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## Liquidity and Securitization

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### Abstract

In the run up to the financial crisis, the essential functions intermediaries played seemed to become less important. Commercial and industrial loans, as well as residential mortgages, the quintessential banking products, were securitized and sold. At the same time, the “skin in the game” intermediaries held in their activities (including in securitizations) diminished, while their leverage increased. Some have suggested these developments stemmed from rising agency problems in the financial sector. Instead, we attribute the diminution of traditional intermediation activities, as well as the reduced intermediaries’ skin in the game, to rising liquidity in real asset markets. Under a variety of circumstances, prospective liquidity tends to enhance leverage, which crowds out both internal and external corporate governance as supports to debt. This tends to make debt returns more skewed. We develop a more general theory of the interaction between intermediary activities, intermediary capital structure, and real asset market liquidity.

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How does economy-wide liquidity affect corporate leverage and the leverage of the financial intermediaries that firms borrow from? How do securitizations and loan sales vary across the financing cycle? How does securitization affect the quality of newly issued credit? Since the Global Financial Crisis of 2007-2008, a large literature has examined the wave of securitization that took place just before. Some see the increased ability to securitize and sell claims against financial assets such as loans as problematic because it reduces originators' incentives to do due diligence on the underlying assets being originated. For example, Keys et al. (2010) examine sub-prime low documentation non-agency mortgages and conclude that the easier ability to sell these mortgages through securitization vehicles, especially in the low-documentation segment where hard information was unavailable, made originating banks less careful about screening out low quality credits. In contrast, Begley and Purnanandam (2016) find in their study of residential mortgage backed securities (RMBS) originated between 2001-2002 and 2005 that even low-documentation informationally opaque pools can be securitized effectively so long as they are structured appropriately to give originators skin in the game. They find when originators held a higher level of the equity tranche, deals had lower abnormal default rate ex post, and ex ante they command a higher price.. So is the Keys et al. (2010) finding an aberration or perhaps due to some features of the economy in the period examined?

Benmelech et al. (2012) study collateralized loan obligations (CLO), which are pooled vehicles for securitized loans, and find little evidence of adverse selection before 2005 – securitized loans performed no differently from loans held on bank balance sheets. However, the evidence is more mixed in the 2005-2007 sample. Much like Begley and Purnanandam (2016), they suggest that structuring helped give originators the right incentives; CLOs primarily held syndicated loans, where originators had substantial skin in the game by holding on to a fraction of the originated loans on their balance sheets. Moreover, despite relatively modest losses, the CLO market shut down through much of 2009 and 2010, suggesting that an incentive-compatible structure alone was not enough to ensure the popularity of the CLO market.

In sum, there seems to be evidence that the ability to securitize does not automatically drive down credit quality, originators can create structures that signal they will screen carefully while originating, and they do get rewarded for this. At the same time, the evidence also suggests there seems to have been some deterioration in the relative quality of securitizations in the years immediately before the financial crisis, at least as reflected in greater defaults in the underlying loans. We argue in this paper that one common factor that drives all these patterns is the underlying liquidity of the real assets being financed. Higher expected liquidity can make

securitization more attractive, increase the extent to which real assets are leveraged, but also reduce the due diligence required of intermediaries, and hence the need for structures that give them incentives. It can also increase the volatility of returns on the underlying assets, and in some cases, of the securities issued.

Let us be more specific. Consider an economy where a number of firms (equivalently, projects) are available for sale. Each firm will be sold in an auction, with bidders funding their bid partly with their wealth and partly with a loan against the firm's asset. The loans to fund the winning bidder in each auction will be pooled in a securitization vehicle, which will be funded by selling securities. Now consider one such firm. To produce cash flows, a firm will have to be run by an expert manager with special managerial knowledge. There are a number of such experts who are willing to bid for each firm, but they have little money of their own. In addition to experts, the other agents in the model are securitizers and investors. Securitizers arrange securitizations; they screen applicants (we will describe this shortly), making the loan to each winning bidder, pool loans, sell securities against the pooled loan repayments, and hold some securities, often the junior tranches, as "skin in the game" to provide incentives. Our securitizer undertakes all the activities in the securitization process, some of which in practice are done by different intermediaries. Investors buy the securities. They can also finance experts directly, though they cannot screen. Neither securitizers nor investors know how to run firms.

The size of the loan that experts can receive for their bid depends on how much debt capacity the firm can support. Financiers have two sorts of control rights, which allow them to be repaid and are the basis for the firm's debt capacity; first, control through the right to repossess and sell the underlying asset being financed if payments are missed and, second, control over cash flows generated by the asset. The first right only requires the frictionless enforcement of property rights in the economy, which we assume. It has especial value when there are a large number of capable potential buyers willing to pay a high price for the firm's assets. Greater wealth amongst experts (which we term *liquidity*) increases the availability of this asset-sale-based financing, as in Shleifer and Vishny (1992). Clearly, this kind of control right is exogenous to the firm and depends on economic conditions.

The second type of control right is more endogenous, and conferred on creditors by the firm's incumbent expert manager as she makes the firm's cash flows more *pledgeable* to, or appropriable by, creditors over the medium term. She could do this, for example, by improving accounting quality or setting up escrow accounts so that cash flows are hard to divert. We assume enhancing pledgeability takes time to set up but is also semi-durable (improving accounting

quality is not instantaneous because it requires adopting new systems and hiring reputable people; equally, firing a reputable accountant or changing accounting practices has to be done slowly, perhaps at the time the accountant's term ends, if it is not to be noticed). So the incumbent manager sets pledgeability one period in advance, and it lasts a period.

The two sources of control rights interact. When anticipated liquidity is sufficiently high, increased pledgeability has no effect on how much experts will bid to pay for the firm; they have enough wealth to buy the firm at full value without needing to borrow much against the firm's future cash flows. Higher pledgeability is not needed for enhancing future bids for the firm when liquidity is anticipated to be high, and thus does not enhance its ex ante debt capacity. In contrast, when anticipated liquidity is lower, higher pledgeability does enhance their bids, and in doing so, enhances ex ante debt capacity.

Let us now understand an incumbent manager's incentives to choose cash flow pledgeability for the next period, once she wins the initial auction. Let us assume she may have some reason to sell some or all of the firm next period with some probability – either because she lost the ability of running it, or she needs to raise finance for new investment. We assume the incumbent has bought the firm by borrowing as much as she can to bid for it, which allows us to examine leverage choices also. Clearly, as discussed above, high expected liquidity will reduce the need for higher pledgeability. But even if pledgeability is useful in enhancing future outside bids – and the incumbent personally benefits from higher bids if she wants to sell the firm -- she faces moral hazard associated with pledgeability. A higher possible bid from experts enables her to sell the firm for more if she loses ability but also enables her existing creditors to collect more if she stays in control because the creditors have the right to seize assets and sell them when not paid in full. In such situations, the incumbent has to “buy” the firm from creditors, by outbidding experts (or paying debt fully), which reduces her incentive to enhance pledgeability. Similarly, a higher promised debt payment reduces the residual proceeds that she receives if she sells the firm. Therefore, higher promised debt payments exacerbate the incumbent's moral hazard associated with pledgeability, and when the payments exceed a threshold, the incumbent will set pledgeability low. Since pledgeability choice is not verifiable, creditors will limit how much they will lend to the incumbent up front when they require the incumbent to have incentives to keep pledgeability high.

In sum then, we have two outside influences on pledgeability –the anticipated liquidity of experts and the level of outstanding debt. In normal times, the need to provide the incumbent incentives for pledgeability keeps up-front borrowing moderate. As prospective liquidity

increases, though, the incumbent is able to borrow more to finance the asset, while still retaining the incentive to set pledgeability high. Eventually, though, when prospective liquidity is very high – that is, experts will have enough wealth to bid full value for the firm without needing to pledge its cash flows – any earlier corporate borrowing is enforced entirely by the potential high resale value of the firm, and high pledgeability is not needed for them to make their bid.

Since pledgeability is not needed to enforce repayment in a future highly liquid state, a high probability of such a state encourages high borrowing up front, which crowds out the incumbent's incentive to enhance pledgeability, even if there is a possible low liquidity state where pledgeability is needed to enhance creditor rights. In other words, when prospective liquidity gets very high, lenders can profitably stop imposing any constraint on leverage, and take their chances if that liquidity does not materialize. Bidders, competing to buy the firm up front, bid more, but are financed with risky debt.

A crisis or downturn under these circumstances is when anticipated high liquidity does not materialize. If the low liquidity state is realized, the enforceability of the firm's debt, as well as its borrowing capacity will fall significantly. Experts, also hit by the downturn, no longer have much personal wealth, nor does the low cash flow pledgeability of the firm allow them to borrow against future cash flows to pay for acquiring the firm. Unable to raise funds to repay debt, the firm gets into financial distress even if the firm's earning potential is still high. Credit spreads rise substantially, and they will stay high till the firm raises pledgeability, which will take time, or liquidity comes back up, which could take even longer. The neglect of pledgeability because of high leverage at the end of a sustained boom, makes the recovery difficult and drawn out.

Now let us return to the securitizer's problem. We assume his job is to distinguish between reliable experts and unreliable experts. Reliable experts have a low cost of setting pledgeability high when they run the firm and unreliable experts have an impossibly high cost of doing so. In normal times when pledgeability is needed to enhance debt capacity, the securitizer does screen out the unreliable applicants, finances only reliable experts, and arranges the configuration of securities he sells against the pool of loans so that he signals a commitment to screening (by having skin in the game).<sup>2</sup> Investors buy the securities at a price that rewards the securitizer for undertaking the screening. Given that they would face substantial adverse selection if they financed experts directly, the extent of direct financing of experts by investors is small. As

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<sup>2</sup> We follow the securitization literature by designing tranching and pooled securities to overcome the incentive problems faced by securitizers. We use results in DeMarzo (2005), DeMarzo-Duffie (1999), and Gorton-Soules (2006). See Gorton-Metrick (2013) for a survey.

prospective liquidity increases, though, eventually up front lending is high enough that even the reliable expert has no incentive to enhance pledgeability if she buys the firm. At this point, there is really no point screening out the unreliable experts.

Put differently, as the market becomes more liquid, governance becomes less important for debt recovery – analogously, if a house can be easily repossessed and sold profitably because they are selling like hot cakes, what need is there to determine if the mortgage applicant has a job or income? Securitizers no longer need to signal they have enough skin in the game to screen since they no longer screen. Indeed, they become no different from investors, and securitization vehicles become complete “passthroughs”. The speed of securitization (which we do not model) will increase since little due diligence is being done, and the volume of issuances will increase for a given underlying capacity. None of this is an aberration – financial intermediaries such as securitizers are able to rely on liquidity for recovery at such times, and this forces them to abandon their usual due diligence. One can question whether such expectations of high liquidity make the economy better off (see Diamond, Hu, and Rajan (2018)) but our focus is on securitization here.

Changes in the underlying liquidity for the assets being securitized may therefore explain some of the differences in the empirical evidence described earlier. Arguably, liquidity was moderate but increasing as the economy recovered from the Dot Com bust. Securitizers did substantial due diligence, and securitization structures reflected their desire to signal their commitment, as suggested by Begley and Purnanandam (2016). As the recovery picked up and policy interest rates stayed lower than normal, liquidity increased, and the need for screening diminished, until very little screening was done just before the crisis, as suggested by Keys et al. (2010). Seen with the benefit of hindsight from the depth of the crisis, this may have seemed to be an aberration, and some indeed was. Yet it was also consistent with the kind of behavior induced by expectations of high liquidity. It is also possible that the expectations were too extreme, with the probabilities of the low liquidity state underestimated as in Gennaioli, Shleifer and Vishny (2015), yet that does not take away from the fundamental thrust of our arguments.

As explained above, anticipated high levels of future liquidity crowds out pledgeability, which leads to both high firm and intermediary leverage. Current levels of liquidity, as measured by the wealth of the initial bidders for the firm, however, drive firm and intermediary leverage differently. This is consistent with the evidence presented in Adrian and Shin (2010). At low levels of current liquidity, the analysis we just described continues to hold. At higher levels of current liquidity, however, leverage at both levels is reduced. It is reduced at the firm level since

the need for the initial bidder to borrow to pay full value diminishes. Moreover, the value of the firm is also higher under the low firm leverage that encourages high pledgeability. At the intermediary level, the intermediary needs skin in the game to incentivize screening, so leverage levels, as measured by the value of securities he sells, are also moderate. As the initial bidder's wealth goes higher still, her need to borrow to make up the gap between the liquidity she already has and the full valuation of the asset is so low that she can borrow unscreened directly from investors. In this case, firm leverage is low, but since the securitizer does not screen, his skin in the game is low, and leverage high.

In the rest of the paper, we will formalize these arguments. In section I, we present the framework, in section II we solve the basic model, in section III we examine first how future or anticipated liquidity affects securitization and then how current liquidity affects securitization, in section IV we relate our paper to the literature, and then conclude.

