improves liquidity because it creates securities whose prices are less information-sensitive than those of the underlying claims. But securitization also implies a reallocation of risk among economic agents. Setting aside its liquidity dimension, I focus here on securitization as a risk-sharing mechanism.

My starting point is the basic securitization model of Dewatripont and Tirole (1994) in which risk-averse bankers sell risky loans for insurance motive. The authors focus on incentive schemes and care, therefore, about the informational value of income (the extent to which balance sheet figures reflect manager performance). In such context, they show that securitization is desirable when it gives bankers insurance against the noise component of the risk only (which is assumed independent of effort). This happens when the component of the risk that is informative about effort realizes early whereas most of the noise realizes later.

To assess the merits of securitization from a risk-sharing perspective, I generalize this model and extend it in two directions: I consider a richer information structure and I introduce market discipline, which turns out to be a crucial element of the analysis.

Market discipline is mostly known as the "Third Pillar" of the Basel II capital accord. Still, it is not a uniquely well-defined concept in economics. According to Flannery (2001), it encompasses at least two different ideas. It refers to investor ability to observe and accurately interpret information on bank behavior, and it also corresponds to potential-counterpart ability to influence this behavior.

The first contribution of this paper is methodological: I propose a general formalization of the concept of market discipline, which captures these different ideas. The formal definition is outcome based, and the main idea is the following: a *market* is said to impose *discipline* on an agent if its anticipated outcome influences the agent's ex-ante behavior in a socially preferable way. According to this approach, market discipline has therefore to be apprehended as the difference in chosen (or equilibrium) actions by agents under different institutional arrangement, and in particular with or without the existence of the market under consideration. I comment on several possible applications and mainly focuses in the case where market participants can *obverse*, and therefore trade on, *non-verifiable* information. This enables me to nest the model of Dewatripont and Tirole in an incomplete contract framework and to derive richer insights on the optimal timing for risk-transfer.

I consider a stylized economy in which risk-averse bankers face idiosyncratic risk on their investment portfolios. Expected return is increasing in screening effort, and bankers receive private information about returns at the time they invest. Securitization takes place in an interim competitive secondary market, and the only gains from trade lie in the diversification of idiosyncratic risk among market participants. I focus on the case in which part of the screening effort is observable but not verifiable, and I find that such an informational friction leads to a trade-off between moral hazard and adverse selection. On the one hand, ex-ante risk-sharing is not subject to adverse selection (all bankers are identical ex-ante) but embeds a moral hazard problem (insured bankers do not fully internalize the return to effort and have thus an incentive to shirk, which depresses average quality; a free-rider problem thus). On the other hand, the participants to an interim risk-sharing mechanism can be selected according to a broader information set (effort is partially observable), which mitigates the free-rider problem (this is the market discipline part of the story), but these participants are however likely to be an adverse selection of privately informed bankers.

The main conclusion of this exercise is that the conditions under which securitization is an efficient risk-sharing mechanism seem quite restrictive. First, it requires that bankers do not receive, during the issuing process, too much private information about the quality of the loans they securitize. Second, market discipline has to be strong: the securitization market outcome should be better than other mechanisms at rewarding screening effort. When this is not the case, there exist better risk-sharing mechanisms.

This relates thus to the conclusion of Dewatripont and Tirole (1994). An accurate signal on the effort-driven component of the risk has indeed to realize early, but there are two other conditions: this signal should have been non contractible and the loans should not be too prone to a *lemons problem*.

This is an interesting issue at least because the US Government seems to take for granted that such securitization should be promoted (TALF and others programs aim explicitly at restoring securitization markets) and because the "it-spreads-risk-better hypothesis" was one of the most common justifications for its existence (see for instance Duffie, 2008; Hoffmann and Nitschka, 2009, or speeches of Allan Greenspan[1]

[1] "[...] the development of financial products, such as asset-backed securities, collateral

and Ben Bernanke[2]). The present study contributes therefore to the growing literature on the costs and benefits of securitization. For instance, we know that it creates less-information-sensitive securities, which is likely to improve liquidity (Gorton and Pennacchi, 1995), which in turn can help financial intermediaries to raise funds (DeMarzo and Duffie, 1999; DeMarzo, 2005). However, it distorts screening incentives (Keys et al., 2010; Parlour and Plantin, 2008; Malherbe, 2011), and it may also create systemic risk (Coval et al., 2009; Malherbe, 2011). Finally, liquid securitization markets, while fostering long-term investment, are subject to self-fulfilling dry-ups when agents start hoarding cash (Malherbe, 2010).

The second result is the following: increasing initial risk-exposure, which I interpret as increasing leverage, mitigates interim adverse selection in securitization markets and may therefore enhance ex-post risk-sharing. This is interesting because high leverage is usually associated with "excessive" risk-taking.

Section 2 provides a formalization of market discipline and a discussion of the related literature; in section 3, I present the model of securitization with market discipline; I solve it in section 4 and derive the conditions under which securitization is efficient; in section 5, I consider the impact of of leverage on adverse selection; and section 6 concludes.

2 Market discipline

In the literature, the notion of market discipline is intimately linked to the question of whether "the market" can (and does) prevent bank excessive risk-taking. In this section, I first review the several dimensions and ideas spanned by the concept of market discipline. Then, I propose a general formalization and suggest several applications, among them is the bank excessive risk-taking issue.

Related literature

According to Flannery (2001), the concept of market discipline encompasses at least two different ideas. It refers to investor ability to observe and accurately interpret

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loan obligations, and credit default swaps, [...] facilitate the dispersion of risk." (Allan Greenspan. "*Economic flexibility*". Chicago, September 27, 2005.) Available at: http://www.federalreserve.gov/boarddocs/speeches/2005/20050927/default.htm.

[2] "Securitization and the development of deep and liquid derivatives markets eased the spreading and trading of risk." (Ben Bernanke, Jackson Hole, August 31, 2007.) Available at http://www.federalreserve.gov/newsevents/speech/Bernanke20070831a.htm)

information on bank behavior, and it also corresponds to potential-counterpart ability to influence this behavior.

In the late eighties, a first wave of empirical papers studied the former relationship but failed to find concluding evidences in its favor. An usual strategy was to regress yield spreads (or underlying implied-volatility) on bank accounting risk measures (see for instance Gorton and Santomero, 1990). A decade later, it appeared that this absence of relationship could be explained by the implicit government guarantees on subordinate debt. As the regulatory environment had evolved, further studies found significant evidences of that relationship (see Sironi (2003) for an overview of the relevant literature and an application to european banks).

To assess whether the market has indeed an influence on bank manager behavior, Nier and Baumann (2006) focus on bank capital buffers, which are assumed to result from past bank manager decisions. Big buffers are interpreted as evidences of strong market discipline. The authors find that market discipline increases with the quality of disclosure and with the proportion of uninsured liabilities but is attenuated by the presence of public implicit guarantees. Bliss and Flannery (2002) have a different approach since they look at the impact of price changes on *future* actions of bank managers. They do not find convincing evidences of such an effect.

The theoretical literature on market discipline is much thinner.

Freixas et al. (2007) do not explicitly formalize this concept but suggest that financial conglomerates, whose actions are non verifiable, are subject to market discipline because their trading branch's risk-taking behavior is observable, which has an impact on the conglomerate liability prices.

