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Liquidity and the Structure of Intermediation

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Abstract

In the run up to the financial crisis, the essential functions financial 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 (such as securitizations) diminished, while their leverage increased. Some have suggested these developments stemmed from rising agency problems in the financial sector. Instead, we attribute them to rising liquidity in real asset markets. Under a variety of circumstances, prospective liquidity tends to enhance firm 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 general theory of the interaction between intermediary activities, intermediary capital structure, and real asset market liquidity.

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How do variations in the corporate sector's prospective wealth, that is, prospective *liquidity*, and its current wealth, that is, current liquidity, affect the relative weight of intermediated and direct finance? How do prospective and current liquidity affect corporate leverage and the leverage of the financial intermediaries that firms borrow from? What kind of financial intermediary services should we expect at different points of the financing cycle? To what extent do financial intermediaries themselves effectively become "pass-through" vehicles at the peak of a financing cycle, where access to funding is at its highest? To what extent do these phenomena contribute to raising systemic risk? These are the questions we attempt to answer in this paper.

Our focus is on how exogenous variations in liquidity affect the amount of external finance borrowers and financial intermediaries raise, and the actions they take to make debt repayments more effective. Let us be more specific. Consider an economy where expert managers with special knowledge could produce cash flows by starting a firm with a minimum investment scale. Experts fund their investment partly with their own wealth – which we term current liquidity and partly with a loan against the firm's assets. The other agents in the model are investors and financial intermediaries. Investors are individuals with some personal funds to lend, but who do not have the inclination or ability to engage closely with borrowers. Financial intermediaries, such as banks or sponsors of securitization vehicles, intermediate between investors and experts by raising funds from investors and lending to experts. Neither investors nor financial intermediaries can run firms.

The size of the loan that an expert receives for their initial investment depends on the debt capacity the firm can support – which in turn depends on how much future buyers will bid for the firm. This is because lenders have two sorts of control rights, which allow them to be repaid and are the basis for the firm's debt capacity. First, they have the right to repossess and sell the underlying asset if payments are missed. This 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 potential buyers in the future, willing to pay a high price for the firm's assets. Greater future wealth amongst experts outside the firm (which we term *prospective liquidity*) leads to higher prices in asset resale markets, with less of a fire-sale discount. This increases the availability of this asset-sale-based financing upfront, as in Shleifer and Vishny (1992). Clearly, this kind of control right is exogenous to the firm and depends on economic conditions.

The second right is that lenders can obtain control over the cash flows generated by the asset. It is endogenous because it stems from actions taken by the expert who makes the initial

investment – she can improve the pledgeability of the firm’s cash flows so that they are more directly appropriable by creditors. Raising pledgeability might entail, for example, improving accounting quality or setting up escrow accounts so that the expert cannot divert project cash flows into their own coffers. To introduce the need for an intermediary, we assume there are two types of experts – reliable experts who can participate in enhancing pledgeability and unreliable experts who cannot. The financial intermediary’s job is to screen the experts who apply for a loan to determine who is potentially reliable and who is not (the experts are assumed ignorant of their type). Once an expert is identified to be potentially reliable, borrows from the intermediary, and makes the investment, she can enhance pledgeability. We assume enhancing pledgeability takes time to set up and is also semi-durable.² So the reliable expert incumbent sets pledgeability one period in advance, and it lasts a period.

In general, both the higher prospective wealth of non-incumbent experts outside the firm (that is, prospective liquidity) as well as the higher amount of the firm’s future cash flow that a non-incumbent expert can borrow against (that is, higher pledgeability of the firm’s cash flows) will increase their bids for the firm. Higher prospective bids will increase debt repayments, and thus the willingness of creditors to lend up front. So *higher liquidity and pledgeability increase up front debt capacity*.

However, pledgeability is an endogenous decision made by the reliable incumbent manager, after taking on the initial debt. Let us describe her incentives while choosing cash flow pledgeability for the next period. We assume she may have some likelihood of selling some or all of the firm next period – either because she loses ability and is no longer capable of running it, or because she needs to raise finance for new investments. If she had no debt claims outstanding, she would undoubtedly want to increase pledgeability, especially if the direct costs of doing so are small – this would simply increase the amount she would obtain by selling the firm to non-incumbent experts if she loses ability. Indeed, one of the benefits of financial intermediation – obtained through the intermediary’s screening and monitoring -- is that by identifying reliable experts and enabling them to increase pledgeability, the intermediary effectively raises the value the incumbent expert can get when she has to sell part or the whole of the firm, thus enhancing the value of the investment up front.