## **I. The Framework**

### *A. The Economy and States of Nature*

Consider an economy with three dates (0,1,2) and two periods between these dates. Date  $t$  marks the end of period  $t$ . We focus on a representative firm. In period 1, the economy is in state  $s_1 \in \{G, B\}$ , with the probability of state G being  $q^G$ . State G and B respectively stand for economy-wide prosperity and distress. When the state is G in period 1, the firm produces cash flows  $C_1$  when managed by the incumbent. When the state is B, however, the firm does not produce any cash flow. In period 2, we assume the economy returns to state G and produces cash flows  $C_2$  for sure. Figure 1 illustrates the evolution of the state of nature. The firm does not face any idiosyncratic risk.

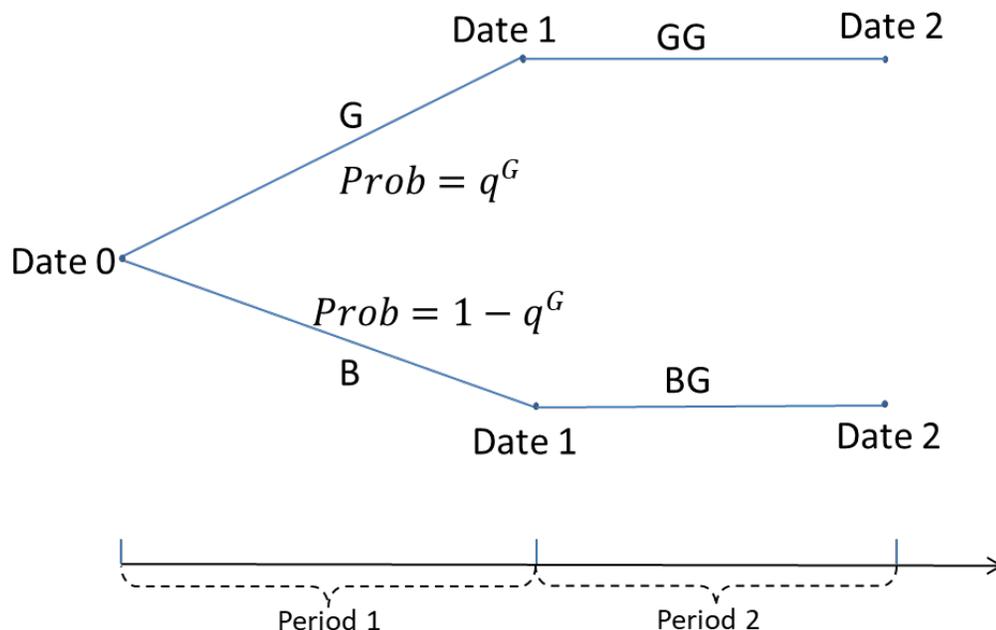


Figure 1: States of Nature

### B. Agents and the Asset

There are three groups of agents in the economy: experts who know how to manage the firm to produce cash flows, securitizers, and investors. All agents are risk neutral. Experts and investors do not discount future cash flows. Securitizers are less patient: their discount rate is  $\rho < 1$ . This can also be thought of as a rough proxy for persistent intermediary capital constraints.<sup>3</sup> We will present the results of the general model, but our focus will be on the case  $\rho \rightarrow 1$ .

At date 0, one expert acquires control of the firm by winning a competitive auction (described in Section I.G) for the firm's assets and therefore becomes the *incumbent manager*. Other experts stay in the economy, hoping to gain control at date 1. Let  $\theta^H$  be the stability of the firm – the extent to which the skills needed in the firm are stable. In a rapidly changing industry, the incumbent manager's ability may not continue to match the industry's needed skill set. So, after cash flows (if any) are produced, the incumbent may lose her ability with probability  $1 - \theta^H$ , in which case she is forced to sell the asset to another expert. If that happens, we assume there are plenty of experts at that time to bid for the firm and their skills are compatible with the industry's

<sup>3</sup> Securitizers have a limited amount of inside capital and want to utilize it as intensively as possible. This gives them a shadow cost of any additional capital invested today that exceeds the market interest rate.

needs.<sup>5</sup> The event of losing ability is publicly observable but not verifiable and cannot be written into contracts. Equivalently, the entire model could be reinterpreted as one in which the firm will need additional interim financing with probability  $1 - \theta^H$ . In either case (loss of ability or need for financing), the incumbent has to sell the firm or a portion thereof, which gives them some incentive up front to increase the resale value of the firm.

There are a set of competitive securitizers who have the ability to screen and lend directly to experts. They follow the “originate-to-distribute” model. Specifically, they originate a portfolio of loans and sell tranching claims on this portfolio to investors. Since securitizers are more impatient than investors, they would always prefer selling claims to the entire portfolio. However, the securitizer may also be forced to hold some claims to incentivize them to screen loan applicants—a process we will describe in details in Section I.E. Finally, investors have deep pocket and are willing to invest in any security that breaks even in expectation.

### C. Pledgeability

Any creditor to the firm has two ways of recovering payments from the manager. An improvement in governance could enhance the fraction of generated cash flows that the manager pays in the normal course to the creditor. Alternatively, an improvement in the ability of experts to bid for the firm’s assets could give the creditor a credible threat (through the right to seize the asset and auction it if payments are not made) with which to force repayment. These methods of recovery usually complement each other, but may also be substitutes under certain circumstances, as we will explain shortly.

Let us define *cash flow pledgeability* as the fraction of realized cash flow that goes directly to the firm’s creditor, in this case, the securitizer.<sup>6</sup> Pledgeability can be thought as the fraction of cash flow that can be verified by a court and therefore recovered by the lender. Let  $\gamma_1$  be the preset pledgeability in period 1, reflecting the existing governance of the firm. So  $\gamma_1 C_1$  is the cash the securitizer receives directly if cash flows  $C_1$  are produced in period 1. During period 1, the incumbent can set pledgeability  $\gamma_2$  for cash flows produced during period 2 in the range  $[\underline{\gamma}, \bar{\gamma}]$  that satisfies  $0 < \underline{\gamma} < \bar{\gamma} < 1$ . The range of feasible values for pledgeability is determined by the economy’s institutions supporting corporate governance, both operating within the firm

<sup>5</sup> The results are unaffected as long as more than two bidders bid for the firm at date 1.

<sup>6</sup> The securitizer is also the servicer even if part of (or the entire) the cash flow from loan is sold.

(such as better auditors, more transparent subsidiary structures, contracts, and accounting, etc.) and through outside institutions (such as regulators and regulations, investigative agencies, laws and the judiciary). Pledgeability can be raised by adopting more informative accounting practices, hiring better accountants, setting up escrow accounts for cash flows, simplifying corporate organizational structures and enhancing their transparency, or putting in place better governance structures such as a more expert and independent board. We can also think of increasing pledgeability as closing off tunnels, which divert cash flows generated in the firm. It is because all these procedures take significant time to accomplish that we assume the incumbent can only affect pledgeability one period ahead. Since governance can also be changed over time, we assume pre-set pledgeability lasts only one period. Our intent is to capture the dynamic nature of firm governance, and the important role played by management in setting it.

Experts can be reliable or unreliable. The two types of experts differ in the cost each incurs in raising pledgeability. A reliable expert incurs a small cost  $\varepsilon \geq 0$  to set  $\gamma_2$  above  $\underline{\gamma}$ . Throughout the paper, the analysis will be presented for the limiting case  $\varepsilon \rightarrow 0$  so that none of our results relies on the cost of raising pledgeability being significant. By contrast, we assume the cost of raising pledgeability incurred by an unreliable expert is so high that she will never do so.<sup>7</sup> The two types of experts can be thought of as having different abilities to tunnel cash flow out of the reach of investors – the unreliable manager discovers she has many more such options or fewer scruples, so the cost of binding her is disproportionately higher. Equivalently, she could be ineffective at increasing pledgeability. Henceforward, we sometimes refer to (un)reliable experts also as (un)reliable managers.

A large fraction  $\lambda \rightarrow 1$  of experts are unreliable and they are well aware of their types. Therefore, they will only apply to securitizers for a loan if they anticipate the securitizers will not screen. Otherwise, they will simply borrow from uninformed investors.<sup>8</sup> Among the remaining experts, a fraction  $\mu$  correctly believe they are reliable, whereas  $(1 - \mu)$  consist of unreliable managers who believe themselves to be reliable. The latter group of experts will discover their mistake only when screened by the securitizer, or when they attempt to set pledgeability.<sup>9</sup>

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<sup>7</sup> A sufficient condition is this cost is higher than  $C_2$ .

<sup>8</sup> We assume they borrow from securitizers when they are indifferent, i.e., when the securitizers do not screen.

<sup>9</sup> The presence of this type is necessary only to get screening in equilibrium. Some uncertainty about types is sufficient.

To summarize, among the experts, a fraction  $\lambda$  correctly know they are unreliable; a fraction  $(1-\lambda)\mu$  correctly know they are reliable; and  $(1-\lambda)(1-\mu)$  incorrectly think they are reliable.

#### *D. Financial Contracts*

At date 0, each expert can raise money against the firm's assets and cash flows by writing one-period financial contracts. An expert can borrow from one securitizer or directly from investors who never screen borrowers. The aggregate state  $S_t$  is observable but not verifiable, so we will focus on debt contracts  $D_t$  with fixed promised payment across states at the end of period  $t$ . More specifically, the debt contract takes the form of a loan commitment  $(l_{t-1}, D_t)$ : the securitizer commits a loan amount  $l_{t-1}$  on date  $t-1$  and the gross interest rate of the loan is  $\frac{D_t}{l_{t-1}}$ .

At date  $t-1$ , the incumbent manager wins the auction while funded by the loan and manages the firm. She is forced to repay the debt at date  $t$  in two ways. First, the lender has automatic rights over the pledgeable portion of the cash flow  $\gamma_t C_t$  if the state is G. Second, if the claim has not been paid in full, the lender gets the right to auction the firm. In other words, the lender obtains control rights over the asset through default, which allows them to extract repayment either by actually selling the firm or through the threat of seizing and selling. In this auction, both experts and the incumbent manager are allowed to bid. Implicitly, we assume the incumbent can always bid using other proxies, so contracts that ban her from participating in the auction are infeasible.

#### *E. Screening*

At date 0, before approving a loan, the securitizer may screen the loan applicant. We assume there is no fixed cost associated with screening but instead, a per-applicant cost  $\psi$  is incurred if the securitizer screens the loan applicant. After paying this cost, the securitizer can tell whether the loan applicant is reliable or not without error. The cost  $\psi$  includes the administrative resources spent in processing the application and doing due diligence on the specific applicant. We assume the screening outcome is private so that other securitizers and investors cannot observe it. The lender is referred to as informed if he has screened the applicant. By contrast, a lender who does not screen is referred to as uninformed.

One expert can apply to at most one securitizer. In reality, preparing relevant loan application files and materials takes time and effort. After screening, an informed securitizer essentially has

an information monopoly over the applicant's type, in which case we assume he makes a take-it-or-leave-it offer to the applicant. Alternatively, the applicant can turn to uninformed investors who offer credit as long as they can break even. Since they have no ability to distinguish between various expert types, with the share of the unreliable tending to 1, investors will offer any applicant the rate associated with an unreliable investor.

In period 2, there is no further pledgeability decision since the economy ends at date 2, and pledgeability has already been set for period 2 in period 1. As a result, all experts can bid without screening, since there is no value to determining who is reliable and who is not.

#### *F. Securitization*

Each securitizer extends loans to a large number of experts (each of whom wins an auction for a different firm). These loans are then pooled into a trust (or a special purpose vehicle) which in turn tranches them into different claims. Some claims are subsequently sold to investors. The rest—if any—are retained by the securitizer. All these claims can be broadly interpreted as asset-backed securities.

In practice, the entire securitization package is typically announced before the underlying loans are originated. For example, more than 90 percent of the agency MBS trading is on a to-be-announced (TBA) basis in which the buyer and seller decide on general trade parameters, such as coupon, settlement date, par amount, and price, but the buyer typically does not know which pools will actually be delivered until two days before settlement (Vickery and Wright, 2013). Therefore, we assume the securitizer commits to a final securitization structure with investors *before* he actually screens loan applicants. Importantly, the structure specifies the securities that will be issued to investors as well as securities the securitizer will retain, all of which are backed by the loans to be originated. The securitization structure, as well as the distribution of cash flows to the various tranches, can be verified by a third party such as the court. Therefore, the structure will effectively enable the securitizer to commit to subsequently screen applicants (or not). We show shortly that the securitizer will have to retain some claims to show commitment, while structures without any retention will be proposed by those who do not plan to screen.

Specifically, the securitization structure is denoted as  $\{F^G(x), F^B(x)\}$ , where the function  $F^{s_1}(x)$  represents the cash flows that investors will receive as a function of  $x$ , the cash flows that the securitizer (or the servicer) receives on date 1 in state  $s_1$ . We assume  $F^{s_1}(x) \leq x$ , to allow the lender to have limited liability. For the main analysis, we will examine the case

$F^G(x) = F^B(x)$  so that the securities are not state-contingent and only depend on the received cash flow,  $x$ .

### G. Wealth and Initial Conditions

Let  $\omega_1^{I,s_1}$  and  $\omega_1^{H,s_1}$  respectively be the wealth of the incumbent and experts in state  $s_1$  after cash flows are generated. We term  $\omega_1^{H,s_1}$  *liquidity* at date 1. The wealth of both the incumbent and experts (who work in the economy when not running a firm) is augmented by more when the economy is in state G than when the economy is in state B ( $\omega_1^{H,G} > \omega_1^{H,B}$  and  $\omega_1^{I,G} > \omega_1^{I,B}$ ).