In a bilateral lending framework, Boot and Schmeits (2000) assume that the borrower effort is not verifiable. Effort occurs after the loan has been contracted, but there is a positive probability that the lender observes it and adapts (unilaterally and retroactively) the borrowing terms. Such possibility is taken into account by the borrower when deciding upon effort level. This ex-ante incentive is however not consistent either with the model time-line or with the non-contractible effort assumption. The author acknowledge this shortcoming and claim that an implicit short-run debt roll-over mechanism could justify such "market discipline". Indeed, it is well known that short-term debt can be used as a commitment device, both to contain risk-shifting behavior (Flannery, 1994) and to circumvent renegotiation problems (Diamond and Rajan, 2001).

None of these papers carefully define market discipline as a theoretical concept.

This is what I propose in the next paragraph.

A formalization of market discipline

If the existence of a market is to impose discipline on an agent, it is natural to compare situations, in terms of incentives, when there is a market, and when there is not. Also, as market discipline is often seen as complementary to financial regulation, it suggests that it refers to situations where agents' individual incentives are not aligned with social interest.

The idea I want to formalize is thus the following: the market "imposes discipline" on an agent if the anticipation of the market outcome by this agent influences his actions in a socially beneficial way.

Here is how I propose to formalize the concept:

Consider an agent that takes an action $a \in [\underline{a};\infty[$. For simplicity, I assume that the social optimum is $\underline{a}$, and that social welfare is continuously decreasing in a.

The agent maximizes utility $u(a,\Phi)$, which depends on his action a, and on the institutional arrangement Φ. Here, one can think of this institutional arrangement as everything that would affect agent's utility given his action (for instance, it could be the regulation in place, taxes and subsidies, the existing securities, the contracting space, etc...). In general, his utility may also directly depend on other elements such as is own other actions or other agents' actions, but I abstract here from these for simplicity.

Let $a^*(\Phi)$ denote the agent's private optimum given Φ, that is:

$$a^*(\Phi) = \arg\max_a u(a,\Phi),$$

which I assume being a singleton.

Denoting Φ^0 the initial institutional arrangement, and Φ^m the new institutional arrangement when a market m is created, I can state:

DEFINITION 1

Market m imposes "discipline" on the agent if $a^*(\Phi^m) < a^*\left(\Phi^0\right)$.

This definition is thus outcome based, and independent of a specific model. Essentially, it proposes to assess market discipline as the impact "at equilibrium" of the existence of a given market on a given action. A typical mechanisms that could generate market discipline is when a market outcome is payoff relevant to an agent, and depends on his action. Still, nothing guarantees that, when choosing his action in anticipation of the market outcome, the agent will choose a socially preferable action[3].

Application 1: the market as a mechanism to elicit *non verifiable* information

Imagine that action a is *observable* but *non verifiable*, that is a cannot be proved in court[4]; contracts (or regulation) contingent on a can therefore not be enforced.

Participation in a market is nevertheless a voluntary decision: it is motivated by gains from trade and can be based on any *observable* information. Thus, if *non-verifiable* information is *observed* by market participants, it may still have an impact on agent ex-ante behavior as they anticipate the consequence of their actions on the market outcome. If this induces agents to take socially preferable actions, this is an example of market discipline. This is the mechanism I exploit to study the optimal timing of risk transfer in the next sections of the paper.

Such example is closely related to renegotiation processes in Hermalin and Katz (1991). They indeed show how, in the context of a bilateral agency problem, the reception by the principal of a *non-verifiable* signal can be exploited to induce more efficient actions through renegotiation. What I have described here is the similar in a market set-up. In a sense, in this example, the market can thus be interpreted as a multilateral renegotiation mechanism.

Application 2: banking regulation assessment

The formalization above may shed light on the shortcomings of banking regulation regarding the the role of market discipline..

The Basel II regulation postulates that mandatory and standardized disclosure improve banking sector safety and soundness through market discipline[5]. Although disclosure is likely to improve information observability, the underlying logic seems to embed important shortcomings.

Assuming that the agent is a bank manager and the action is “taking on too much risk”, it indeed remains to specify:

[3]When markets are complete, resulting allocations (of risks for instance as in Arrow 1964) are generally efficient. Opening a new market has therefore no impact. However, when markets are incomplete, opening a new market may have ambiguous efficiency implications (for instance, in Jacklin (1987), opening a market impairs risk-sharing).

[4]See the incomplete contract literature. For instance Hart and Moore, 1988, and Tirole (1999)

[5]“Market discipline imposes strong incentives on banks to conduct their business in a safe, sound and efficient manner.” (Basel Committee BIS, 2001). See the appendix for details.

1. Which market is supposed to impose discipline on bank manager risk-taking behavior;
2. How the market outcome depends on the disclosed information;
3. To what extent the market outcome is payoff-relevant to the bank manager.

A striking cases arises when bank manager compensations are designed so as to maximize shareholder value. Since equity value is convex in the value of the underlying asset, keeping all other things equal, a stock price increases with risk-taking (Merton, 1977). One can cast serious doubts on the ability of equity markets to curb excessive risk-taking indeed.

Application 3: sovereign risk

Finally, my definition of market discipline can also be applied to sovereign risk related issues.

For instance, it is well understood that short-term borrowing can be a commitment device that mitigates sovereign risk (see for instance Jeanne, 2009; Rodrik and Velasco, 1999). Here is the story in terms of market discipline: actions are foreign-investor unfriendly policies. Those policies are arguably *observable*, but are not contractible (or *not verifiable* in the sense that there does not exist a court that could enforce a contract specifying that a sovereign government would not set those policies). If the country (or the firms in the country) borrow short-term, foreign investor can run away if such policies are set. If this potential run is taken into account by the government when setting policies, it is thus subject to market discipline. Note that this is actually beneficial to the country since the decrease in the likelihood of such policies being implemented improves the country's borrowing terms in the first place.

Also related but perhaps in a subtler way is the work of Broner et al., 2010. They consider the sovereign risk arising from strategic enforcement issues: the government may decide not to enforce claims to foreigners. What they show is that the existence of a well functioning secondary market (where foreign investors can sell to local investors) annihilate the strategic enforcement threat and mitigates sovereign risk. The action is here "strategic enforcement", which is observable but not contractible because of sovereignty. In this case, the existence of the market is thus, in itself, the crucial element.

3 A model of securitization with market discipline

This is a single period model with a unique and non storable consumption good.

Bankers

There is a measure one of bankers. Each of them is endowed with one unit of the consumption good at the beginning of the period. They are risk-averse, which captures the idea that there are good reasons to diversify risk at the bank level[6], which is my starting point. Specifically, they maximize expected utility of end-of-period consumption net of effort cost:

$$U_0 = E_0[\ln C] - ke$$

C denotes end-of-period consumption, $e \in [0;\bar{e}]$ is the decision variable relative to screening effort, and k is a positive. Bankers have the specific skills required to screen and select loan applicants. However, screening implies effort and is thus a costly activity. Loans yield a return R_j. They can either succeed, and yield a high return R_H per unit invested, or fail, in which case the unitary payoff is $R_L < R_H$. The probability of success depends on screening effort:

$$prob(R_H) = e + \theta_i$$

where and $\theta_i \in \{-\sigma; \sigma\}$ is a binary random variable with $prob(\sigma) = 0.5$ and $\sigma \geq 0$. θ_i captures the noise, that is the probability of success that does not depend on the banker's screening effort. Note that it will also be a source of information asymmetry (see below).