² 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.

When the incumbent expert has taken on debt, however, enhancing *cash flow pledgeability* is a double-edged sword. The higher future bid from non-incumbent experts also enables the financial intermediary to collect more payments if the incumbent stays in control because the intermediary has the right to seize assets and sell them when not paid in full. In such situations, the incumbent has to “buy” the firm from the intermediary, by outbidding experts (or repaying the initial loan fully). The higher the probability she will retain ability and stay in control and *the higher the outstanding debt, the lower her incentive to raise pledgeability*.

Now consider the effect of industry liquidity on pledgeability choice. Experts will never pay more for the firm than its fundamental value. Therefore, when future industry liquidity is very high, non-incumbent experts will have enough wealth to buy the firm at the full fundamental value without needing to borrow against the firm’s future cash flows. In this case, higher pledgeability has no effect on how much experts will bid to pay for the firm. In other words, *high future liquidity crowds out the need for pledgeability* in enhancing debt repayments. Therefore, we have two influences on pledgeability – the level of outstanding debt taken on to buy the firm and the prospective liquidity of non-incumbent experts.

In normal times, the need to provide the reliable incumbent expert 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, non-incumbent experts will have enough wealth to bid full value for the firm in the future without needing to borrow against its cash flows – any earlier corporate borrowing is enforced entirely by the bids made by wealthy non-incumbent experts, and high pledgeability is not needed for them to make their bid.

This also implies the value of financial intermediation varies with prospective liquidity. The screening and monitoring services provided by the intermediary enables the reliable expert to raise pledgeability and sell the firm at higher prices when she loses ability. Higher prospective liquidity diminishes the need for the financier’s intermediation services: if higher pledgeability no longer increases the bids by non-incumbent experts -- because their higher prospective liquidity allows them to bid as much as they desire -- then there is a diminished need for an intermediary to screen experts to find the reliable amongst them. Indeed, if prospective liquidity gets sufficiently high, all experts will be financed by investors directly (and without screening) since the expert’s reliability is no longer valued.

Depending on the levels of current and prospective liquidity, we show five intermediation equilibria can emerge in the contracts offered to experts up front. This allows us to describe the prevalence of different forms of intermediation in practice. There is the *no lending* equilibrium where there is too little current liquidity and prospective liquidity for an expert to borrow. There is the *no screening* equilibrium where there is abundant current and prospective liquidity so that experts do not need intermediation services to borrow. This could be thought of as the predominance of direct market finance or full securitization (relative to intermediated finance). When liquidity conditions are such that intermediaries are needed for certification, there are two kinds of separating equilibria (where reliable and unreliable experts are offered different contracts after screening). In the *separation with lending to the unreliable* equilibrium, the intermediary lends to both reliable and unreliable experts after screening, but retains some skin in the game in the former to convince investors that the loan is higher quality. This resembles bank origination with retention of reliable loans on balance sheet backed by bank equity and full sales of loans to unreliable experts. In the *separation with rationing of the unreliable* equilibrium, the intermediary lends only to experts found reliable after screening (and retains some exposure to them), and denies loans to unreliable experts. This resembles banking with rationing. There is also the possibility of *pooling equilibria* where the intermediary offers a common contract to both reliable and unreliable experts after screening, and lends for sure to the reliable but only with some probability (weakly) less than one to the unreliable.

It turns out that when the parameter space is such that both the *separation with lending to the unreliable* equilibrium and the pooling equilibrium exist, a competitive intermediary will offer the separating contract since that is preferable to the experts who seek loans up front. Intuitively, the separating contract enables the intermediary to retain different stakes in loans to different borrowers, a force explored in DeMarzo (2005). Interestingly, though, when both the *separation with rationing of the unreliable* equilibrium and the pooling equilibrium exist, the competitive bank will offer the expert the pooling contract. The reason this is more attractive to the expert is that it insures the expert against the likelihood that screening finds her unreliable, for the bank will still lend with positive probability after finding her unreliable even though it is directly unprofitable to make the loan. The reason the bank does not lose in making the loan is because investors pay an average price for the securities the bank issues, and the embedded cross-subsidy the intermediary gets from raising financing for the loan to the unreliable compensates for any loss in making them. Put differently, the bank offers cross-subsidies to the unreliable by hiding information from the investor markets, and thus finances socially beneficial projects that would not get private financing on a stand-alone basis. Asymmetric information between the bank and

investors reduces rather than increases credit rationing, and the bank performs an information-hiding cross-subsidy function along with screening. There is some relation between the ideas here and the ideas in Stein (1997) and Dang, Gorton, Holmstrom, and Ordonez (2017) that we will elaborate on later.