Note that  $\omega_1^{I,G}$ , the incumbent's wealth in state G also includes the unpledged cash flows

$$(1 - \gamma_1)C_1.$$

At date 0, there is no prior incumbent, and each firm is sold in a competitive auction. For simplicity, we assume experts, whose type is not common knowledge, apply to different securitizers for loans, and if financed, bid. Among them, only two believe they are reliable.<sup>10</sup> Investors, who cannot screen, are willing to finance experts as if they are unreliable, but only if such investors break even conditional on making the loan. The highest bidder wins the auction and pays his/her bid amount, borrowing from the securitizer/investors who have financed them. Let  $\omega_0$  be a bidder's initial wealth at date 0. Also let  $(l_0, D_1)$  denote the contract signed between the bidder and the securitizer, where  $l_0$  is the initial amount raised from the bank at date 0, and  $D_1$  is the amount the winning bidder promises to repay on date 1. Therefore, in any auction, experts can bid  $\omega_0 + l_0$ , conditional on this being weakly less than the value of the firm to them. The winning bidder (henceforth the incumbent) has to repay  $D_1$  by date 1.

### H. Timing

The timing of events is described in Figure 2. Three events occur consecutively on date 0. First, each securitizer specifies securities  $\{F^G(x), F^B(x)\}$  to be sold to investors given the loans that will be made, where  $x$  is the cash flow received by the securitizer on date 1. Next,

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<sup>10</sup> We can easily handle more such bidders, but two is enough to introduce some competition while giving each securitizer some rents from screening. In this case, the total size of bidding experts are  $\frac{2}{1-\lambda}$ , which goes to infinity as  $\lambda \rightarrow 1$ .

experts whose type is not publicly known choose whether to borrow from a securitizer or investors. Given the securitization structure, each securitizer decides whether to screen the applicant and potentially offer a loan commitment  $(l_0, D_1)$ . Finally, each expert bids with their wealth and the loan commitment they have received. The bidder with highest bid wins and acquires control.

In period 1, the incumbent sets  $\gamma_2$ , the pledgeability for period 2's cash flow. If there was no screening conducted at date 0, the incumbent learns whether she is reliable or not at this stage through the act of trying to set pledgeability. Next, the aggregate state  $s_1$  is realized.

Production takes place and the pre-set pledgeable fraction  $\gamma_1$  of cash flows goes to the securitizer automatically if state G is realized. Subsequently, the incumbent's ability in period 2 becomes known to all. At date 1, the incumbent either pays the remaining debt due or enters the auction. The period ends with potentially a new incumbent in control.

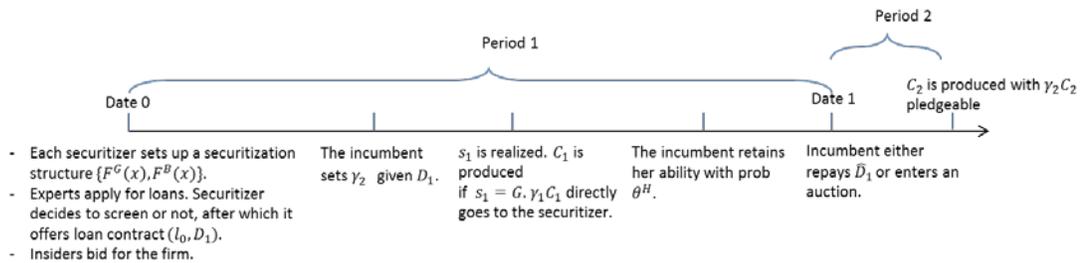


Figure 2: Timeline and Decisions

## II. Solving the Model

We solve the model in this section. With a single state in period 2, and the economy ending after that, the analysis in that period is straightforward. Experts as well as the incumbent who retains ability can only commit to repay  $D_2 = \gamma_2 C_2$  in period 2, where  $\gamma_2$  is the pledgeability set in period 1. As a result, they can borrow up to  $D_2 = \gamma_2 C_2$  when bidding for control at date 1. During period 2, there is no distinction between a reliable and an unreliable manager, since no further pledgeability choice will be made. With no need for screening at date 1, the securitizer finances new lending by selling all securities to investors – effectively, everyone will borrow directly from investors. Next, we proceed to the analysis during period 1 and at date 0. We make some assumptions to focus the analysis.

### Assumption 1:

- a.  $\omega_1^{I,G} \geq \omega_1^{H,G}$ ,  $\omega_1^{I,B} \geq \omega_1^{H,B}$
- b.  $\omega_1^{H,B} < (1 - \bar{\gamma}) C_2$
- c.  $\gamma_1 C_1 + \omega_1^{H,G} + \underline{\gamma} C_2 > \omega_1^{H,B} + \bar{\gamma} C_2$
- d.  $q^G > \theta^H$

Assumption 1a stipulates that the incumbent has weakly more wealth than experts in all states so she can retain control regardless of her choice of pledgeability by outbidding them in any possible date-1 auction if she retains ability. This is because her choice of pledgeability increases what both parties can borrow by the same amount. Assumption 1b further stipulates that in state B, experts' wealth  $\omega_1^{H,B}$  is insufficient to allow them to bid the full value of the asset,  $C_2$ , even when pledgeability is set high,  $\gamma_2 = \bar{\gamma}$ . By contrast, we don't put any restriction on the level of liquidity in state G. Assumption 1c ensures the difference in the liquidity between the two future states is large enough that regardless of choice of pledgeability, repayment is strictly more in future state G than in future state B. Finally, Assumption 1d effectively limits the degree of moral hazard in setting pledgeability by requiring the probability of the good state  $q^G$  to be higher than the probability of the incumbent keeping her ability  $\theta^H$ . We will discuss how results change if this assumption doesn't hold.

We now study payments at date 1 and decisions made in period 1. We start by analyzing the incumbent's incentive in setting pledgeability and how the promised payment  $D_1$  affects the decision.

#### A. Incumbent's Pledgeability Choice

An expert can borrow  $\gamma_2 C_2$  against future cash flows at date 1. So in a possible date-1 auction, he can bid up to  $\omega_1^{H,s_1} + \gamma_2 C_2$  for the firm. Since the value of the future cash flows is  $C_2$ , an expert's date-1 bid will be  $B_1^{H,s_1}(\gamma_2) = \min\{\omega_1^{H,s_1} + \gamma_2 C_2, C_2\}$ . In the auction at that date, the incumbent will match if she can, but will not exceed the expert (we assume ties go in her favor). So in order to retain control, the incumbent either pays the minimum of the remaining debt or outbids experts. That is, she pays  $\min\{\widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)\} = \min\{\widehat{D}_1^{s_1}, \omega_1^{H,s_1} + \gamma_2 C_2, C_2\}$ , where  $\widehat{D}_1^G = D_1^G - \gamma_1 C_1$  and  $\widehat{D}_1^B = D_1^B$  are the remaining debt payment due on date 1. Clearly, through the choice of pledgeability,  $\gamma_2$ , the incumbent could potentially affect the amount of payment needed for her to stay in control. The maximum the incumbent can bid is  $B_1^{I,s_1}(\gamma_2) = \min\{\omega_1^{I,s_1} + \gamma_2 C_2, C_2\}$ . Comparing  $B_1^{I,s_1}(\gamma_2)$  and  $B_1^{H,s_1}(\gamma_2)$ , we see that the incumbent will outbid experts whenever she has (weakly) more wealth ( $\omega_1^{I,s_1} \geq \omega_1^{H,s_1}$ ), since both parties can borrow up to  $\gamma_2 C_2$  if needed. The incumbent is always willing to retain the firm if she retains ability since the continuation value of the firm,  $C_2$ , is identical for the incumbent and experts.

A few points are worth noting here. First, the greater the anticipated liquidity,  $\omega_1^{H,s_1}$ , the greater will be the bid of experts, and the greater will be the debt face value that can be enforced. Second, the greater the pledgeability  $\gamma_2$  chosen, the greater again the enforceability of debt payments. Finally, because no bidder will pay more than the residual value of the firm,  $C_2$ , when liquidity is sufficiently high (that is,  $\omega_1^{H,s_1} \geq (1 - \underline{\gamma})C_2$ ), higher pledgeability is no longer needed to enhance debt capacity – bidders have enough wealth of their own to make a bid for full value, without borrowing any more than the minimum pledgeable cash flows of the asset,  $\underline{\gamma}C_2$ . In other

words, high liquidity can crowd out the need for pledgeability. We will use all these in what follows.

Let  $V_1^{l,s_1}(\widehat{D}_1^{s_1}, \gamma_2)$  be the incumbent's payoff when she chooses  $\gamma_2$ , given the remaining payment  $\widehat{D}_1^{s_1}$  that an incumbent needs to pay to avoid the auction. In both state  $s_1 = G$  and  $s_1 = B$ ,

$$V_1^{l,s_1}(\widehat{D}_1^{s_1}, \gamma_2) = \theta^H \left( C_2 - \min \{ \widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2) \} \right) + (1 - \theta^H) \left( B_1^{H,s_1}(\gamma_2) - \min \{ \widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2) \} \right) - \varepsilon \mathbf{1}_{\{\gamma_2 > \underline{\gamma}\}}, \quad (1)$$

The terms on the R.H.S. of (1) are straightforward. With probability  $\theta^H$ , the incumbent retains her ability and needs to pay  $\min \{ \widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2) \}$  to retain control and receive cash flows  $C_2$  in period 2. With probability  $1 - \theta^H$ , the incumbent loses her ability, in which case she has to sell the asset at price  $B_1^{H,s_1}(\gamma_2)$ , repay creditors  $\min \{ \widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2) \}$ , and keep the remaining proceeds. A cost  $\varepsilon$  is incurred whenever she sets pledgeability  $\gamma_2$  above  $\underline{\gamma}$ .

Note from (1) that the incumbent faces a tradeoff in raising pledgeability. A higher  $\gamma_2$  (weakly) increases the amount the incumbent has to pay the financier when she retains capability and control, therefore (weakly) decreasing the first term, while it (weakly) increases the amount the incumbent gets in the auction if she loses capability, thus (weakly) increasing the second term. In choosing to increase  $\gamma_2$ , the incumbent therefore trades off being forced to make higher possible repayments -- when she *buys* the firm from the lender conditional on retaining ability -- against the higher possible resale value when she *sells* the firm after losing ability. More generally, the incumbent trades off the cost of the boost to the value of existing claims on the firm against the benefit from the boost to the value of new future claims. The higher the stability  $\theta^H$ , the more the costs loom large relative to the benefits, and higher is the moral hazard associated with raising pledgeability.

The level of current outstanding claims clearly shifts how the incumbent sees this tradeoff. The incumbent's benefit from choosing high versus low pledgeability if state  $S_1$  is

known to be realized for sure is  $\Delta_1^{s_1}(\widehat{D}_1^{s_1}) = V_1^{I,s_1}(\widehat{D}_1^{s_1}, \bar{\gamma}) - V_1^{I,s_1}(\widehat{D}_1^{s_1}, \underline{\gamma})$ . It is easily checked that the incumbent's benefit in raising pledgeability in any state  $s_1$ ,  $\Delta_1^{s_1}$ , (weakly) decreases in the level of outstanding debt,  $\widehat{D}_1^{s_1}$ . The reason is straightforward. If the incumbent retains her ability, she has to pay the securitizer more on the outstanding debt when she raises pledgeability, and the higher the outstanding debt, the more this is. Similarly, if she loses her ability, she gets the residual value after the selling the firm, and higher the outstanding debt, the less this is. Thus higher outstanding debt depresses the incumbent's incentive to set pledgeability high.

Proposition 2.1 summarizes the incumbent's incentive for raising pledgeability for any given  $D_1$  emanating from future state  $s_1$ .

**Proposition 2.1:** Under Assumption 1,

1. A reliable incumbent's net benefit from choosing high pledgeability in state  $s_1 \in \{G, B\}$

is

$$\Delta_1^{s_1}(\widehat{D}_1^{s_1}) = \begin{cases} -\theta^H [B_1^{H,s_1}(\bar{\gamma}) - B_1^{H,s_1}(\underline{\gamma})] - \varepsilon & \text{if } \widehat{D}_1^{s_1} > B_1^{H,s_1}(\bar{\gamma}) \\ \theta^H B_1^{H,s_1}(\underline{\gamma}) + (1 - \theta^H) B_1^{H,s_1}(\bar{\gamma}) - \varepsilon - \widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\underline{\gamma}) < \widehat{D}_1^{s_1} \leq B_1^{H,s_1}(\bar{\gamma}) \\ (1 - \theta^H) [B_1^{H,s_1}(\bar{\gamma}) - B_1^{H,s_1}(\underline{\gamma})] - \varepsilon & \text{if } \widehat{D}_1^{s_1} \leq B_1^{H,s_1}(\underline{\gamma}). \end{cases}$$

2. There exists a unique threshold  $D_1^{IC}$  such that the incumbent sets high pledgeability if and only if  $D_1 < D_1^{IC}$ .
3. An unreliable incumbent manager will always choose low pledgeability:  $\gamma_2 = \underline{\gamma}$ .