For simplicity, I assume that k is the same for all bankers and that each banker fully invests in a single loan, of size 1. The probability distribution of the loan return might thus be interpreted as that of the whole portfolio of the bank. In reality, bank portfolios are of course diversified to some extent. What I want to capture here is the fact that there are frictions (local knowledge of firms for instance) that prevent banks to fully diversify all idiosyncratic risk at the loan portfolio level. To make things interesting, I assume that screening effort is efficient:

[6] It is a strong assumption per se. A simple argument could be, for instance, that shareholders can diversify their portfolio and that there is thus no need to do it at the financial intermediary level. In this paper, I take an "in between" standpoint. I assume that there are good reasons to diversify risk at the intermediary level, and I compare different risk-sharing mechanisms.

$$k < R_H - R_L \tag{1}$$

Information structure

Informational frictions have an important place in the model.

Firstly, I assume that bankers are better informed about the quality of the loan they have issued. Concretely, they receive a private signal just after issuing their loans. For simplicity, they privately observe the realization of the noise:

$$\theta_i \in \{-\sigma; \sigma\}$$

σ is therefore a measure of information asymmetry.

Secondly, I assume imperfect information about banker screening effort. Effort generates two public signals.

The first one:

$$s_v(e) = min(e, \underline{e})$$

where $0 < \underline{e} < \overline{e}$, is *verifiable*. Any effort level inferior to $\underline{e}$ is thus ex-ante contractible and fairly rewardable. Hence, it does not yield a moral hazard problem. Furthermore, as it is assumed to be efficient (1), it is always properly exerted at equilibrium. Without loss of generality, I thus assume that the optimal choice of effort is bounded below by $\underline{e}$.

The second signal:

$$s_{nv}(e) = min(e, e^o)$$

where $\underline{e} \leq e^o \leq \overline{e}$, is *non-verifiable*. Any effort level up to e^o is therefore *observable* but cannot be proved in court; it is thus not contractible.

Finally, I impose the following regularity conditions: $\overline{e} + \sigma \leq 1$ and $\underline{e} - \sigma \geq 0$, which simply ensure that the probability of success is in $[0; 1]$.

Risk-sharing

Since bankers are risk-averse, risk sharing can be welfare improving. Risk-sharing possibilities are however limited by information asymmetries: when a banker is involved in a risk-sharing mechanism that is contingent on R_j but does not depend on his true effort level e, he does not fully internalize the benefits of effort and has an incentive to shirk.

The main purpose of this model is to compare the outcome of different institutional arrangements, which I call mechanisms. Mechanisms mainly differ on the available information-set upon which they can be based. The most natural way to interpret difference in the information set is that different mechanisms have different timing. I therefore make a distinction between ex-ante risk-sharing mechanisms (before effort is exerted and loans are issued) and interim risk-sharing mechanisms (after loans are issued but before the payoffs are observed), which I interpret as securitization. For simplicity, I first use an equilibrium approach to expose the results in a very stylized securitization equilibrium. Later I show that it corresponds to an interim optimal contract under some assumption, and explain why the results generally hold under different assumptions.

Concretely, this paper focuses on three classes of mechanisms.

1. Ex-ante risk-sharing contracts $x(R_j)$, where $\left\{R_j\right\}$ is the space of ex-ante contractible information[7]. These contracts specify the level of banker consumption contingent on the realization of R_j.

2. Securitization on a secondary market, which will be shown to correspond to an interim risk-sharing contract $y(R_j, e \leq e^o, t_i)$. Payoffs are thus contingent on R_j, and depend on observable information $e \leq e^o$ and on t_i, the self-reported type of the banker.

3. Ex-ante contracts $z(R_j)$ that anticipate the existence of the interim securitization market.

I compare the two first mechanism in section 4, and I study the third one, which is in fact a mix of the first two, in section 5.

4 A trade-off between moral hazard and adverse selection

The main question is the following: given the information structure, is it more efficient to share risk *ex-ante* or *ex-interim*. Here is the trade-off: an ex-ante mechanism is not subject to adverse selection (all bankers are identical ex-ante) but embeds a moral

[7] Recall that I assumed a minimal effort level of $\underline{e}$.

hazard problem (insured bankers do not fully internalize the return to effort and have therefore an incentive to shirk, which can be interpreted as free-riding in this context since the quality of the market portfolio depends on individual effort). On the other hand, the participants to an interim mechanism can be selected according to a broader information set ($s_{nv}(e)$ is then observable), which mitigates the free-rider problem (this is the market discipline dimension), but these participants are likely to be an adverse selection of privately informed bankers (i.e. agents for which $\theta_i = -\sigma$).

As a benchmark, I first characterize the first-best allocation. Then I show how moral hazard restrict ex-ante risk-sharing on the securitization market (*lemma 1*); I formalize the welfare loss due to adverse selection (*lemma 2*); and I compare the outcomes (*proposition 1*). Then, I discuss the results and finally compare securitization with potential other *interim* risk-sharing mechanisms.

Benchmark: the first-best allocation

At the first-best allocation, since screening effort is assumed efficient (1), bankers should exert full effort: ($e = \bar{e}$). This maximizes the size of the pie. Then, idiosyncratic risk is diversified to provide them with full-insurance:

$$C^{FB} = \bar{e}R_H + (1-\bar{e})R_L$$

4.1 Ex-ante risk-sharing mechanisms

In this subsection, I show how moral hazard restricts ex-ante risk-sharing. It is of course well known that private information about effort embeds a moral hazard problem[8]. However, it will prove useful to have it formalized in this set-up and to show that k is an indirect measure of the welfare loss.

To make my point, it is not necessary to explicitly look at the implementation of a given allocation. I therefore take an optimal contract approach and describe the optimal allocation without specifying the underlying mechanism[9].

Before their screening decision, bankers are all identical. It is therefore possible to set up a full risk-sharing mechanism. However, this would cause a free-rider problem because screening is a costly activity, and full insurance implies that the return on effort are no longer fully internalized. Therefore, the optimal ex-ante contract should balance insurance motive with incentives to screen.

[8] See for instance Holmstrom (1979)

[9] The optimal contract can for instance be implemented with bankers taking equity cross-participation.

The ex-ante optimal risk-sharing contract $x_j \equiv x(R_j)$ solves the following program:

$$\underset{x_j}{max} U_{ea} = E[\ln C_j] - ke^* \tag{2}$$

$$\begin{cases} & C_j = R_j - x_j \\ IC_e: & e^* \in \underset{e}{argmax} E\left[\ln C_j\right] - ke \\ RC: & \underset{j}{\Sigma} C_j = e^* R_H + (1-e^*) R_L \end{cases}$$

Where $x_j = C_j - R_j$ is the transfer an agent receives in the case its loan portfolio yield a return R_j. The second constraint states that e^* should be the optimal effort level under that contract, and the third one is the resource constraint: the contract should break-even.