Interestingly, results differ when the banking market is monopolistic (for example, in a developing country), banks will offer contracts that maximize their own value rather than the utility of would-be borrowers. While this does change the nature of contracts offered, it also changes the equilibrium the bank chooses. In particular, the pooling contract is never preferred by the bank in equilibrium. The reason is that the implicit cross-subsidy reduces its rents relative to the separating equilibrium with rationing out of the unreliable. This then suggests an additional rationale for why a competitive banking system may ration credit less, and have greater social value.

Our paper follows an earlier paper (Diamond, Hu, and Rajan, forthcoming) on industry liquidity and firms' pledgeability choices. It is closely related to the seminal work by Shleifer and Vishny (1992) and related work such as Acharya and Vishwanathan (2011), Dow, Gorton, Krishnamurthy (2005), Eisfeldt and Rampini (2006, 2008), Holmström and Tirole (1997) and Rampini and Vishwanathan (2010). Securitization and the role of financial intermediaries are not explicitly modeled until this paper. The structure of the intermediary draws on work by Diamond (1984), DeMarzo (2005), DeMarzo and Duffie (1999), and Gorton and Souleles (2006) (see Gorton and Metrick (2013) for a comprehensive survey on securitization).

Apart from describing when intermediary services are most useful – and when the waxing and waning of the demand for intermediary services with liquidity conditions can be disruptive for the economy -- the model also allows us to discuss the financial intermediary's capital structure. In order for the financier's screening and certification to be credible (when identifying the reliable expert is valuable for lending), the financier has to have some claims at risk (as in Diamond (1984)). We describe how the intermediary's requirement for capital at risk changes with the anticipated level of future liquidity and thus the nature of the certification services the intermediary is required to provide. This gives us a theory of the demand for intermediary capital (equivalently, a theory of the fluctuation in the demand for intermediary leverage), where both firm leverage and intermediary leverage are endogenously determined.

In contrast, most of the analysis of intermediary asset pricing and intermediary leverage (see Holmström and Tirole (1997), Brunnermeier and Sannikov (2014), Rampini and Vishwanathan

(2018) and He and Krishnamurthy (2013) for example) has studied the effects of variation in the supply of intermediary capital. In such models, past repayments shock intermediary net worth, which constitutes the supply (or a fixed fraction of the supply) of intermediary capital. Because some types of asset holdings or monitored lending can only occur if the intermediaries have sufficient own net worth, these shocks have pervasive effects of their own (in addition their effects on firm net worth). In contrast, our focus on the demand for intermediary capital suggests the fluctuations in its level may be due to fluctuations in the need for some intermediation activities. In particular, at very high levels of prospective liquidity, with little need for intermediation services, there is also little need for existing intermediaries to limit leverage and retain much capital. So with little demand, intermediaries can operate with little capital. In contrast, as prospective liquidity fades, and the demand for intermediation services expands, the need for intermediary capital also increases. To the extent that intermediary capital is run down in periods when liquidity is expected to be plentiful, it may not be available in sufficient quantities when liquidity conditions turn and demand for capital ramps up.

We are not the first to describe conditions where securitizer “skin in the game” retention might vary with conditions and possibly be zero, but we show why this may happen during times of high asset valuations. Chemla and Hennessy (2014) presents a signaling model where retention is zero when asset prices are sufficiently informative of true value, implying that the amount of private information known by securitizers is small. By a similar logic, we get low or zero retention when anticipated industry liquidity is high implying little value in providing incentives to securitizers to screen and certify borrowers. Unless high industry liquidity (high asset valuations) are very highly correlated with informative asset prices, however, the models have very different predictions.

In the rest of the paper, we will formalize our arguments. In Section I, we describe the basic framework and the timing of decisions in a two-period model. To illustrate the role of pledgeability, we present two simple motivating examples in Section II. In Section III, we solve the basic model, and in Section IV we examine first how future or anticipated liquidity affects the structure of financial intermediation and then how current liquidity affects this structure. In Section V we present a few extensions, relate our paper to the literature, and then conclude.