These results are derived in the appendix and follow from Diamond, Hu, and Rajan (2018). It is useful to understand the intuition here. Let us graph  $\Delta_1^{s_1}$  as a function of  $\widehat{D}_1^{s_1}$  as described in Proposition 2.1.

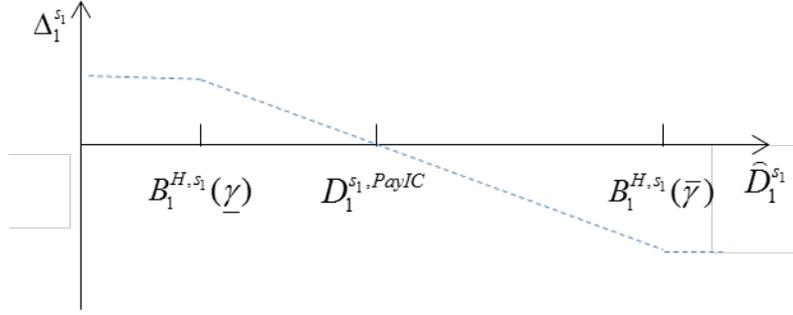


Figure 3: The net payoff to high pledgeability

For  $\widehat{D}_1^{s_1} \leq B_1^{H, s_1}(\underline{\gamma})$ , debt repayment is not increased by higher pledgeability because of the low value of outstanding debt. Instead higher pledgeability only increases outside bids, which is beneficial when the incumbent loses ability and sells the asset. The benefits of high pledgeability are capped at  $(1 - \theta^H) [B_1^{H, s_1}(\bar{\gamma}) - B_1^{H, s_1}(\underline{\gamma})] - \varepsilon$ , which is the difference between the price that the incumbent can sell the asset at by setting pledgeability high versus setting it low. As  $\widehat{D}_1^{s_1}$  rises above  $B_1^{H, s_1}(\underline{\gamma})$ , the incumbent has to pay more in expectation to debt holders when she raises pledgeability, so  $\Delta_1^{s_1}(\widehat{D}_1^{s_1})$  falls to zero and then goes negative as the face value of debt increases further. When  $\widehat{D}_1^{s_1} > B_1^{H, s_1}(\bar{\gamma})$ , the incumbent has to pay the entire increment in sale price from increasing pledgeability to debt holders when she loses ability – she gets nothing from increasing pledgeability under those circumstances – while she has to pay  $B_1^{H, s_1}(\bar{\gamma})$  instead of  $B_1^{H, s_1}(\underline{\gamma})$  if she retain ability. Hence there is no benefit but only cost to the incumbent by increasing pledgeability, and the cost is capped at  $\theta^H [B_1^{H, s_1}(\bar{\gamma}) - B_1^{H, s_1}(\underline{\gamma})] - \varepsilon$ .

If liquidity in the G state,  $\omega_1^{H, G}$ , gets sufficiently high such that  $\omega_1^{H, G} \geq (1 - \underline{\gamma})C_2$ , experts can pay the full price of the asset  $C_2$  even with low pledgeability – they have no need for additional borrowing to make a full bid. In that case, both  $B_1^{H, G}(\bar{\gamma})$  and  $B_1^{H, G}(\underline{\gamma})$  equal  $C_2$ , and  $\Delta_1^G(\widehat{D}_1^G) = -\varepsilon$  for any  $\widehat{D}_1^G$ . Put differently, when liquidity crosses the threshold of  $(1 - \underline{\gamma})C_2$  in state G, no incentive to raise pledgeability can come from that state.

For lower levels of  $\omega_1^{H,G}$ , i.e., if  $\omega_1^{H,G} < (1-\underline{\gamma})C_2$ , Proposition 2.1 implies there is a maximum debt level for each state where the incumbent has the incentive to set pledgeability high were that state to occur with certainty. That debt level,

$D_1^{s_1, PayIC} = \theta^H B_1^{H, s_1}(\underline{\gamma}) + (1-\theta^H) B_1^{H, s_1}(\bar{\gamma}) - \varepsilon$ , obtained by setting  $\Delta_1^{s_1}(D_1^{s_1, PayIC}) = 0$ . Note that the higher the moral hazard associated with pledgeability,  $\theta^H$ , lower is  $D_1^{s_1, PayIC}$ . It is easily checked that  $D_1^{G, PayIC} > D_1^{B, PayIC}$ .

For any levels of  $\omega_1^{H,G}$ , given the probability of the good state being  $q^G$ , the risk-neutral incumbent will choose high pledgeability for any given  $D_1$  if and only if  $q^G \Delta_1^G(D_1 - \gamma_1 C_1) + (1-q^G) \Delta_1^B(D_1) \geq 0$ . Since  $\Delta_1^{s_1}$  is weakly decreasing in  $\widehat{D}_1^{s_1}$ , it must be that  $D_1^{IC}$ , the threshold of debt below which higher pledgeability is incentivized given the incumbent's knows the probabilities of each future state, lies between  $D_1^{B, PayIC}$  and  $\gamma_1 C_1 + D_1^{G, PayIC}$ . If  $\omega_1^{H,G} \geq (1-\underline{\gamma})C_2$ , all the incentive to raise pledgeability comes from state B so that  $D_1^{IC} = D_1^{B, PayIC}$ . High liquidity, by reducing the need for pledgeability, reduces the incentive compatible level of debt.

This implies the maximum amount that a borrower can repay may not be  $D_1^{IC}$ . An alternative is to set  $D_1$  at  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$ . If  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma}) > D_1^{IC}$ , this will lead to low pledgeability choice but also enables the incumbent to promise more of the future cash flows in state G since the debt level is no longer constrained by incentive compatibility. Even with low pledgeability choice, the incumbent is able to promise repayment of  $\underline{l} = q^G (\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})) + (1-q^G) B_1^{H,B}(\underline{\gamma})$  at date 0. By contrast, to incentivize high pledgeability, the promised payment cannot exceed  $D_1^{IC}$ , which will imply expected repayment of  $\bar{l} = q^G D_1^{IC} + (1-q^G) \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\}$ . If the difference between  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  and  $D_1^{IC}$  is large (either because liquidity in the G state is high or the moral hazard associated with pledgeability  $\theta^H$  is high so that  $D_1^{IC}$  is low) and if the probability of the good state  $q^G$  is sufficiently high, the incumbent could pledge more repayment (and thus raise more) by setting

$D_1 = \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$ . The broader point is that the prospect of a highly liquid future state not only makes feasible greater promised payments, but these promised payments also eliminate incentives to enhance pledgeability that only emanates from the low liquidity state. To restore those incentives, debt may have to be set so low that funds raised are greatly reduced – something the incumbent will not want to do if she is bidding at date 0 for the firm. Note that this can happen even if the probability of the low state is significant, and even if the direct cost  $\mathcal{E}$  of enhancing pledgeability is infinitesimal or zero.

**Corollary 2.1:** Under Assumption 1, the face value that enables the manager to pledge out the most at date 0 is either  $D_1 = \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  or  $D_1 = D_1^{IC}$ . If  $\omega_1^{H,G} < (1 - \bar{\gamma}) C_2$ , then

$D_1^{IC} > \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  so that  $D_1^{IC}$  is the debt level that enables the manager to pledge out the most at date 0.

Proof: See appendix.

### *B. Optimal Lending and Securitization*

In stage 1, the securitizer chooses a securitization structure, which specifies securities sold  $F(x)$  and consequently his retention. We assume for now that the securitizer keeps the junior claim with payoff  $\max\{x - F(x), 0\}$ . In stage 2, the securitizer sets  $l_0$ , the amount that will be committed to the reliable bidder to finance the bid. If the bidder wins the auction, the amount lent  $l_0$  is observable and verifiable, as is the required and actual repayment. All loans are subsequently pooled, tranching, and sold to investors according to the securitization structure chosen in stage 1.

The expected amount repaid under  $D_1 = D_1^{IC}$  when the bidder is found reliable (which implies the reliable incumbent will choose  $\gamma_2 = \bar{\gamma}$ ) is

$\bar{l} = q^G D_1^{IC} + (1 - q^G) \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\}$ . If  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma}) > D_1^{IC}$ , the expected amount repaid under  $D_1 = \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  (which implies the reliable incumbent will choose  $\gamma_2 = \underline{\gamma}$ ) is

$\underline{l} = q^G (\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})) + (1 - q^G) B_1^{H,B}(\underline{\gamma})$ .<sup>11</sup> This is also what the unreliable incumbent will repay, since he will not be able to set pledgeability high. A precondition for screening and securitization to be implementable is  $\bar{l} > \underline{l}$ , else everyone is better off with unscreened lending, since incentivizing pledgeability does not enhance borrowing capacity.

Three necessary and sufficient conditions have to be met for screening and securitization to be viable.

- (i) Given the securitization structure  $F$ , the present value of what the securitizer receives by lending to a reliable manager should exceed what the unreliable manager can borrow from uninformed investors, else the reliable manager will never get enough to bid to win the auction.
- (ii) Conditional on setting up the securitization structure, the securitizer should have the incentive to screen rather than lend unscreened – he should have sufficient “skin in the game” to screen after selling securities. (IC constraint)
- (iii) The securitizer should earn enough informational rents to offset the cost of setting up the screening mechanism. (Participation constraint)

An informed lender can never earn any profit from lending to the unreliable. Intuitively, unreliable managers can always borrow  $\underline{l}$  from uninformed investors and since  $\rho < 1$ , they always borrow strictly less from the informed lender (unless the lender sells out the entire loan in which case there is no difference between different types of lenders). Therefore no expert who knows they are unreliable will apply to be screened, since screening is accurate. Only those who believe they are reliable will apply. Each (of the two) securitizers will support the bid of the expert they respectively screen if she is found to be reliable. The large number of other experts will also bid unscreened, borrowing from investors. Because there are many of these experts, no

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<sup>11</sup> If  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma}) \leq D_1^{IC}$ , then all lenders will ask borrowers to repay  $D_1 = D_1^{IC}$ . If so, the reliable manager will repay  $\bar{l} = q^G D_1^{IC} + (1 - q^G) \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\}$  and the unreliable will repay  $\underline{l} = q^G (\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})) + (1 - q^G) B_1^{H,B}(\underline{\gamma})$ . Given that the fraction  $\lambda$  of unreliable applicants to investors tends to 1, the amount investors will be willing to lend each applicant if they win the auction will converge to  $\underline{l}$ .

such bidder makes more than a vanishingly small expected rent. Experts who are rejected in the screening do not bid.<sup>12</sup> We now characterize each of the three conditions.

Consider without loss of generality any pre-chosen securitization structure  $F(x) \leq D_1^{IC}$  in stage 1. Let  $m(F) = q^G F + (1 - q^G) \min\{B_1^{H.B}(\bar{y}), F\}$  be the total proceeds from selling the security  $F$  when investors anticipate high pledgeability will be chosen by the incumbent, which also implies the securitizer's IC constraint and the participation constraint will be satisfied. After selling  $F$ , the securitizer expects to receive  $(\bar{l} - m)$  at date 1, discounted at  $\rho$ . Therefore, the total amount that the securitizer will receive under screening is  $\rho(\bar{l} - m) + m$ . Given this, he would never lend any amount above  $\rho(\bar{l} - m) + m$ . That implies for any securitization structure  $F(x)$ , if  $\rho(\bar{l} - m) + m \leq \underline{l}$ , the securitizer can never lend more to a reliable manager than would uninformed investors, and condition (i) is not satisfied. Note that this feasibility constraint loosens as  $\rho$ ,  $F$ , and  $m$  increase. Intuitively, the screening securitizer finds it more feasible to lend if his cost of investing capital gets lower, or if he is able to securitize a large fraction of the loan commitment thus retaining little. For the main analysis, we will focus on the case  $\rho \rightarrow 1$  so that condition (i) becomes  $\bar{l} > \underline{l}$ .

Next, we study the informed lender's choice of loan amount lent  $l_0$  when the applicant is found to be reliable after screening. Given the assumption that the securitizer makes a take-it-or-leave-it offer, we focus on the strategic interactions between the securitizers who finance the bidders. Because there are possibly two screened bidders for a firm (in addition to a vast number of unreliable bidders), both the informed lender and the reliable applicant realize that with probability  $\mu$ , the other bidder is also reliable, whereas with probability  $1 - \mu$ , the other bidder will be found to be unreliable. In this case, the competitive bid will be  $\underline{l}$  from the "reserve army" of the unreliable, financed by investors. Whenever the highest possible competing bid is known in advance and is below the highest amount that a reliable applicant can be lent, it will be in the informed lender's interest to finance a slightly higher bid. The following lemma shows that, as a result, the choice of  $l_0$  cannot be a pure-strategy equilibrium.

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<sup>12</sup> The results would not change if they then bid after securing loans from investors, who assume they are unreliable. Essentially, the probability for any unreliable bidder to win is vanishingly small, and so are the expected rents from bidding. Thus opening this option has little effect on incentives.