LEMMA 1

1. *Since effort is costly ($k > 0$), ex-ante risk-sharing mechanisms cannot implement the first-best allocation.*
2. *The welfare loss under ex-ante risk-sharing (with respect to the first-best) increases with k.*

Proof: see appendix

Due to the linear cost structure of the model, there are only two candidates for the optimal contracts: either full insurance and inefficiency up to the contractible level of effort ($\underline{e}$), or the efficient effort level ($\bar{e}$) but limited insurance to preserve incentive.

The solution to the latter is given by:

$$x_L^* = \frac{R_H - R_L exp(k)}{1/\bar{e} - 1 + exp(k)}$$

Which is decreasing in k. Then, the higher k, the less agents are insured at equilibrium, and the higher the welfare loss with respect to the first-best. Note that one can then find a threshold for k, from which a full insurance contract would Pareto dominate this contract. Of course, the latter implies the minimum effort level $\underline{e}$. From this threshold, increasing k no longer has an impact on welfare loss.

4.2 Securitization

As already mentioned, I expose here the results in a very stylized securitization equilibrium. This is not restrictive in the sense that the informational frictions would qualitatively affect risk-sharing in the same way in any interim mechanism (see subsection 4.5).

Securitization takes place in an interim competitive secondary market where the gains from trade lie in the diversification of idiosyncratic risk. There are no transaction costs, but trade might be limited by information asymmetry.

Two pieces of information are potential sources of adverse selection in the securitization market:

- The private signal (θ_i); it generates *interim* heterogeneity and leads to a text-book lemons problem.

- Generally, the efficient effort level is superior to what is observable. Hence, when bankers are sharing risk on the securitization market, they also face the temptation to free ride. In such a case, the participants in that market are likely to be an adverse selection of free riders.

In the following paragraph, I explain how, in the cases of interest, effort is correctly inferred by market participants at equilibrium. It is thus not a source of adverse selection.

Market discipline and optimal effort under securitization

As effort is efficient (1), bankers are better-off exerting effort as long as it is fairly rewarded. In a competitive market, the terms at which bankers can trade reflect their *observed* effort level.

Since effort is observable up to e^o, such effort levels can be fairly rewarded. e^o is thus a lower bound for the equilibrium effort level of bankers that participate in the securitization market.[10]

From here onward, I assume that the optimal effort-level under securitization is e^o. The idea is that the free-rider problem precludes the fair reward of higher effort levels. This is without loss of generality because when such higher effort level are individually optimal (i.e. $e > e^o$ is *incentive compatible*) under securitization, it has to be true under ex-ante risk-sharing too. Therefore, the non-verifiable signal $s_{nv}(e)$ is “useless”, and securitization cannot be more efficient than ex-ante risk sharing[11].

[10] Another way to interpret this is that shirking bankers (those that exerted lower effort levels), are identified and excluded from the market. That trade occurs after the information has arisen is of course crucial.

[11] Formally, when the individually optimal effort under securitization is higher than e^o, securitization is less efficient than ex-ante risk sharing. See the proof of *proposition 1* in the appendix.

Let me define the following measure of *market discipline*[12]*:*

$$\delta \equiv \frac{e^*_{secu} - \underline{e}}{(\overline{e} - \underline{e})}$$

where e^*_{secu} is the choice of effort in a securitization equilibrium (see below).

Since, in the cases of interest, $e^*_{secu} = e^o$, market discipline is determined by the proportion of *non verifiable* effort that is *observable* (note that $\delta \in [0;1]$).

Securitization equilibrium

At the time they issue loans, bankers receive a private signal $\theta_i \in \{-\sigma, \sigma\}$ on the probability of success. From here onward, I will name "H-types" agents who got the positive signal ($\theta_i = \sigma$), and "L-types" the other ones. I also denote $q_i \equiv e + \theta_i$ the interim, privately known, probability of success.

I consider a competitive market in which bankers issue claims to shares of their loan and buy shares of the market portfolio. I assume that it is not possible to monitor trade.[13] As a consequence, bankers cannot credibly commit to retain part of the risk on their balance sheet, and the price is linear.[14]

Since all participants in a securitization market choose the same effort level (that is: e^o, see the argument above), the price at which loans trade in that market is the same for everyone. Trading is therefore equivalent to swapping 1 to 1 unit claims to private return R_j with claims to the market return, which I denote R^m.

In this case, a i-type banker solves:

$$\max_{\alpha_i} U_i = E\left[\ln C_{ij} \mid \theta_i\right] \tag{3}$$

$$s.t. \begin{cases} C_{ij} = \alpha_i R^m + (1-\alpha_i) R_j \\ 0 \leq \alpha_i \leq 1 \end{cases},$$

where $\alpha_i \equiv \alpha(\theta_i)$ denote the portfolio share a i-type banker decides to sell. There-

[12] I assume that the maximum sustainable effort level under securitization would be $\underline{e}$ if $s_{nv}(e)$ were not observed. This is without loss of generality because, when it is not the case, it suffices to redefine the lower bound of effort.

[13] This is however not a crucial assumption, and it is probably more realistic than the opposite. In reality, it is indeed almost impossible to know the accurate hedging position of a counterpart. See subsection (4.5) for a discussion and the appendix for an example of equilibrium with monitoring.

[14] In theory, retention could be used as a signaling device by H-types. However, if transactions cannot be monitored, L-types could mimic the signal and benefit from the cross-subsidy *and* still fully share the remaining risk among themselves.

fore, I have:

$$R^m \equiv \frac{\alpha_H E[R \mid \theta_H] + \alpha_L E[R \mid \theta_L]}{2}$$

Of course, $R^m \geq E[R_j \mid \theta_L]$ and thus $\alpha_L^* = 1$. Even without the participation (and the cross subsidy) of the H-types, L-types are best-off fully diversifying risk.

Since $R^m < E[R_j \mid \theta_H]$, the decision of the H-types is less trivial: there is a lemons problem in the market and they face a trade-off between expected return and insurance. The relevant first order conditions is:

$$\frac{q_H(R^m - R_H)}{C_{HH}} + \frac{(1-q_H)(R^m - R_L)}{C_{HL}} = 0 \tag{4}$$

This condition ensures that a marginal increase in α_H leaves expected utility unchanged. That is: the additional decrease in consumption volatility ($R_L < R^m < R_H$) is exactly offset by the loss of expected consumption ($R^m < E[R]$).

From (4) I get:

$$\alpha_H^* \equiv \alpha_H(R^m) = \frac{R_H(1-q_H)}{R_H - R^m} - \frac{R_L q_H}{R^m - R_L}$$

.

Hence,

$$R^m(\alpha_H) = E[R \mid e] - \sigma(1-\alpha_H^*)\frac{[R_H - R_L]}{1+\alpha_H^*} \tag{5}$$

and there is a unique fixed point $R^* = R^m(\alpha_H(R^*))$ that pins down the equilibrium in that market. The implied allocation is then:

$$\begin{array}{lcl} C_{LL}^* = R^* & ; & C_{HH}^* = R_H + \alpha_H^*(R^* - R_H) \\ C_{LH}^* = R^* & ; & C_{HL}^* = R_L + \alpha_H^*(R^* - R_L) \end{array} \tag{6}$$

In summary, L-types are perfectly insured and are cross-subsidized by H-types. The latter are happy to cross-subsidize L-types in exchange of some insurance. Finally, from an ex-ante perspective, the cross-subsidy provides insurance, though not complete, against the noise component of the risk (θ_i).