I. The Framework and Model Setup

Consider an economy with two periods spanning across three dates: $t = 0, 1, 2$. A firm can be started at date 0 with a fixed-scale investment I . At date 1, the firm generates interim cash flows

C_1 if the economy is in the good prosperous state G , which occurs with probability q . With probability $1 - q$, the economy enters the bad distressed state B , and the firm fails to generate any cash flow. At date 2, the firm will produce final cash flows C_2 with certainty. Figure 1 illustrates the evolution of the state of nature.

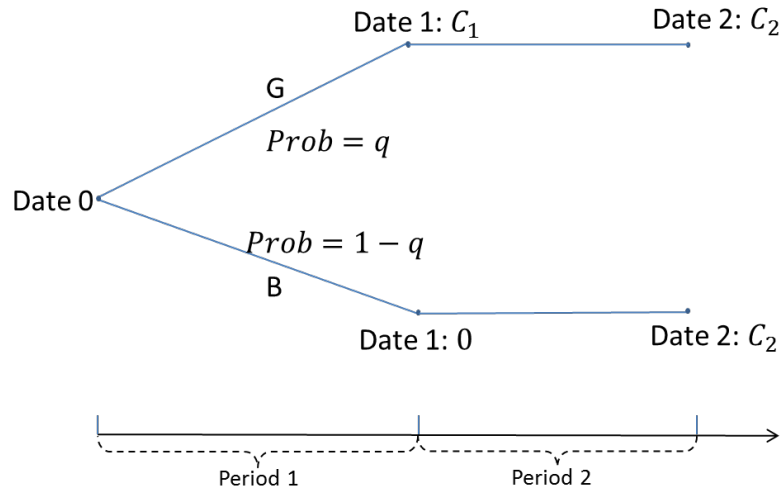


Figure 1: States of Nature

A. Agents

The economy is populated with three groups of agents: experts, financial intermediaries, and investors. All agents are risk neutral and the prevailing gross interest rate is 1. Experts have access to the investment technology and have the ability to produce cash flows from it. However, they have insufficient funds to put up the entire investment outlay and need to borrow from either financial intermediaries or investors. Once the initial investment is made, the funded expert becomes the *incumbent manager* of the firm (there are a number of such firms). During period 1 and after cash flows (if any) have been produced, the incumbent may lose her ability with probability $1 - \theta$, in which case she is forced to sell the firm to another expert.³ If that happens, we assume there are plenty of non-incumbent experts at that time to bid for the firm and their skills are compatible with the firm's needs. θ can be understood as the *stability* of the firm's technology – the extent to which the skills needed in the firm are unchanging. The event of losing ability is publicly observable but not verifiable and cannot be written into contracts. After losing

³ Equivalently, the entire model could be reinterpreted as one in which the firm will need essential additional interim financing with probability $1 - \theta$.

ability, the incumbent has to sell the firm, which is a reason for her to increase the resale value of the firm after investing in it.

For much of this paper, we refer to the financial intermediaries as banks for simplicity, though they will be reinterpreted as other kinds of intermediaries in certain environments, as we will discuss. Banks can screen and certify borrowing experts, a process that we will describe in detail in subsection I.C.⁴ Banks have sufficient funds to lend to all who seek finance, but we assume that after the initial loans have been made at date 0, banks have a scalable investment opportunity that returns $R > 1$ at date 1 with certainty. This assumption implies banks want to raise as much financing as possible from investors against the loans they make (and thus use own capital funds as little as possible). Alternatively, one can assume banks are less patient or have a higher opportunity cost of own capital – a rough proxy for persistent intermediary capital constraints.⁵ Finally, investors have deep pockets. They are willing buy any security as long as they break even in expectation.

B. Payment Enforcement and Cash-flow Pledgeability

In general, a bank has two ways of enforcing payments from the incumbent manager. First, the bank automatically gets paid the “*pledgeable*” portion of the cash flows produced over the period, up to the amount of the financier’s claim. Second, just before the end of the period, the bank gets the right to seize and auction the firm to the highest expert bidder if it has not been paid in full. This allows it to extract repayment either by threat of, or by actually, seizing and auctioning the firm. In this auction, both other 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.