**Lemma 2.2:** In the auction where the informed securitizer finances the reliable manager, no pure strategy equilibrium exists for the choice of  $l_0$ . In the mixed strategy equilibrium, the lender sets

$l_0 = y \in [\underline{l}, \bar{y}]$ , where  $\bar{y} = (1 - \mu)\underline{l} + \mu\{\rho(\bar{l} - m) + m\}$  and

$\Gamma(y) = \frac{1}{\mu} \left\{ \frac{(1 - \mu) \times [\rho(\bar{l} - m) + m - \underline{l}]}{[\rho(\bar{l} - m) + m - y]} - (1 - \mu) \right\}$  is the CDF of  $y$ . The informed lender's

expected profits are:  $(1 - \mu) \times [\rho(\bar{l} - m) + m - \underline{l}]$ . As  $\rho \rightarrow 1$ ,  $\bar{y} \rightarrow (1 - \mu)\underline{l} + \mu\bar{l}$ . The

lender's expected profits will converge to  $(1 - \mu) \times (\bar{l} - \underline{l})$ .

Proof: See appendix.

### C. Screening and Securitization

We now solve for screening and securitization choices and characterize the incentive and participation constraints.<sup>13</sup> The securitizer has the choice whether to screen or not, given the structure  $F(x)$  that he has set up.

The amounts that the securitizer receives in each state may depend on whether he screens or not. If he screens and therefore only lends to a reliable manager at  $D_1 = D_1^{IC}$ , he receives  $D_1^{IC}$  in state G for sure. If he does not screen, with probability  $\mu$ , the applicant is reliable, in which case he can still receive  $D_1^{IC}$ . With probability  $1 - \mu$ , however, the applicant will turn out unreliable, in which case the securitizer only receives  $\min[D_1^{IC}, \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})]$ . Therefore, in

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<sup>13</sup> If the size of each loan commitment  $l_0$  is observable and verifiable by outside investors, whenever the securitizer sells securities against a pool of loans, the distribution of  $l_0$  within this pool must satisfy the cumulative distribution function  $[\Gamma(y)]^2$ , where  $\Gamma(y)$  is the CDF of  $y$ , the size of the loan commitment. The quadratic form applies because there are two bidders and only the winning bidder actually takes out the loan. In the off-equilibrium path when investors observe an alternative distribution of  $l_0$ , a refinement such as intuitive criteria makes it clear that the belief is always the lender did not screen. So once the securitizer sets up the securitization structure consistent with screening (see shortly), he is locked into the distribution of loan amounts  $[\Gamma(y)]^2$ .

state G, he receives  $\max\{\underline{x}^G - F, 0\}$  without screening and  $\bar{x}^G - F$  with screening, where

$$\underline{x}^G = \mu D_1^{IC} + (1 - \mu) \min\left[D_1^{IC}, \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})\right] \text{ and } \bar{x}^G = D_1^{IC}.$$

Given  $\underline{x}^G$  and  $\bar{x}^G$ , the additional amount that the securitizer will receive through screening is

$R^G(F) = \bar{x}^G - \max\{\underline{x}^G, F\}$ , which decreases (weakly) with  $F$ . Intuitively, the securitizer has a lower incentive to screen the more the senior claims that have been sold and the lower his skin in the game.

The results in state B are similar. The securitizer receives  $\max\{\underline{x}^B - F, 0\}$  without screening and  $\max\{\bar{x}^B - F, 0\}$  with screening, where

$$\underline{x}^B = \mu \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\} + (1 - \mu) B_1^{H,B}(\underline{\gamma}) \text{ and } \bar{x}^B = \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\}. \text{ Therefore, the additional amount he will receive is } R^B(F) = \max\{\bar{x}^B, F\} - \max\{\underline{x}^B, F\},$$

which again decreases (weakly) with  $F$ . Let  $R(F) = \rho[q^G R^G(F) + (1 - q^G) R^B(F)]$  be the expected gains to the securitizer from screening, which clearly decrease with  $F$ . Therefore, the maximum expected gains to the securitizer from screening is

$$R(0) = \rho(1 - \mu) \left[ \begin{array}{l} q^G \left( D_1^{IC} - \min\{D_1^{IC}, \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})\} \right) \\ + (1 - q^G) \left( \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\} - B_1^{H,B}(\underline{\gamma}) \right) \end{array} \right].$$

According to Corollary 2.1,  $D_1^{IC} > \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  if  $\omega_1^{H,G} < (1 - \bar{\gamma}) C_2$ , in which case

$$R(0) = \rho(1 - \mu)(\bar{l} - \underline{l}).$$

Next, we examine the expected screening cost associated with each granted loan, which equals the cost conditional on screening  $\psi$ , divided by the probability of extending the loan conditional on screening. With probability  $\mu$ , an applicant is reliable, in which case her

probability of winning the auction equals  $\left(\frac{\mu}{2} + (1 - \mu)\right)$ . Therefore the probability an applicant

wins is  $\mu\left(\frac{\mu}{2} + (1 - \mu)\right)$ . If  $R(0)$  is less than the expected per-loan screening cost

$\frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}$ , no securitization structure can ever incentivize the lender to screen. This will

be the case when  $(\bar{l} - \underline{l})$  is small so there is little value in telling the reliable from the unreliable. When the loan applicant is highly likely to be reliable (higher  $\mu$ ), the additional amount received from screening is also small, however the effective per-loan screening cost is also lower so that the overall result on screening incentives is ambiguous.

For any given securitization structure  $F$ , a securitizer screens if and only if

$$R(F) \geq \frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}. \text{ Given that } R(F) \text{ decreases with } F, \text{ let } F^{\max} \text{ be the maximum } F$$

that satisfies  $R(F) = \frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}$ , the securitizer's IC constraint becomes  $F \leq F^{\max}$ .

Finally, we discuss the securitizer's participation constraint. According to Lemma 2.2, the informed securitizer's expected profits are  $(1-\mu) \times [\rho(\bar{l} - m) + m - \underline{l}]$ , which increase in  $m$  and therefore  $F$ . Intuitively, the securitizer's profits get higher if he can set up a securitization structure that sells a higher fraction of loans (due to the assumption that he is less patient). Given there's no fixed cost in screening, the participation constraint in this case becomes

$$\underbrace{(1-\mu) \times [\rho(\bar{l} - m) + m - \underline{l}]}_{\text{expected profits}} \geq \frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}.$$

Let  $F^{\min}$  be the minimum face value that satisfies

$$(1-\mu) \times [\rho(\bar{l} - m) + m - \underline{l}] = \frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}. \text{ The participation constraint requires}$$

$F \geq F^{\min}$ . Note that as  $\rho \rightarrow 1$  and if  $D_1^{IC} > \gamma_1 C_1 + B_1^{H,G}(\gamma)$  holds, both the IC and PC

constraint become  $(1-\mu)(\bar{l} - \underline{l}) \geq \frac{\psi}{\mu\left(\frac{\mu}{2}+(1-\mu)\right)}$ . In this case, the IC constraint can always

be satisfied conditional on the participation constraint holding, and vice versa.

To summarize, the IC constraint in screening requires  $F \leq F^{\max}$ , whereas the participation constraint requires  $F \geq F^{\min}$ . In the general solution, the securitizer chooses  $F^{\max}$  if  $F^{\min} \leq F^{\max}$ . Otherwise, no securitization structure can incentivize both screening and participation simultaneously. In the appendix, we will examine the kinds of securities the securitizer might hold to maximize incentives while minimizing retention.

### III. How Liquidity Affects Securitization

Now that we have laid out the framework, let us study first how an increase in future liquidity, and then how an increase in current liquidity affects the extent of debt, screening, and securitization.

#### A. The Effect of Anticipated Liquidity

Consider an increase in  $\omega_1^{H,G}$  from low levels. We assume the screening cost  $\psi$  is sufficiently low such that for low  $\omega_1^{H,G}$  (and thus also  $\omega_1^{H,B}$ ) the firm is underpriced at date 1 in both states even with high pledgeability (in that maximum date-1 bids are below  $C_2$ ). In this case, retained claims in either state G or state B alone can provide sufficient incentive to screen. In addition, we assume Assumption 1 continues to hold.

##### Low anticipated liquidity

When  $\omega_1^{H,G} < (1 - \bar{\gamma})C_2$  so that  $B_1^{H,G}(\bar{\gamma}) < C_2$ , then Corollary 2.1 implies

$D_1^{IC} > \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$ . In this case, both  $R^G(0)$  and  $R^B(0)$  are strictly positive so that screening will affect the amount the securitizer receives in both future states. Specifically,  $R^G(0) = (1 - \mu)[D_1^{IC} - \gamma_1 C_1 - B_1^{H,G}(\underline{\gamma})]$  and  $R^B(0) = (1 - \mu)[B_1^{H,B}(\bar{\gamma}) - B_1^{H,B}(\underline{\gamma})]$ . Since

we assume  $q^G R^G(0) \geq \frac{\psi}{\mu \left( \frac{\mu}{2} + (1 - \mu) \right)}$  so that the claims in state G alone can provide

sufficient incentives to screen, the securitizer chooses  $F \in (\underline{x}^G, \bar{x}^G)$  such that

$q^G R^G(F) = \frac{\psi}{\mu \left( \frac{\mu}{2} + (1 - \mu) \right)}$ . In this region, increased pledgeability increases the bids by a

constant amount, making  $D_1^{IC}$  increase with  $\omega_1^{H,G}$ .

*Intermediate levels of anticipated liquidity*

As  $\omega_1^{H,G}$  increases further and exceeds  $(1-\bar{\gamma})C_2$ ,  $D_1^{IC} - B_1^{H,G}(\underline{\gamma})$  starts to decrease with  $\omega_1^{H,G}$ . So does  $R^G(0)$ , the maximum gains to the securitizer in state G. By contrast,  $R^B(0)$  is unaffected. Ultimately,  $q^G R^G(0)$  falls below the per-loan screening cost

$\frac{\psi}{\mu\left(\frac{\mu}{2} + (1-\mu)\right)}$ . In that case, the claim from state G alone is unable to provide sufficient

incentive for screening and therefore  $F$  needs to drop dramatically to some level below  $B_1^{H,B}(\bar{\gamma})$ . In other words, the securitizer must choose  $F \in (\underline{x}^B, \bar{x}^B)$  such that

$q^G R^G(F) + (1-q^G)R^B(F) = \frac{\psi}{\mu\left(\frac{\mu}{2} + (1-\mu)\right)}$ . As a result, there will be a discontinuous drop

in securitization structure  $F$  and therefore an increase in retention.

*High anticipated liquidity*

As  $\omega_1^{H,G}$  further increases so that  $D_1^{IC}$  falls below  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$ ,  $\underline{l}$  may increase beyond  $\bar{l}$ . In this case, there is no screening thus also no retention. Intuitively, high liquidity facilitates debt of higher face value than  $D_1^{IC}$ , which crowds out the incentive for pledgeability. All loans are sold to investors or to securitizers who do not screen, and who therefore retain nothing and sell out the securities against the loan entirely, with no skin in the game.

To summarize, as liquidity  $\omega_1^{H,G}$  increases, one of the three events may occur and subsequently reduces (or eliminates) the incentive to screen. First,  $R^G(0)$  gets smaller so that the amount received in state G is less sensitive to screening. Second,  $D_1^{IC}$  may fall below  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  so that incentives to screen cannot come from retentions in state G. In both cases, the IC and PC constraints in screening are more likely to get violated. Finally,  $\underline{l}$  may increase beyond  $\bar{l}$  as  $\omega_1^{H,G}$  increases, so that being screened does not allow a larger loan, and there is no demand for screening. The more general point is that liquidity tends to diminish the differences between screened and unscreened lending, because it reduces the need for incentives

at the borrower level, and hence reduces the need for incentives at the screener level (as also increases the difficulty of providing incentives to the screener).

Let us illustrate of the effect of anticipated liquidity with a numerical example.

**Numerical Example: Parameters:**  $q^G=0.5$ ,  $\theta^H=0.2$ ,  $\bar{\gamma}=0.6$ ,  $\underline{\gamma}=0.3$ ,  $C_1=C_2=1$ ,  $\omega_1^{I,G}=0.8$ ,  $\omega_1^{I,B}=0.2$ ,  $\omega_1^{H,G} \in [0,0.8]$ ,  $\omega_1^{H,B}=0$ ,  $\gamma_1 = \bar{\gamma}$ ,  $\mu=0.5$ ,  $\rho \rightarrow 1$ ,  $\psi=0.005$

Under these parameters, a reliable incumbent can always outbid outside experts in an auction at date 1. The bids in state G and  $D_1^{G,PayIC}$  will depend on  $\omega_1^{H,G}$ . The bids in state B (conditional on the chosen pledgeability) are  $B_1^{H,B}(\bar{\gamma})=0.6$  and  $B_1^{H,B}(\underline{\gamma})=0.3$ . In addition,  $D_1^{B,PayIC}=0.54$ . Additionally, under given parameters,  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  is greater than 0.9, which always exceeds  $B_1^{H,B}(\bar{\gamma})=0.6$ . As a result, the payoff relevant regions in state G and state B do not have any overlap, as illustrated in figure 4.