LEMMA 2

1. *When either there is information asymmetry about returns ($\sigma > 0$), or when market discipline is not perfect ($\delta < 1$), securitization does not implement the first best allocation.*

2. *The welfare loss under securitization (with respect to the first-best allocation) is increasing in information asymmetry (σ) and decreasing with market discipline (δ).*

Proof: see appendix.

The main intuition is the following. First, it is well known that an insurance mechanism is likely to attract an adverse selection of agents. The severity of this problem increases obviously with σ[15]. Then, when agents can unload risk from the balance sheet, the free-rider problem limits sustainable level of effort. This effort level depends on the market ability to observe non-verifiable effort (which determines also δ at equilibrium). When $\delta < 1$ the first-best level of effort is thus not sustainable.

I can now compare this allocation with the one obtained under ex-ante risk-sharing and assess which one is optimal.

4.3 Which one is optimal?

PROPOSITION 1

1. *When $e^o = \underline{e}$, securitization is less efficient than ex-ante risk sharing;*

2. *When information asymmetry is limited (σ is small), there is a threshold level for market discipline ($\hat{\delta}$) from which securitization is more efficient than ex-ante risk-sharing;*

3. *this threshold is increasing in information asymmetry (σ), and decreasing in the cost of effort (k).*

Proof: see the appendix.

The first element of the proposition is obvious but important: *when $e^o = \underline{e}$*, the *observable* but *non-verifiable* signal is vacuous, hence there cannot be market discipline *($\delta = 0$)*. Since interim private information (θ_i) yields a lemons problem, it is preferable to share risk before such information has arisen.

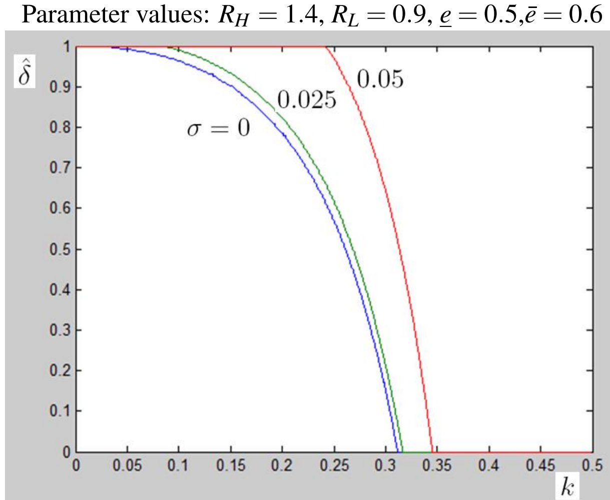
The intuition for the second part of the proposition goes as follows. Strong market discipline means that high levels of effort *and* insurance are compatible. When the underlying welfare gains are not totally offset by adverse selection in the securitization market (this is case when σ is small enough), securitization is more efficient than ex-ante risk-sharing.

[15]That is: $\frac{\partial \alpha_H^*}{\partial \sigma} < 0$

The minimum level of market discipline for this to be true depends on information asymmetry σ and on the cost of effort k. It depends on the former because it drives adverse selection and on the latter because it determines the severity of the moral hazard problem that restricts ex-ante risk-sharing possibilities.

Figure 1 illustrates *proposition 1*.

Figure 1: The market discipline threshold
Parameter values: $R_H = 1.4$, $R_L = 0.9$, $\underline{e} = 0.5$,$\bar{e} = 0.6$



The three curves represent the market discipline threshold $\hat{\delta}$ as a function of the cost of effort k for $\sigma = 0$, $\sigma = 0.025$, and $\sigma = 0.05$.

Below the "threshold lines" are the regions where ex-ante risk-sharing is more efficient than securitization. One can see that the region in which securitization is efficient shrinks as σ increases. Thus, securitization is an optimal risk-sharing mechanism only if market discipline is strong enough *and* information asymmetry is limited. Note that when k is high, ex-ante risk-sharing implies the inefficient level of effort ($\underline{e}$). In such case, it is very costly to incentivize agents with an ex-ante contract, and $s_{nv}(e)$ is most beneficial.

4.4 Can risk-sharing motives account for the boom of securitization?

There exist thus conditions under which securitization is more efficient than ex-ante risk sharing. Strong market discipline and limited information asymmetry make indeed the former more attractive than the latter. Whether those conditions are satisfied in reality is an empirical question and is therefore beyond the scope of this study.

Still, it is worth to relate the results to the literature and discuss the lemons problem issue in securitization markets.

Contrarily to the banks of my model, real ones are not single-loaned. Bankers may thus cherry-pick the loans they securitize, in which case the lemons problem might be severe. However, DeMarzo and Duffie (1999) and DeMarzo (2005) have shown that pooling and tranching cash flows can usually circumvent such a problem. This is confirmed by Holmström (2008), who points out that, in normal times, AAA asset-backed securities are low-information-sensitive assets (see also Gorton and Pennacchi, 1995). These arguments can probably explain why securitization markets have been rather liquid until the crisis, which also suggest that they did not exhibit much adverse selection[16].

The key point is however that pooling and tranching loans circumvents the lemons problem *because* the issuer (the most informed agent) retains the riskiest tranche. Such a mechanism is therefore of little use for risk-sharing purpose[17].

My tentative conclusion is therefore that the *it-spreads-risk-better* hypothesis is not very likely to account for the boom of securitization in the last two decades before the crisis.

4.5 Interim mechanisms

The question of whether it is preferable to share risk ex-ante or ex-interim is not confined to the case of the stylized securitization equilibrium I have exposed. After all, what is important is simply that adverse selection restricts interim risk-sharing but that strong market discipline might more than offset this effect. The analysis could thus be readily extended to other *interim* risk-sharing mechanisms.

Another related question is whether the securitization equilibrium above is interim efficient. In this subsection, I generalize the interim risk-sharing problem and I relate it to the relevant literature.

The general program for an interim optimal risk-sharing mechanism $y_{ij} \equiv y(R_j, t_i, e^o)$ is:

$$\max_{y_{ij}} = E[\ln C_{ij} \mid \theta_i]$$

[16]See Eisfeldt (2004), and Malherbe (2010) for models of adverse-selection-driven illiquidity

[17]In DeMarzo and Duffie (1999),DeMarzo (2005), and Gorton and Pennacchi, 1995 trade is indeed driven by difference in opportunity cost rather than by risk-sharing motive.

$$
s.t. \begin{cases} \quad C_{ij} = R_j + y_{ij} \\ IC_H: \quad q_H \ln C_{HH} + (1-q_H) \ln C_{HL} \geq q_H \ln C_{LH} + (1-q_H) \ln C_{LL} \\ IC_L: \quad q_L \ln C_{LH} + (1-q_L) \ln C_{LL} \geq q_L \ln C_{HH} + (1-q_L) \ln C_{HL} \\ IR_i: \quad q_i \ln C_{iH} + (1-q_i) \ln C_{iL} \geq u_i \\ RC: \quad \sum_{ij} C_{ij} \leq E\left[R \mid e^o\right] \end{cases},
$$

where u_i denotes the i-type "outside option".