We define *cash flow pledgeability* as the fraction of realized cash flow that can be verified by a court and therefore goes directly to satisfy the lender’s claim. Without loss of generality, we assume the cash flows produced during period 1 are not pledgeable, i.e., $\gamma_1 = 0$. However, during period 1, the incumbent can set pledgeability $\gamma_2 \in [\underline{\gamma}, \bar{\gamma}]$ for cash flows C_2 produced during period 2, where $0 < \underline{\gamma} < \bar{\gamma} < 1$. The range of feasible values for pledgeability $[\underline{\gamma}, \bar{\gamma}]$ is

⁴ The special role of financial intermediaries can be justified as a way for investors to avoid the duplication of effort, see Diamond (1984).

⁵ Banks 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.

determined by the economy's institutions supporting corporate governance, both operating within the firm (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 (see Rajan (2012)). 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 put in place that we assume the incumbent can only affect pledgeability one period ahead.

Since date-1 cash flows are not pledgeable, the key to debt enforcement at date 1 (and thus the amount borrowed at date 0) will be the amount other experts would bid for the firm at date 1. To the extent they need to borrow against the pledgeable cash flows to augment their personal wealth in making their bids at date 1, this will, in turn, depend on γ_2 , the pledgeability of period-2 cash flows.

C. Certification and Financial Contracts

Experts can be of two types: reliable or unreliable. The types differ in the cost incurred in raising pledgeability γ_2 . A reliable expert incurs a small cost $\varepsilon \geq 0$ to set γ_2 to any level 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 for an unreliable expert is so high that she will never do so. 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 expert has many more such options or fewer scruples, so the cost of binding her is disproportionately higher.

The fraction of reliable experts in the population is known to be $\mu \in (0, 1)$, but no one (including the expert herself) knows the expert's type. By paying a per-applicant cost ψ , the bank can screen the expert and tell whether she is *potentially* reliable. Subsequently, the bank has to set up a monitoring structure so that the potentially reliable expert actually becomes reliable. The process of screening and monitoring is the essential service provided by the bank, which we will term *certification* from now on. If an expert is screened and found to be potentially reliable, but does not borrow from the screening bank (and thus does not benefit from monitoring), she is

still unreliable. Thus, enhancing pledgeability requires the joint effort of incumbent and intermediary (this assumption of joint effort is relaxed later).

At date 0, each expert applies to at most one bank for certification – preparing relevant loan applications takes time and effort, as does doing the subsequent due diligence, which rules out applying to multiple banks simultaneously. After screening, the bank chooses which loan to offer the borrower from a menu of loan contracts that it has announced originally (we will discuss this in detail in subsection IV.A). If competitive investors can break even while lending to a borrower known to be unreliable, the borrower’s outside option is to fund with them, else it is to not borrow.⁶

In all cases, we assume the financial contract between the expert and financiers (bank or investors) is a one-period debt contract. So at date $t-1$, the financier lends l_{t-1} in return for which the expert promises to repay D_t at date t . The inability to write state-contingent contracts can be justified by assuming the aggregate state $s_1 \in \{G, B\}$ is observable but not verifiable.

D. Timing and Initial Conditions

Let ω_0 be the initial wealth level of experts, also termed *current liquidity*, and let ω_1^{I,s_1} be the incumbent’s wealth in state s_1 at date 1. To make the initial investment, the expert needs to borrow at least the funding gap $I - \omega_0$. In case she borrows more than the funding gap, we assume she consumes the excess funds upfront. Let ω_1^{E,s_1} be the state- s_1 wealth of other experts who do not own any firm, also termed *anticipated future liquidity* at date 1. The wealth of these non-incumbent experts (who work in the economy when not running a firm) is augmented when the economy is in state G, so $\omega_1^{E,G} > \omega_1^{E,B} = 0$. Anticipated future liquidity will play a key role in determining firm leverage, certification, and security issuance.

The timing of events is described in Figure 2. After funding the project at date 0, the incumbent expert sets γ_2 , the pledgeability for period 2’s cash flow, in period 1. A certified reliable expert incurs a low cost ε in raising pledgeability if she has the incentive to do so,

⁶ In equilibrium, a borrower will be indifferent between borrowing directly from investors and borrowing from a bank that does not certify. In this case, we assume without loss of generality that she borrows from the bank, who will subsequently sell out the entire loan to investors.

whereas all others are unable to raise pledgeability. Next, the aggregate state S_1 is realized. Production takes place. 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.