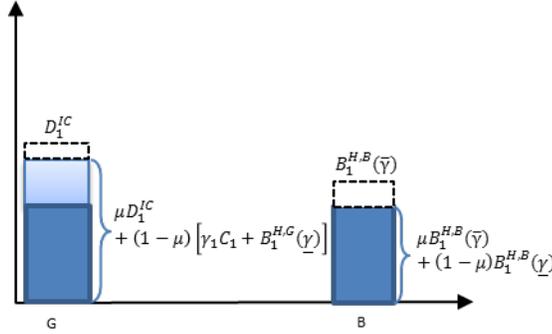


Figure 4 Retention Policy of the Numerical Example

The per-applicant screening cost equals  $\frac{\psi}{\mu\left(\frac{\mu}{2} + (1-\mu)\right)} = 0.0133$ . In Figure 5, Panel A shows  $D_1^{IC}$ ,  $D_1^{\max}$ ,  $\bar{x}^{s_1} - \underline{x}^{s_1}$  (the maximum screening benefits in state  $s_1 \in \{G, B\}$ ), and Panel B shows  $F^{\max}$ , and  $1 - \frac{m}{l}$ , which is the fraction of retention.  $D_1^{IC}$  initially increases at slope 1 until  $B_1^{H,G}(\bar{\gamma})$  reaches  $C_2$  (at which point full value is paid in state G and the bid by experts in

that state no longer increases with  $\omega_1^{H,G}$ , after which  $D_1^{IC}$  increases more gently. When  $\omega_1^{H,G}$  increases from 0.62 to 0.63,  $D_1^{IC}$  drops discontinuously because the benefit of high pledgeability in state G, given the high liquidity, gets sufficiently low that incentives for setting pledgeability high have to come from state B. This then requires the incentive compatible level of debt (for setting pledgeability high) to drop significantly.

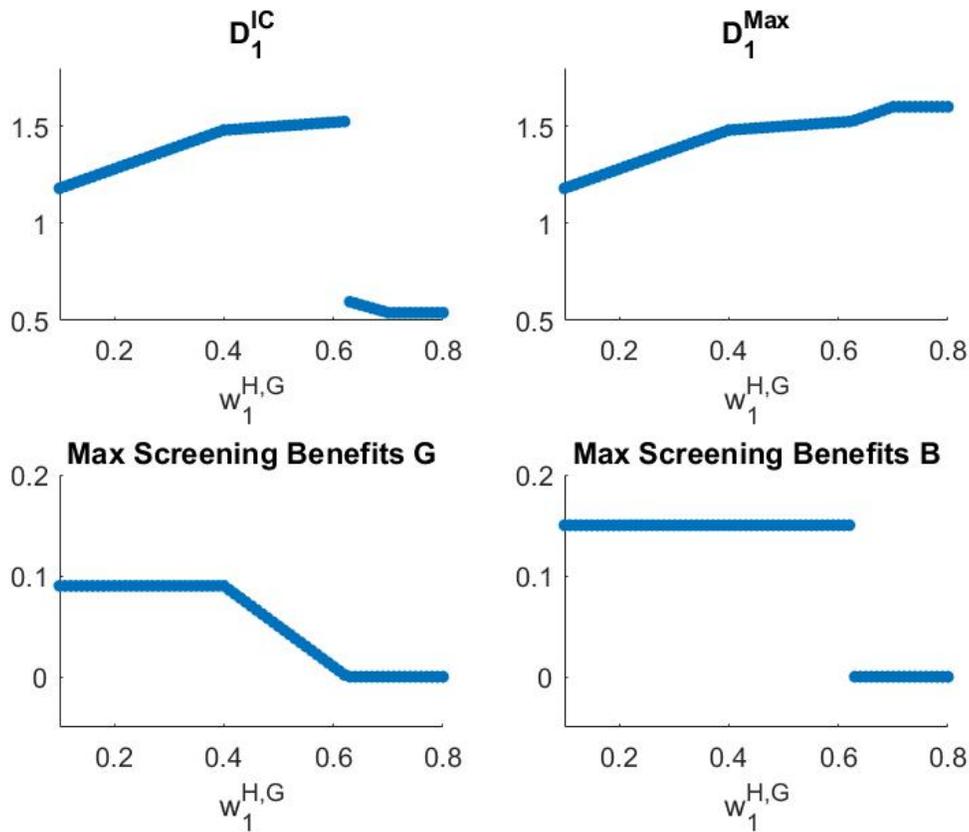
Next, we examine  $\bar{x}^G - \underline{x}^G$  and  $\bar{x}^B - \underline{x}^B$ , the maximum screening benefits in both states. By definition,  $\bar{x}^G - \underline{x}^G = (1-\mu) \left[ D_1^{IC} - \min \left( D_1^{IC}, \gamma_1 C_1 + B_1^{H,G}(\underline{\gamma}) \right) \right]$ . When  $\omega_1^{H,G} < 0.4$ , it equals  $(1-\mu) \left[ D_1^{IC} - \gamma_1 C_1 - B_1^{H,G}(\underline{\gamma}) \right]$ , which is constant over the range because both  $D_1^{IC}$  and  $B_1^{H,G}(\underline{\gamma})$  increase with  $\omega_1^{H,G}$  at slope 1. Note that  $q^G \rho(\bar{x}^G - \underline{x}^G) = 0.045$ , which exceeds the per-loan screening cost 0.0133. As a result, the incentive to screen can be fulfilled by the securitizer retaining claims whose payoff depends on screening only in state G. By contrast,  $\bar{x}^B - \underline{x}^B$  is a constant until  $D_1^{IC}$  falls below  $B_1^{H,B}(\bar{\gamma})$ , in which case  $\bar{l}$  actually falls below  $\underline{l}$  so that no screening can ever be incentivized.

Given all this,  $F$  can be set very high and still incentivize the securitizer to screen. Since both  $\bar{x}^G$  and  $\underline{x}^G$  increase with  $\omega_1^{H,G}$ , so does the maximum  $F$ . With a higher  $F$ ,  $m$ , the amount of date-1 cash flows that can be sold to investors at date 0 also goes up. In fact, when  $\omega_1^{H,G} < 0.4$ ,  $m$  and  $\bar{l}$  increase with  $\omega_1^{H,G}$  at slope 1 (and therefore by the same amount) so that the fraction of retention  $1 - \frac{m}{\bar{l}}$  actually decreases while intermediary leverage,  $\frac{m}{1 - \frac{m}{\bar{l}}}$ , increases. The value of the claim retained is constant, but a larger amount can be lent and securitized. As a result, increasing liquidity reduces the fraction of lending retained when  $\omega_1^{H,G} < 0.4$ .

When  $\omega_1^{H,G}$  further increases between 0.4 and 0.62, the maximum screening benefit in state G,  $(1-\mu) \left[ D_1^{IC} - \gamma_1 C_1 - B_1^{H,G}(\underline{\gamma}) \right]$ , starts decreasing as  $D_1^{IC}$  no longer increases with  $\omega_1^{H,G}$  at slope 1, forcing the securitizer to retain more of the repayment in state G to maintain incentives. Ultimately, the benefits from state G alone is insufficient to cover the cost (when

$\omega_1^{H,G}$  increases from 0.55 to 0.56), in which case  $F$  needs to drop significantly to allow the securitizer to retain claims on repayments in state B as well. Interestingly,  $F$  decreases with  $\omega_1^{H,G}$  when  $\omega_1^{H,G}$  varies between 0.56 and 0.62. Intuitively, the maximum screening benefit in G continues to decrease and therefore the securitizer needs to retain more (lower  $F$ ) to incentivize screening. With a lower  $F$ , the securitizer sells out less to investors ( $m$  is lower) and therefore retention also increases. If retention were more costly ( $\rho$  sufficiently small), unscreened lending (with no retention) would dominate.

Finally, when  $\omega_1^{H,G}$  gets sufficiently high ( $\omega_1^{H,G} > 0.62$ ),  $D_1^{IC}$  drops below  $\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})$  so that screening does not affect the amount that the initial borrower will repay in state G. Under the parameters in this example, after the discontinuous drop in  $D_1^{IC}$ ,  $\bar{T}$  also falls below  $\underline{l}$  so that the incumbent cannot borrow more with incentives for increased pledgeability, and screening is dominated by unscreened lending. At this very high level of future liquidity, no skin in the game is retained by securitizers.



Comparative Statics with Low Screening Cost: Figure 5 Panel A

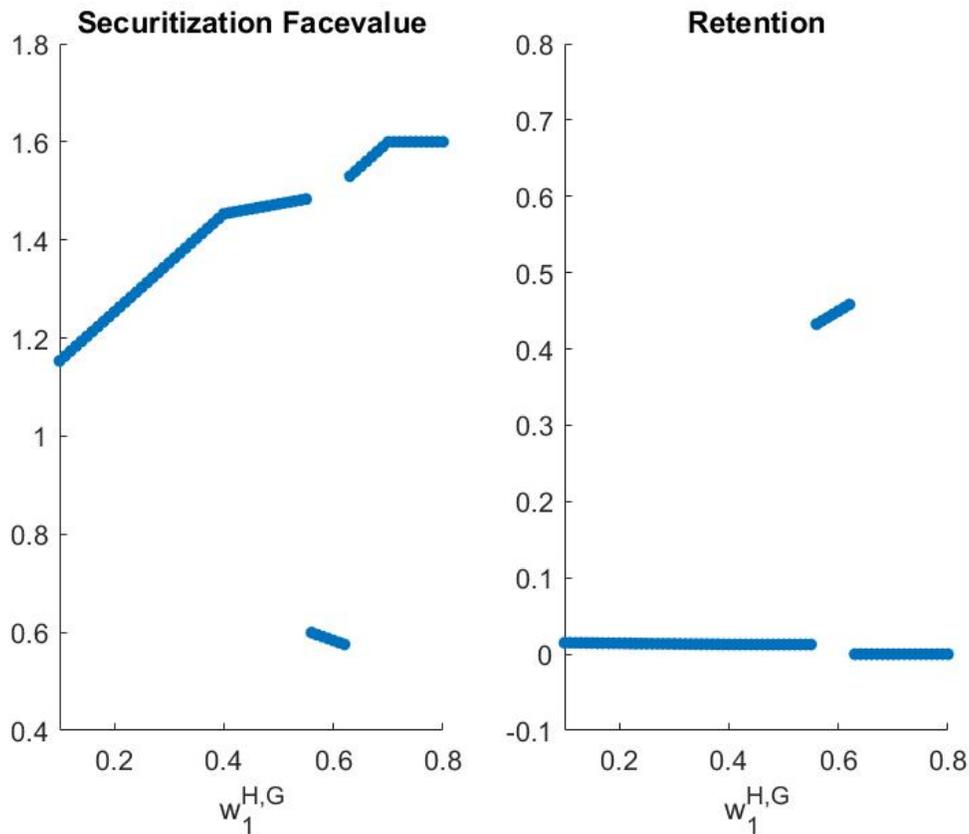


Figure 5 Comparative Statics with Low Screening Cost: Panel B

To summarize, in times of very high liquidity, the advantages of pledgeability are low or zero, screening is squeezed out and retention goes to zero as compared to more normal times where substantial retention is required. Intermediary leverage will increase to one hundred percent. The analysis predicts that securitization will lead to unscreened lending during these periods of high liquidity with high liquidity growth. This may explain the Keys, Mukherjee, Seru, and Vig (2008) result that increased access to the securitization process reduced screening by financial intermediaries of subprime and low documentation borrowers. Our model suggests that it was not securitization per se, but changes in market liquidity that changed the need for screening in securitizations that drives their results. In the period 1997-2003 when house price growth was moderate (and therefore liquidity moderate and securitized screening in effect) they find no difference in default performance of loans just above the rating threshold for securitization and those just below. Their differential effect is concentrated in the period 2004 to first half of 2006, a time of high and rapidly rising housing prices when our model would suggest that securitizers would be unlikely to screen. Interestingly, in the sample from the second half of

2006 and the first half of 2007, when house prices stabilized and even started falling, our model would suggest securitizers would once again start screening. Here again, they find no differential effect in defaults between loans just above the rating threshold for securitization and those just below.

### *B. The Effect of Current Liquidity*

In times of moderate future liquidity, we showed that reliable borrowers want to increase pledgeability to raise additional funding, and this will create a demand for screened lending by securitizers. These borrowers benefit ex-ante, by raising more to increase their chances of acquiring the firm initially, and ex-post, when they choose to raise pledgeability to increase the resale value of the firm should they later lose their abilities. In contrast, when the future liquidity is so high that a borrower can raise more at very high leverage (removing the incentive for increased pledgeability), it is exactly the need to raise more that forces reliable borrowers to lever up and remove their incentive to be screened or to increase pledgeability. Conversely, if she needs to raise only a limited amount initially, a reliable borrower can benefit from being screened if she needs only borrow a lower amount that will ensure her incentives to raise pledgeability.

In our previous analysis, borrowers have been forced to raise the maximum funding initially. Otherwise they would submit a losing bid when the winning bid will be less than the present value of future cash flows. This is because they have insufficient wealth up front to make up the difference between the value of the asset and the amount that they can borrow, given the moral hazard in repayment and pledgeability. A sufficient condition is that initial liquidity  $\omega_0 = 0$ . In this subsection, we relax the assumption of very low initial liquidity, and assume that  $\omega_0 > 0$ . We now examine its effects.