A contract y_{ij} can be interpreted as a revelation mechanism where $t_i \in \{-\sigma, \sigma\}$ is the self-reported type of the agent. So, y_{ij} is the transfer made *ex post* to an agent that declared *ex-interim* being of type i and whose project return end up to be R_j. C_{ij} denotes his resulting consumption.

From (6), one can compute the y_{ij}'s that replicate the allocation resulting from securitization:

$$
y_{ij} = R_j - C^*_{ij}
$$

Under such a contract, the resource constraint *RC* would of course be binding. Therefore, I can focus on *IC* and *IR* constraints to check whether it is a constrained-efficient allocation.

First, under the linear price approach, the first order conditions of the securitization problem ensure that both IC_L and IC_H are satisfied. The menu for α is indeed the same for both types, and they choose the optimal one according to their respective first order condition.

Setting $u_L = \ln\left(E\left[R_j \mid \theta_L\right]\right)$, which is not very restrictive as it allows L-types to deviate collectively, IR_L is obviously satisfied and usually not binding: L-types are more than happy to participate in a mechanism that provides them with full insurance and positive cross-subsidy. An implication is that a potential Pareto improvement should not decrease the average resource dedicated to the consumption of the L-types.

The H-type outside option u_H depends on specific assumptions on the market structure. For instance, if one considers that agents can only deviate alone, the outside option would correspond to $\alpha_H = 0$ and the constraint would of course be satisfied. This is a restriction I could impose to ensure that securitization is interim efficient.

However, with other specifications of u_H, different kinds of equilibria could potentially arise. Following the seminal work of Rothschild and Stiglitz (1976), there is a huge body of literature dedicated to that problem. It is for instance well understood that the equilibrium in such an economy depends on the "insurance market structure", that is the contract space, market monitoring possibilities, short-selling constraints, etc. (see Bisin and Gottardi, 2006, Netzer and Scheuer, 2008). For instance, H-type agents would be better off if they could find a way to advantageously self-select and share risk among themselves only. A way to achieve this could be to impose the retention of part of the portfolio as a condition to participate in the mechanism (in a competitive market this is equivalent to non-linear pricing). However, this requires that trade monitoring is possible[18], an alternative that I explore in the appendix, but that does not change the main results.

Another example for that is the following. If short selling were allowed in my set-up, cross-subsidy would not be possible at equilibrium and separating equilibria could arise. This could make securitization ex-ante less attractive but would not change the main results either. Note also that, if the pooling equilibrium I have described ex-ante Pareto dominates the putative separating ones, short-selling constraints might be an endogenous restriction decided upon at date 0 to promote pooling at date 1.

5 Leverage, maximal risk exposure and improved risk sharing

When agents are risk-averse, it is commonly believed that they would turn down contracts that increase risk without improving expected return. This is of course different when agents are assumed risk-neutral and/or have limited liabilities. In that case, risk-shifting behavior is a pretty standard result[19].

In this section, I neutralize risk-shifting and I illustrate another mechanism by which risk-averse agent expected utility may increase with initial risk-exposure. The main intuition is that increasing the *ex-ante* risk exposure of the agents mitigates *interim* adverse selection[20] and therefore may lead to better *ex-post* insurance.

Concretely, I consider that agents anticipate the existence of an interim securitiza-

[18] This is the equivalent to contract exclusivity in Rothschild and Stiglitz (1976) and Bisin and Gottardi (2006)

[19] See Jensen and Meckling (1976) for the classical risk-shifting argument.

[20] This relates to Eisfeldt (2004) where adverse selection depends on the average motive for trading, and Malherbe (2010) where agents fully invested in long term projects are more likely to be willing to trade for liquidity reasons.

tion market when they write ex-ante contract, and I focus on contracts that increase agent initial risk-exposure, which I interpret as leverage contracts (they imply positive transfers to successful bankers ($x_H > 0$)).

I am thus looking for the leverage contract $z_j \equiv z(R_j)$ that solves:

$$\max_{z_j} U_{lev} \equiv E[\ln C_{ij}] - ke^*$$

$$s.t. \begin{cases} & C_{ij} = \alpha_i R^m + (1-\alpha_i)(R_j + z_j) \\ ICe: & e^* \in \underset{e}{argmax} E[\ln C_{ij}] - ke \\ RC: & \sum_{ij} C_{ij} = E[R \mid e] \\ IC\alpha: & \alpha_i \in \underset{\alpha_i}{argmax} E[\ln C_{ij}] \end{cases},$$

where z_j is the transfer an agent would received in the case its initial loan portfolio yields a return R_j, and $RC$is the resource constraint. I also assume limited liabilities, but I impose the following restriction to prevent strategic default and rule out risk-shifting: $z_j \geq -R_j$.

PROPOSITION 2

Ex-ante leverage:

1. *increases the participation of* H-types *in the interim market* $\left(\frac{\partial \alpha_H^*}{\partial z_H} > 0\right)$*;*
2. *might improve expected utility in the securitization equilibrium and, therefore, decrease the market discipline threshold from which securitization is more efficient than ex-ante risk-sharing.*

Proof:

1.

The first order condition for an interior α_H^* yields:

$$\alpha_H^* \equiv \alpha_H(R^m) = \frac{(R_H + z_H)(1-q_H)}{(R_H + z_H) - R^m} - \frac{(R_L + z_L)q_H}{R^m - (R_L - z_L)}$$

Since RC implies that z_H and z_L have opposite signs, I have $\frac{\partial \alpha_H^*}{\partial z_H} > 0$. □

The intuition is that *ex-ante* leverage renders therefore agents more eager to share risk *ex interim*. Thus, H-type participation increases, which mitigates adverse selection.

2.

The main effects of leverage on expected utility are the following:

A negative direct effect: all other things equal, a transfer at fair odds from C_{HL} to C_{HH} decreases expected utility:

$$\frac{\partial U_{lev}}{\partial z_H} \mid_{\alpha,R^m} \text{constant} < 0$$

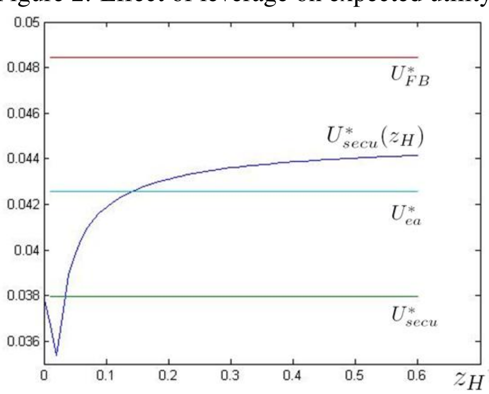
A positive indirect effect: the decrease in adverse selection (increase in α_H^*) increases R^m:

$$\frac{\partial R^m}{\partial \alpha_H^*} > 0$$

which implies better cross-subsidization and higher expected utility. Note that R^m as a positive feedback effect on α_H^*, the effects reinforce thus each other (R^* is thus indubitably higher). Furthermore, the higher α_H^* the lower the negative direct effect.