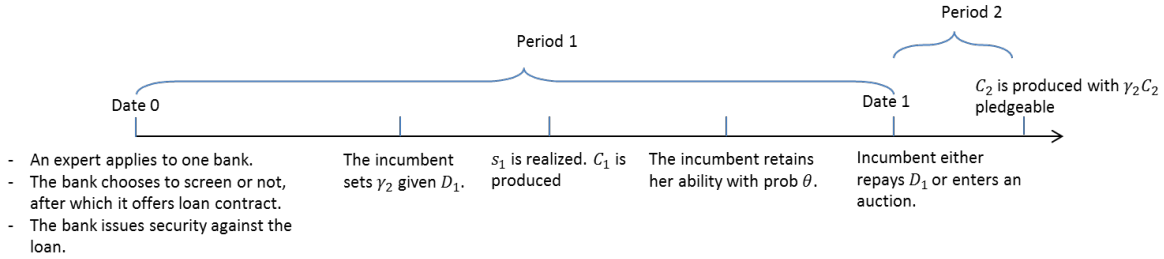


Figure 2: Timeline and Decisions

II. Two Motivating Examples

In the numerical examples below, we will focus on how prospective liquidity affects the nature of the loan and the benefit from bank certification. We let the cost of bank screening ψ be vanishingly small. Since only reliable incumbent experts can increase pledgeability and they need appropriate incentives to do so, the benefits of increased pledgeability will drive the demand for screening.

Let the parameters for the examples be: $q=0.4$, $\theta=0.5$, $\bar{\gamma}=0.6$, $\underline{\gamma}=0.3$, $\varepsilon \rightarrow 0$, $\omega_1^{I,G}=C_1=0.8$, $C_2=1$, $\omega_1^{I,B}=0$, $\omega_1^{E,B}=0$, $\gamma_1=0$, $\mu=0.5$, $\psi=0.05$, $I=1$, $R=1.02$

Example 1: Low anticipated industry liquidity: $\omega_1^{E,G}=0.2$

Debt repayment at date 1 is enforced by the bank, which can seize the firm and auction it to experts. The incumbent has to either pay the amount due or match the auction price, and will therefore choose to pay the lower of the two, defaulting strategically if the anticipated auction price is less than the debt payment. Of course, if the incumbent loses ability, she has no option but to sell in an auction since she cannot run the firm. She will use the auction proceeds to pay off debt and retain the residual proceeds.

A reliable incumbent is able to costlessly raise the pledgeability of future cash flows, which can increase the amount that non-incumbent experts can borrow against the firm at date 1

and can (weakly) increase their bids for the firm's assets. Similarly, higher liquidity – the realized date-1 non-incumbent expert wealth -- will also increase their bids. In state G, a non-incumbent expert can bid using her personal wealth 0.2 and the amount that she can borrow against future cash flows. If period-2 pledgeability had been set high (this is set earlier in period 1 before the state is known), she can borrow 0.6 times the date-2 cash flow of 1 and therefore will bid up to 0.8 in total. If pledgeability had been set low, the amount she can borrow against date-2 cash flows falls to 0.3, in which case she can only bid up to 0.5. Similarly in state B where her liquidity is zero, the non-incumbent expert can bid up to 0.6 if pledgeability has been set high and 0.3 if set low. In sum, *higher liquidity and higher pledgeability increase date-1 non-incumbent expert bids, and thus allows greater enforceable repayment of debt contracted to the bank at date 0*. Note that all of these bids fall below 1, the value of the period 2 cash flows from the asset, which means the asset is underpriced and an expert who acquires the asset at date 1 will enjoy some positive rents.

Now let us examine the effect of higher debt on a reliable incumbent's incentive to choose high pledgeability in period 1. Consider first an incumbent manager's choice when she owns the entire firm and has no debt due at date 1. In this case, the incumbent does not need to pay anything to retain control of the firm, so pledgeability choice will of course have no effect on required payments. On the other hand, if the incumbent manager loses ability and needs to sell the firm, higher pledgeability will increase expert bids by 0.3 and thus the selling price in both state G and state B by 0.3. If the cost of increasing pledgeability is small, as assumed, a reliable incumbent will choose to increase pledgeability. Indeed, as long as the debt due at date 1 is below 0.3 (the lowest possible expert bid which occurs in state B under low pledgeability), high pledgeability will similarly increase the resale value of the asset but will not affect the amount that the incumbent needs to repay to retain control of the firm. In that case, a reliable incumbent will only see the benefit from raising pledgeability.