We assume very high future liquidity for simplicity (since this is the case when we showed pledgeability would be dispensed with). So  $\omega_1^{H,G} > (1 - \underline{\gamma})C_2$  and bidders will pay a full price at date 1 for the asset in future state G. The rest of our assumption 1 still applies. Therefore, payments must be low enough to provide pledgeability incentives in state B (since none emanate from state G), and  $D_1^{IC} = D_1^{B,PayIC}$ . Therefore, if initial bidders are reliable, the face value that pledges out the most is either  $\gamma_1 C_1 + C_2$  or  $D_1^{B,PayIC}$ . Let  $\underline{l} = q^G (\gamma_1 C_1 + C_2) + (1 - q^G) B_1^{H,B}(\underline{\gamma})$  and  $\bar{l} = D_1^{B,PayIC}$ .

The value of the asset to an initial reliable bidder depends on the level of the initial debt  $D_1$ . Let it be  $V$ . Specifically,

$$V(D_1) = \begin{cases} \bar{V} = q^G (C_1 + C_2) + (1 - q^G) [\theta^H C_2 + (1 - \theta^H) B_1^{H,B}(\bar{\gamma})] & \text{if } D_1 \leq D_1^{B,PayIC} \\ \underline{V} = q^G (C_1 + C_2) + (1 - q^G) [\theta^H C_2 + (1 - \theta^H) B_1^{H,B}(\underline{\gamma})] & \text{if } D_1 > D_1^{B,PayIC}. \end{cases}$$

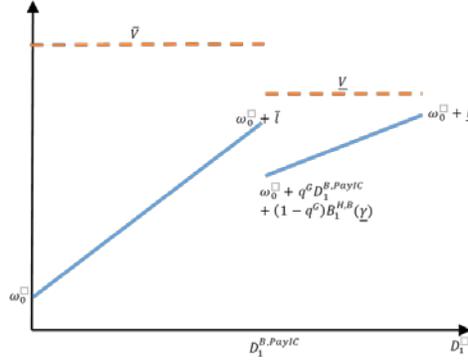
Because there is no underpricing in state G, the initial bidder always recoups the full value of the asset  $C_1 + C_2$  if state G is realized. If  $D_1 \leq D_1^{B,PayIC}$  and state B is realized, the incumbent will set pledgeability high and will sell the firm for  $B_1^{H,B}(\bar{\gamma})$  if she loses ability. The value she collects before debt payment is  $\bar{V}$ . If  $D_1 > D_1^{B,PayIC}$ , the incumbent chooses  $\gamma_2 = \underline{\gamma}$ . In this case, if state B occurs and if the incumbent loses her ability, she only sells the firm at price  $B_1^{H,B}(\underline{\gamma})$ , so she expects to receive  $\underline{V}$  overall.

We will analyze two cases, depending on whether screening allows for a larger loan to a borrower identified as reliable ( $\bar{l} > \underline{l}$ ) or not. If liquidity in state B is very low compared to liquidity in the boom in state G,  $\bar{l} = D_1^{B,PayIC}$  will be low.

#### Case 1: $\bar{l} \leq \underline{l}$

##### *Low current liquidity*

In this case the unscreened loan amount actually exceeds the screened loan amount. Therefore, if there are rents to initial bidders (no one can afford to bid the full expected value of the asset, which in this case is  $\underline{V}$ ), even a reliable initial bidder would still borrow the maximum (to have a chance of making the winning bid), issuing an unscreened loan with face value  $\gamma_1 C_1 + C_2$  directly to investors. Figure 6 illustrates this scenario. The dashed lines show respectively the levels of  $\bar{V}$  and  $\underline{V}$ . The solids lines show the maximum amount that the reliable expert can borrow as a function of promised payment  $D_1$ . In this case, any bidder will bid  $\omega_0 + \underline{l}$ , and there is no screening and retention.



**Figure 6 Bids and Values with low levels of  $\omega_0$**  The blue solids lines show the maximum amount that the reliable expert can repay as a function of promised payment  $D_1$ .

Now let  $\omega_0$  increase further so  $\omega_0 + \bar{l}$  increases above  $\underline{V}$  (the value of the asset if pledgeability is set low). The initial bid given an unscreened loan will be  $\underline{V}$ , which means there are no rents to initial bidders who borrow unscreened loans. However, as long as  $\omega_0 + \bar{l} < \underline{V}$ , even a reliable bidder must borrow unscreened. Otherwise, there is no chance for her to beat other bidders who borrow unscreened. In this case as well, firm leverage is high because high future liquidity crowds out pledgeability, and securitizer leverage is high (equivalently equity retention is zero or investors lend directly) because liquidity crowds out screening.

#### Intermediate current liquidity

As  $\omega_0$  further increases above  $\underline{V} - \bar{l}$ , a screened loan can allow a reliable bidder to win if screened, and a reliable manager would rather borrow screened because she captures more of the future value in the firm by selling at a higher value when she loses ability (because she sets pledgeability high). Figure 7 illustrates this scenario. Any bidder who borrows an unscreened loan will bid exactly  $\underline{V}$  and does not enjoy any rent. A reliable bidder can pay up to  $\min(\omega_0 + \bar{l}, \bar{V})$ , where  $\omega_0 + \bar{l}$  is the amount she can pay and  $\bar{V}$  is the value of the asset to her. Following a similar analysis to Lemma 2.2 and due to strategic concerns in the bidding process, a reliable manager bids between  $\underline{V}$  and  $\underline{V} + \mu \left[ \min(\omega_0 + \bar{l}, \bar{V}) - \underline{V} \right]$ . Note that her bid is still below  $\bar{V}$  so that she enjoys positive rents upon winning the bid. In this case, there is screening and retention. Both firm leverage and securitizer leverage are low. Reasonably high current liquidity can reduce the need for extreme leverage even while allowing more to be bid.

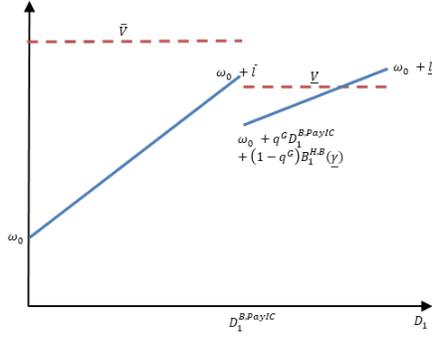


Figure 7 Bids and Values with intermediate levels of  $\omega_0$

Note: the red dashed lines show the levels of  $\underline{v}$  and  $\bar{v}$ . The blue solids lines show the maximum amount that the reliable expert can repay as a function of promised payment  $D_1$ .

### High current liquidity

As  $\omega_0$  gets yet higher such that  $\omega_0 + B_1^{H,B}(\underline{\gamma})$  exceeds  $\bar{V}$ . As illustrated in Figure 8, the reliable bidder can borrow  $B_1^{H,B}(\underline{\gamma})$  by setting  $D_1 = B_1^{H,B}(\underline{\gamma})$ . In other words, she borrows from a lender who doesn't screen and receives  $B_1^{H,B}(\underline{\gamma})$ . In this case, however, she would voluntarily set high pledgeability after getting control of the firm. She has sufficient liquidity such that even by borrowing a small amount without screening, she can bid up to the full value of the firm  $\bar{V}$ . Meanwhile, even an unreliable bidder is able to fully repay  $D_1 = B_1^{H,B}(\underline{\gamma})$ . Therefore, there is no need for the securitizer to screen or retain anything. Firm leverage is low while securitizer leverage is high. The high wealth of initial bidders allows assets to sell at full fundamental values without substantial use of outside borrowing.

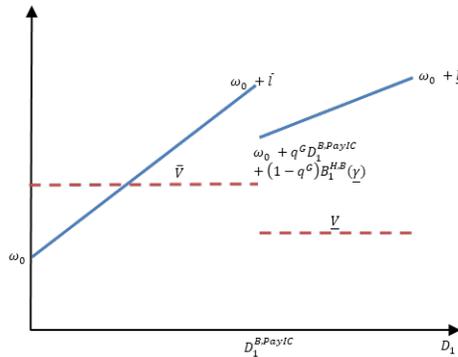


Figure 8 Bids and Values under high levels of  $\omega_0$

Note: the red dashed lines show the levels of  $\underline{v}$  and  $\bar{v}$ . The blue solids lines show the maximum amount that the reliable expert can repay as a function of promised payment  $D_1$ .

Now let us turn to the case where a screened reliable borrower can raise more.

Case 2: A Reliable Borrower can raise more:  $\bar{l} > \underline{l}$

Low current liquidity

A reliable borrow can raise more (with screening) when the liquidity in state B is not that much less than in state G, and  $\bar{l} = D_1^{B,Pay/C}$  is reasonably high. There is very little uncertainty about future liquidity. As a result a reliable bidder is never forced to choose extremely high leverage simply to outbid the unscreened and will not choose extreme leverage. In this case, the analysis is the same as for  $\bar{l} \leq \underline{l}$  except for low levels of  $\omega_0$ , where previously there was unscreened borrowing and extreme leverage. Figure 9 illustrates this situation. At low levels of  $\omega_0$ , a reliable bidder would like to borrow up to  $\bar{l}$  as long as  $\omega_0 + \bar{l} < \bar{v}$ . As a result, both screening and retention are still needed. Both firm and securitizer leverage are moderate.

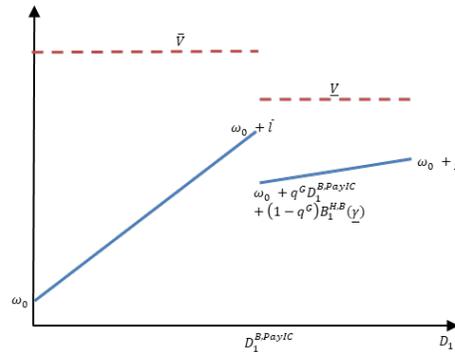


Figure 9 Bids and Values under low levels of  $\omega_0$

Note: the red dashed lines show the levels of  $\underline{v}$  and  $\bar{v}$ . The solids lines show the maximum amount that the reliable expert can borrow as a function of promised payment  $D_1$ .

High current liquidity

Screened lending (low firm and securitizer leverage) will dominate until initial liquidity,

$\omega_0$ , is high enough that even by borrowing just  $D_1 = B_1^{H,B}(\underline{\gamma})$ , the expert can bid the full value of the asset,  $\bar{V}$ . Firm leverage is low as the need to borrow is also low. This level of debt can be fully repaid even if the incumbent turns out unreliable. As a result, no screening is needed and securitizer can again take high leverage. Because we have assumed that a borrower has to pay rents to the screening lender relative to borrowing unscreened, the reliable borrower will not choose to be screened in this case.

In summary, when future liquidity is expected to be high, unscreened lending and extreme leverage will allow borrowers to raise more and  $\bar{l} \leq \underline{l}$ . Except in cases where current net worth/liquidity is also extremely high, this future liquidity will squeeze out pledgeability and screening and cause high firm and securitizer leverage. In contrast if there is moderate liquidity in most future states, firm leverage will be low and there will be screening, implying low securitizer leverage.

#### **IV. Relationship to the Literature**

To be written.

#### **Conclusion**

While this paper has been written to describe how securitization, a form of intermediation, varies with anticipated liquidity and current liquidity in the underlying real borrowing sector, there is a more general point here. Liquidity tends to diminish the consequences of many kinds of moral hazard over repayment. Internal governance matters little if the asset can be seized and sold for full repayment. Similarly, liquidity can also diminish the consequences of adverse selection over borrower types. Once again, it matters less if the manager is reliable or unreliable if the asset she manages can be seized and sold for full value. Therefore, liquidity encourages leverage at both the borrower and intermediary level, even while requiring less governance. Equivalently, because the intermediary performs fewer useful functions, high prospective liquidity encourages disintermediation.

Evidence that intermediaries abandon their natural functions of screening (or monitoring) when markets are very liquid does not mean their functions are without value at other times. Similarly, it may not be appropriate to look back after liquidity collapses to claim securitization is problematic. Both borrowing and securitization may have been optimized for the high liquidity

states ex ante, and that may have been the best thing for the borrower and securitizer to do. Effectively, both may have neglected the low liquidity state, but that is a consequence of the liquidity leverage nexus.

We have examined screening intermediaries in this paper. We can also examine monitoring intermediaries – for example, those that can add to the internally set pledgeability. The thrust of the results are similar – liquidity increases borrower leverage, diminishing the value of intermediary monitoring, and enhancing intermediary leverage. Importantly, intermediary capital in our model serves as skin in the game, giving the intermediary the incentive to screen. Other work tends to focus on the state-contingent variation in the supply of intermediary capital, which can disrupt the process of intermediation.<sup>14</sup> Our analysis, in contrast, can be thought of as variation in the demand for intermediary capital as the necessity of the fundamental functions that intermediaries perform, such as monitoring and screening, vary with liquidity. We hope to take these predictions to the data in future work.

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<sup>14</sup> Key studies of the effects of varying supply of intermediary capital are Holmstrom-Tirole (1997), He-Krishnamurthy (2012) and Rampini-Vishwanthan (2018).