Which effect dominates depends on parameter values. A typical case is the one where a small z_H decreases expected utility (the negative direct effect dominates) but, as z_H increases, the positive effect more than compensates: expected utility finally increases. *Figure 2* illustrates such a case. In the depicted example, ex-ante risk-sharing dominates securitization *without leverage*, but this is the opposite *with full leverage*. The existence of this example proves *2*.□

Figure 2: Effect of leverage on expected utility



Parameter values: $R_H = 1.4$, $R_L = 0.9$, $\underline{e} = 0.5$,$\bar{e} = 0.6$, $\delta = 1$,$k = ln(1.25)$, and $\sigma = 0.05$.

Discussion

This result might be surprising at first but the logic is similar to that in Eisfeldt (2004) and Malherbe (2010): what determines the severity of the *lemons problem* is the average reason to trade and, when (all other things equal) agents face larger risks, trades for risk-sharing motive get on average more likely.

However, this allocation can obtain only when leverage, and thus initial risk-exposure, is at least observable. Indeed, boosting initial risk-exposure mitigates the lemons problem, which improves interim liquidity, but interim liquidity does not make initial risk exposure more appealing per se. There is thus a potential free-rider problem and a formal contract on leverage (if verifiable), or strong market discipline (if leverage is observable only), is needed to sustain such an equilibrium. In the latter case, the market should thus be able to accurately assess agent hedging positions, which seems a strong assumption.

Hence, one can cast doubt on the possibility to implement such an allocation. Still, I should mention that I took a very conservative approach to leverage as I considered a mean preserving dispersion of the returns. I have shown in Malherbe (2010) that when there is a risk-return trade-off, the existence of a secondary market creates strong strategic complementarities in the extent to which agents expose themselves to maturity mismatch. This mechanism could perhaps be exploited in the case of leverage.

This result may thus raise an interesting question: was the rise in leverage before the 2007-2009 crisis (see Adrian and Shin, 2010) excessive and driven by risk-shifting motive only, or was it also a way to commit to future market participation in a coordination equilibrium?

6 Conclusion

In this paper I have provided a general and outcome-based formalization of market discipline. I have shown that this concept can be used to study the temporal dimension of risk-sharing contracting in an incomplete contract framework: when non-contractible information arises with time, it might makes sense to delay the risk transfer until then.

What this exercise tells us it that the conditions under which securitization is an efficient risk-sharing mechanism seem quite restrictive:

- An accurate public signal on banker effort has to realize early, and this signal should have been non contractible so that the securitization market outcome rewards more effectively diligent loan origination than an ex-ante contract would do.

- and the securitized assets should not be too prone to a *lemons problem*.

Otherwise, there exist better risk-sharing mechanisms, which suggests that securitization helps to spread risk better for a very restricted class of assets only.

The moral-hazard versus adverse selection trade-off I have highlighted is not, in itself, the most interesting result of the paper; it is rather mechanical indeed. What is interesting is the role of market discipline plays in its resolution and the questions this raises

- *Within the incomplete contracts* paradigm:
  - To which extent is the market really able to extract information on banker effort?
  - To which extent and *why* is that information non contractible ex-ante?
- And from a *complete contract perspective*:
  - How well do markets for securitized assets elicit observable but non-verifiable information?
  - To which extent does private information impair such a mechanism?

To illustrate the kind of stakes embedded in these questions, let me suggest the following introspection exercise to the reader: as an investor, would you promise a banker today that you will buy a non-existing-yet financial product from him in the future "provided that it will be rated AAA", or would you prefer to wait until it is produced and you can have a look at it before deciding whether you will buy it or not?

Finally, the contribution of this model of market discipline goes beyond temporal risk-sharing concerns and might be of great use for policy issues. For instance, the Basel II Accord acknowledged the role of market discipline in financial stability. According to my model this is equivalent to assuming that the market is able to extract information that is not ex-ante contractible upon, and that such observability feeds back into bank risk-taking behavior in a way that favors financial stability. To my knowledge, there exists no formal model that maps Basel II three Pillars into such mechanisms.

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A Additional Proofs

A.1 Proof of LEMMA 1

1. At the first-best, there is full insurance, i.e. $C_j = C^{FB}$, which is incompatible with the first order conditions for $e^* = \bar{e}$:

$$\ln(C_H) - \ln(C_L) \geq k$$

$\square$

2. Due to the linear cost structure of the model, there are only two candidates for the optimal contracts[21]: either full insurance and inefficiency up to the contractible level of effort ($\underline{e}$), or the efficient effort level ($\bar{e}$) but limited insurance to preserve incentive.

The latter solves:

$$\underset{x_j}{max} = E[\ln(R_j + x_j)] - k\bar{e}$$

$$\begin{cases} IC_e: & \bar{e} \in \underset{e}{argmax} E[\ln C_j] - ke \\ RC: & \bar{e}x_H + (1-\bar{e})x_L = 0 \end{cases}$$

To find the highest x_L such that $\bar{e}$ is sustainable, I set IC_e binding:

$$\ln(R_H + x_H) - \ln(R_L + x_L) = k \tag{7}$$

Which, combined to RC, yields:

$$x_L^* = \frac{R_H - R_L exp(k)}{1/\bar{e} - 1 + exp(k)}$$

Which is decreasing in k.

One can then find a threshold for k, from which a full insurance contract would Pareto dominate this contract. Of course, the latter implies the minimum effort level $\underline{e}$.

[21] It can be formally proved as follows: starts by assuming that $e^{'} \in]0;\bar{e}[$ is the optimal effort level. Then, find $x_j(e^{'})$ such that RC and IC_e are binding. Third, show that the derivative of $U(e^{'}, x_j(e^{'}))$ with respect to $e^{'}$ is always positive. Intuitively, an increase in effort relaxes the resource constraint. It is therefore possible to increase consumption in the H state, which increases utility since IC_e is initially binding. This is however a contradiction with $e^{'}$ being optimal.

□

A.2 Proof of LEMMA 2

1. First, by (5), $E[R \mid e^o]$ is an upper bound for R^m. If $\delta < 1$, the first-best level of effort cannot obtain in a securitization equilibrium.

Second, $\sigma > 0$ implies $\alpha_H(E[R \mid e^o]) < 1$, which precludes full risk-sharing in a securitization equilibrium.□

2. Assuming $e = \underline{e} + \delta e^{nc}$, $R^m(\alpha_i)$ can be rewritten as follows:

$$R^m(\alpha_i) = E[R \mid \delta e^{nc}] - \sigma(1-\alpha_H^*)\frac{[R_H - R_L]}{1+\alpha_H^*}$$

which is increasing in δ and decreasing in σ. Therefore, the equilibrium market return R^*, which is given by

$$R^* = R^m(\alpha_i(R^*))$$

has the same properties.

Then, plug $R^m = R^*$ in the securitization allocation (6) and compute expected utility. The concavity of the utility of consumption and the efficiency of effort assumption (1) ensure that expected utility is increasing in R^m, which proves the welfare loss is increasing in σ, and decreasing in δ.□

A.3 Proof of PROPOSITION 1

PROPOSITION 1

1. *When $e^o = \underline{e}$, securitization is less efficient than ex-ante risk sharing;*

2. *When information asymmetry is limited (σ is small), there is a threshold level for market discipline ($\hat{\delta}$) from which securitization is more efficient than ex-ante risk-sharing;*

3. *this threshold is increasing in information asymmetry (σ), and decreasing in the cost of effort (k).*

First, let me define the following welfare metrics:

- $U^*_{ea}(k)$ is the value of expected utility corresponding to the solution to the ex-ante risk-sharing problem (2) for parameters (k). Note that, by construction, U^*_{ea} does not depend on σ and δ.

- $U^*_{secu}(k,\sigma,\delta)$ is the value of ex-ante expected utility corresponding to the securitization equilibrium for the same parameters and with $e = e^o$. It corresponds thus to the solution to the unconditional expectation version of program (3):

$$\max_{\alpha_i} U_{secu} = E\left[\ln C_{ij}\right] - ke^o$$

$$s.t. \begin{cases} C_{ij} = \alpha_i R^m + (1-\alpha_i)R_j \\ 0 \leq \alpha_i \leq 1 \end{cases}$$

1. Assume $e^o = \underline{e}$ and denote e^*_{secu} the optimal effort level (possibly higher than the lower bound e^o) and C^*_{ij} the optimal contingent consumption levels under securitization. This allocation (that is the ex-ante probability to reach these levels of consumption) is actually replicable with the following ex-ante contract:

$$C_j = \begin{cases} C^*_{Hj} & \text{; with probability 0.5} \\ C^*_{Lj} & \text{; with probability 0.5} \end{cases}$$

Concretely, under that contract, if banker's loan succeeds, he gets a good lottery, and a not so good one if it fails. Note that under the considered contract, the maximal sustainable effort level stays e^*_{secu}, which comes from the first order condition:

$$0.5\left[\ln(C_{HH}) + \ln(C_{LH})\right] - 0.5\left[\ln(C_{HL}) + \ln(C_{LL})\right] = k$$

Now, if $C^*_{Hj} \neq C^*_{Lj}$, which is the case when $\sigma > 0$, it is however possible to decrease the underlying uncertainty of both lotteries while keeping constant the difference of expected utility. This would maintain incentive and increase ex-ante expected utility by Jensen's inequality, which shows that securitization is less efficient than ex-ante risk-sharing:

$$U^*_{secu}(k,\sigma,\delta = 0) < U^*_{ea}(k)$$

□

2. First, note that under perfect market discipline ($\delta = 1$) and without private information ($\sigma = 0$), securitization implements the first best:

$$U^*_{secu}(k, \sigma = 0, \delta = 1) = U^*_{FB} > U^*_{ea}(k)$$

By *lemma 2*, I know that U^*_{secu} decreases with σ. I can thus define $\bar{\sigma}(k)$ such that:

$$U^*_{secu}(k, \bar{\sigma}, \delta = 1) = U^*_{ea}(k)$$

Then, $\forall \sigma < \bar{\sigma}(k)$, I have $U^*_{secu}(k, \sigma, \delta = 1) > U^*_{ea}(k)$. Also, I proved above that $U^*_{secu}(k, \sigma, \delta = 0) < U^*_{ea}(k)$. Thus there exist a $\hat{\delta}(\sigma) < 1$ such that:

$$U^*_{secu}\left(k, \sigma, \hat{\delta}\right) = U^*_{ea}(k)$$

and, for all $\delta > \hat{\delta}(\sigma)$, securitization is more efficient ex-ante risk-sharing.□

3. The fact that $\hat{\delta}(\sigma)$ increases in σ is then a direct consequence of *lemma 2*.

To establish that $\hat{\delta}(\sigma)$ decreases with k, recall that:

- $e^o \leq \bar{e}$ and the direct negative effect on utility (through ke) of a cost increases is weakly stronger under ex-ante risk-sharing;
- Under ex-ante risk-sharing, distortions increases with k (*lemma 1*) and there is thus a negative additional indirect effect;
- Under securitization, there is no indirect effect when $e = e^o$ (that is when market discipline is "binding": $e^o > e^*_{secu}(\delta = 0)$), which must be the case at the threshold level since market discipline should compensate for the loss due to adverse selection:

$$U^*_{secu}(k, \hat{\delta}, \sigma) = U^*_{ea}(k) > U^*_{secu}(k, 0, \sigma)$$

B Additional material and extension

B.1 Basel II - Market Discipline: excerpt

The Basel Committee BIS (2001)

Part 1/General Considerations/Introduction/paragraph 1.

"Pillar 3 recognises that market discipline has the potential to reinforce capital regulation and other supervisory efforts to promote safety and soundness in banks and financial systems. Market discipline imposes strong incentives on banks to conduct their business in a safe, sound and efficient manner. It can also provide a bank with an incentive to maintain a strong capital base as a cushion against potential future losses arising from its risk exposures. The Committee believes that supervisors have a strong interest in facilitating effective market discipline as a lever to strengthen the safety and soundness of the banking system."

B.2 Interim equilibrium under trade monitoring (or contract exclusivity)

I consider here a market in which it is possible to monitor the trades of others. Therefore, banker can credibly commit to retain part of the risk on their balance sheet. I interpret this as a stock market. This market structure might help H-type agents to achieve a higher level of insurance.

The idea is for H-type to extract as much surplus as possible from L-type agents. A way to do that would be to give them full insurance with respect to diversifiable risk and then compensate them just enough for them to tell the truth. Formally, one needs constant consumption and the IC_L constraint to be binding:

$$\begin{cases} C_{LH} = C_{LL} = C_L \\ \ln C_L = q_L \ln C_{HH} + (1-q_L)\ln C_{HL} \end{cases}$$

Which boils down to:

$$q_L \ln \frac{C_L}{C_{HH}} = (1-q_L)\ln \frac{C_{HL}}{C_L}$$

hence:

$$C_L = C_{HH}^{q_L} C_{HL}^{(1-q_L)}$$

or

$$C_L(\zeta) = \left(\bar{C_H} + \zeta\right)^{q_L} \left(\bar{C_H} - \zeta\right)^{(1-q_L)}$$

This gives a trade-off for the H-types: the lower to cross subsidy, the higher the exposure they have to accept to maintain IC_L.

Call this incentive ζ, they face the problem:

$$\max_{\zeta} U_H = q_H \ln\left(\bar{C_H} + \zeta\right) + (1 - q_H) \ln\left(\bar{C_H} - \zeta\right)$$

$$s.t. \left\{ p_H\left(\bar{C_H} + \zeta\right) + (1 - p_H)\left(\bar{C_H} - \zeta\right) = E\left[\tilde{R} \mid e^o, \sigma\right] - C_L(\zeta) \right.$$

or

$$\left(\bar{C_H} - \zeta\right) = \frac{E\left[\tilde{R} \mid e^o, \sigma\right] - C_L(\zeta) - q_H\left(\bar{C_H} + \zeta\right)}{(1 - q_H)}$$

The first order condition is:

$$\frac{q_H}{\bar{C_H} + \zeta} - \frac{1}{\bar{C_H} - \zeta}\left(\frac{\partial C_L(\zeta)}{\partial \zeta} + q_H\right) = 0$$

This can be solved for ζ^* and a coalition of H-type could offer a take it or leave contract of ζ^* that would be accepted by L-types.

It can be ex-ante welfare improving or detrimental with respect to the equilibrium presented in the text. This depends parameter values. However, risk-sharing is still limited by adverse selection, which is the reason why the main results would still be valid when agents can monitor trade.