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## Appendix

### Proofs of Lemma 2.2:

Proof: Without loss of generality, we refer to the informed securitizer as Lender 1. Suppose a pure strategy exists. Lender 1's probability of extending a loan is  $p^1 = \mu \times 1_{y > l_{0,2}} + (1 - \mu)$ , where  $y \geq \underline{l}$  is the loan amount  $l_0$  it commits to its borrower and  $l_{0,2}$  is the choice by Lender 2. Note that Lender 1 always wins conditional on financing a reliable manager when, with probability  $(1 - \mu)$ , Lender 2's applicant turns out to be unreliable. If a loan is extended, Lender 1 receives  $m$  from selling the securities immediately and the discounted value  $\rho(\bar{l} - m)$  from the retained portion of the loan at date 1. Therefore, Lender 1's objective function after screening and finding out the borrower is reliable is:  $p^1 \pi_1(y)$ , where  $\pi_1(y) = \rho(\bar{l} - m) + m - y$ . Clearly, if lender 2 adopts a pure strategy in  $l_{0,2}$ , Lender 1 can always increase its choice slightly above  $l_{0,2}$ , in which case its expected profits experience a jump unless  $l_{0,2}$  reaches  $\rho(\bar{l} - m) + m$ . However, this cannot be a pure-strategy equilibrium either because if so, each lender has zero profit and then each lender receives strictly positive profits by deviating to just slightly above  $\underline{l}$  and earning  $(1 - \mu)[\rho(\bar{l} - m) + m - \underline{l}]$ . For a similar reason, there cannot be a mass point in the distribution of  $l_{0,2}$ . As a result, the probability density function for the distribution of  $l_0$  must be continuous. Let  $\Gamma(y)$  be the CDF of  $y$ . In that case, the lender's profit by choosing  $l_0 = y$  is  $[\mu \times \Gamma(y) + (1 - \mu)] \pi_1(y)$ , assuming the competing lender also adopts the same mixed strategy. When  $y \rightarrow \underline{l}$ , the securitizer's profits are  $(1 - \mu) \times [\rho(\bar{l} - m) + m - \underline{l}]$ .

In a mixed strategy, any  $y$  must generate the same profits, therefore,

$$(1 - \mu) \times [\rho(\bar{l} - m) + m - \underline{l}] = [\mu \times \Gamma(y) + (1 - \mu)] [\rho(\bar{l} - m) + m - y].$$

If we let  $\Gamma(y) = 1$ , we get  $\bar{y} = (1 - \mu)\underline{l} + \mu[\rho(\bar{l} - m) + m]$ .

Q.E.D.

### The pecking order in retention

Does the securitizer only retain junior claims? We now study his choice of retention without restricting him to junior claims. We start by assuming that

$D_1^{IC} > B_1^{H,B}(\bar{\gamma}) > \mu D_1^{IC} + (1-\mu)[\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})]$ . As illustrated in the figure below, the incentive to screen can come from retention in both state G and state B. Moreover, the payoff relevant regions (dashed rectangle) in the two states have significant overlap. Throughout the exercise, we assume the securitization structure  $F$  is also not explicitly state-contingent. It is intuitive that the securitizer wants to retain any claim that provides him with incentives while selling any claim that does not. The difficulty, as we will see, arises with claims that provides him with incentives in one state but not in another.

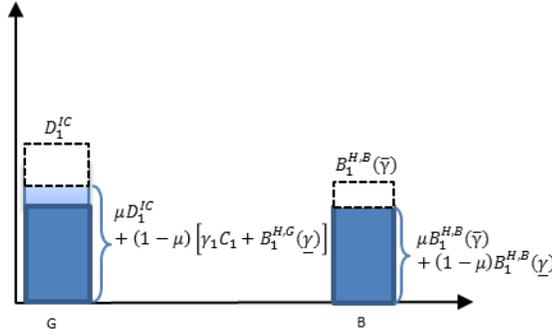


Figure 10 Retention Policy when both states matter

Given that retention provides incentive to screen, the optimal retention policy for the securitizer is always to retain the claim that only pays off when the realized cash flow  $x$  exceeds  $\mu D_1^{IC} + (1-\mu)[\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})]$ , which is the cash flow that would be realized if he lent  $D_1^{IC}$  to the applicant without screening. In this case, he is indifferent between the fully-overlapped claims  $[\mu D_1^{IC} + (1-\mu)[\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})], B_1^{H,B}(\bar{\gamma})]$  and the claim that only pays off in state G  $[B_1^{H,B}(\bar{\gamma}), D_1^{IC}]$ : both claims offer him incentive to screen and do not involve unnecessary retentions. If holding the entire tranche above  $\underline{x}^G = \mu D_1^{IC} + (1-\mu)[\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})]$  is still insufficient, the IC constraint requires the incumbent to retain a fraction of the claims that pays off if the realized cash flows  $x$  exceed  $\underline{x}^B = \mu B_1^{H,B}(\bar{\gamma}) + (1-\mu) B_1^{H,B}(\underline{\gamma})$ . However, such retention is more costly, because the securitizer is essentially holding some claims in state G (the range between  $\mu B_1^{H,B}(\bar{\gamma}) + (1-\mu) B_1^{H,B}(\underline{\gamma})$  and  $\mu D_1^{IC} + (1-\mu)[\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})]$ ) that do not enhance his incentives).

When screening affects the amount that the securitizer receives in both state G and state B, assuming the securitizer holds the junior claim is without loss of generality. If screening only affects the amount received in state B, the securitizer would like to sell both the senior and junior claims while holding the mezzanine stake. As illustrated in the figure below, when

$\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma}) > D_1^{IC}$ , both the reliable and unreliable experts can make the required payments in the G state. The incumbent would hold claims that only pay off if realized cash flows  $x \in (\mu D_1^{IC} + (1-\mu) B_1^{H,B}(\underline{\gamma}), D_1^{IC})$ , where there is a difference between repayment if unscreened and if screened.

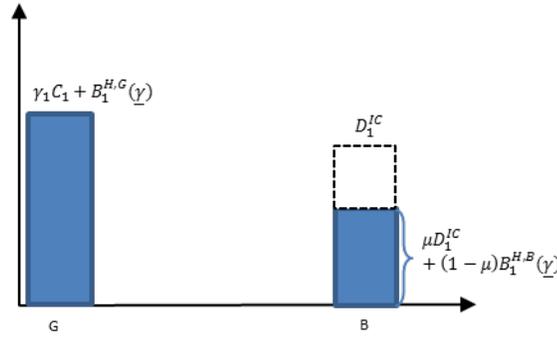


Figure 11 Retention Policy when only state B matters

### General case on The Effect of Current Liquidity

In this subsection, we conduct the comparative static analysis for the effect of current liquidity of the more general case. To proceed, let us define

$$V(D_1) = \begin{cases} \bar{V} = q^G [\theta^H C_2 + (1-\theta^H) B_1^{H,G}(\bar{\gamma})] + (1-q^G) [\theta^H C_2 + (1-\theta^H) B_1^{H,B}(\bar{\gamma})] & \text{if } D_1 \leq D_1^{IC} \\ \underline{V} = q^G [\theta^H C_2 + (1-\theta^H) B_1^{H,G}(\underline{\gamma})] + (1-q^G) [\theta^H C_2 + (1-\theta^H) B_1^{H,B}(\underline{\gamma})] & \text{if } D_1 > D_1^{IC}. \end{cases}$$

Also, let  $\bar{l} = q^G D_1^{IC} + (1-q^G) \min\{D_1^{IC}, B_1^{H,B}(\bar{\gamma})\}$  and

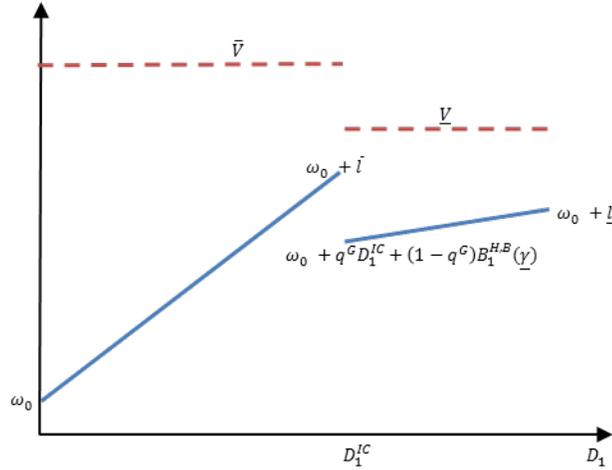
$\underline{l} = q^G (\gamma_1 C_1 + B_1^{H,G}(\underline{\gamma})) + (1-q^G) B_1^{H,B}(\underline{\gamma})$ . Clearly,

$$\bar{V} - \underline{V} = (1-\theta^H) \left[ q^G (B_1^{H,G}(\bar{\gamma}) - B_1^{H,G}(\underline{\gamma})) + (1-q^G) (B_1^{H,B}(\bar{\gamma}) - B_1^{H,B}(\underline{\gamma})) \right] > 0.$$

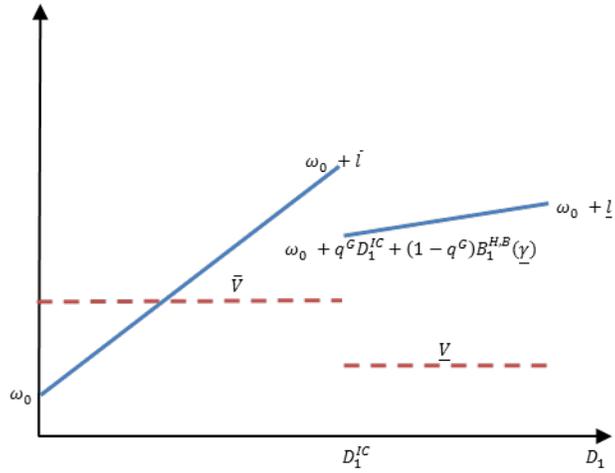
We again differentiate between two cases.

Case 1:  $\underline{l} < \bar{l}$

We start with low levels of  $\omega_0$ . As illustrated below, when there are rents to initial acquirers,  $D_1 = D_1^{IC}$  is preferred and the initial bidder can borrow up to  $y \in (\omega_0 + \underline{l}, \omega_0 + \underline{l} + \mu(\bar{l} - \underline{l}))$ .

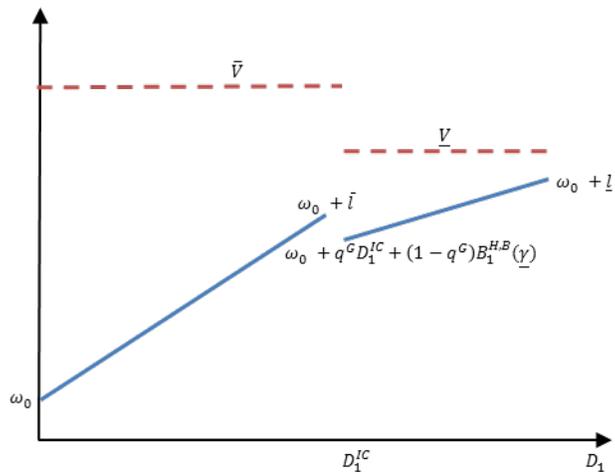


As  $\omega_0$  gets higher such that  $\omega_0 + q^G D_1^{IC} + (1 - q^G) B_1^{H,B}(\underline{\gamma})$  exceeds  $\bar{V}$ , even the reliable bidder can borrow  $q^G D_1^{IC} + (1 - q^G) B_1^{H,B}(\underline{\gamma})$  by setting  $D_1 = D_1^{IC}$ . In other words, she borrows from a lender who doesn't screen and therefore gets treated as an unreliable one as  $\lambda \rightarrow 1$ . In this case, however, she would voluntarily set high pledgeability after getting control of the firm. She has sufficient liquidity such that even by borrowing a small amount without screening, she can bid up to the full value of the firm  $\bar{V}$ . Therefore, there is no need for the securitizer to screen or retain anything. Firm leverage is low while securitizer leverage is high.

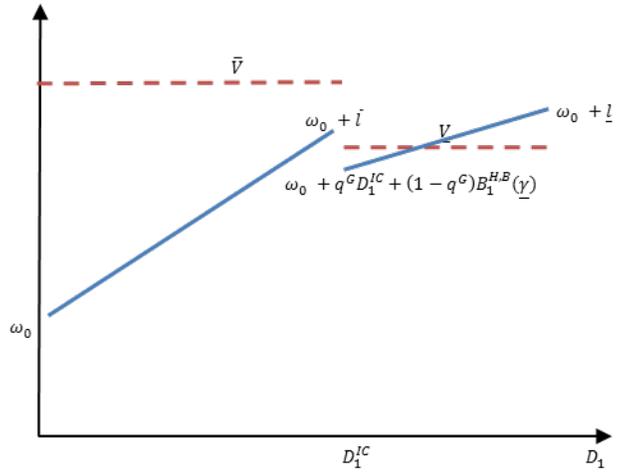


Case 2:  $\bar{l} \leq \underline{l}$

At low levels of  $\omega_0$ , all manager borrow  $\underline{l}$ . Both firm leverage and intermediary leverage are high.



When  $\omega_0$  increases above  $\underline{V} - \bar{l}$ , both firm and intermediary leverage are low. The reliable bidder receives  $y \in (\underline{V}, \underline{V} + \mu(\omega_0 + \bar{l} - \underline{V}))$ .



As  $\omega_0$  gets higher such that  $\omega_0 + q^G D_1^{IC} + (1 - q^G) B_1^{H,B}(\underline{\gamma})$  exceeds  $\bar{V}$ , firm leverage is low, and intermediary leverage is high.