Consider next what happens if a reliable incumbent manages an identical but highly levered firm with payment of 0.8 due on date 1. In this case, the incumbent does not benefit from high pledgeability when she loses ability, because the proceeds from selling the asset must be first used to repay the outstanding debt. Since expert bids never exceed 0.8 (the bid in state G with high pledgeability), debt consumes all the auction proceeds. Moreover, higher pledgeability increases the amount that the incumbent manager has to pay to stay in control when she retains ability. To see this, note that the incumbent can retain control either by fully repaying the outstanding debt of 0.8, or by defaulting strategically and outbidding other experts in the auction

(similar to Chapter 11 bankruptcy). High pledgeability increases experts' bids by 0.3 in both states B and G, implying that the incumbent has to pay 0.3 more in either state. In this case, high pledgeability will not be chosen even if the incumbent is reliable. *Higher debt reduces the reliable incumbent's incentive to raise pledgeability*, so that even reliable managers will behave as if they are unreliable. Therefore, there is no need to distinguish different types of experts through screening.

It is easy to see that, if the state was sure to be B, a promised date-1 debt payment of 0.45 would make the reliable incumbent indifferent between setting pledgeability low or high: when she loses ability she is able to receive $(0.6-0.45)$ if she sets pledgeability high but nothing if low, whereas when she retains ability, she has to pay 0.45 if she had set pledgeability high but only 0.3 if low. The expected benefits and costs balance when promised debt is 0.45, since the probability that she loses ability is 0.5. At any higher debt she would set pledgeability low. A similar calculation shows this indifference level of debt is 0.65 if the state was certain to be G.

It turns out that when the incumbent manager knows the probability of the G state is 0.4, the outstanding debt level that will make her indifferent in expectation is 0.55, something we will show formally later.⁷ This promised debt level also enables a reliable manager to repay the most in expectation. Having set pledgeability high, she repays the full amount 0.55 in the G state, which falls below expert bids 0.8, and hence is enforceable. In state B, she will also repay 0.55, so that in expectation, she is able to commit to make full payment of the debt outstanding. In contrast, any debt level above 0.55 will induce the reliable incumbent to choose low pledgeability, so the incumbent will default strategically in both state G and B and only repay the amount that experts bid when period-2 pledgeability is low: 0.5 in G, 0.3 in B, and 0.38 in expectation. Unreliable incumbents can only commit to pay this amount, 0.38, as would reliable incumbents who owed more than 0.55.

To summarize, so long as contracted repayment stays below a threshold, the reliable incumbent expert repays more on date 1 if she raises pledgeability, and therefore can borrow a higher amount initially at date 0. This is why, as we will see, there is some benefit from bank certification. However, as we now show, this benefit does not carry over to periods of high liquidity.

⁷ This is the payment level which makes the expected (across the two states) increase in payments when ability is retained equal to the expected increase in proceeds from selling when ability is lost.

Example 2: High anticipated industry liquidity $\omega_1^{E,G} = 0.8$

Suppose now that the anticipated liquidity in state G increases to 0.8. The increased net worth enables the non-incumbent expert to bid up to 1.4 in state G when pledgeability has been set high and 1.1 when pledgeability has been set low (because the expert can borrow only 0.3). In either case, though, she will bid no more than 1, the full value of the future cash flows, C_2 , generated by the asset. Given the expert can bid that amount even if pledgeability were set low, higher pledgeability has no effect on the experts' bid, and hence debt repayment at date 1 in state G. In effect, *high liquidity crowds out the need for pledgeability* in state G.

Following example 1, 0.45 is still the promised date-1 debt payment in state B at which the incumbent is indifferent between setting pledgeability low or high. Since high liquidity crowds out the need for pledgeability in state G, the incentive for high pledgeability can only come from state B. In sum, when anticipated industry liquidity in state G, $\omega_1^{E,G}$, is high, 0.45 is the highest level of debt that incentivizes high pledgeability because no incentives emanate from the G state.

Unlike example 1, the maximum debt level that still gives the incumbent the incentive to raise pledgeability is no longer the debt level that enables the incumbent to commit to repay the bank the most. If the incumbent borrows at date 0 by setting date-1 debt payment at or above 1, she will set pledgeability low, fully repay the debt in state G (which happens with probability 0.4) but default in state B, where creditors will only recover 0.3. In expectation, the reliable incumbent is able to repay 0.58 even though pledgeability is set low. In contrast, by setting the face value at 0.45—which is the maximum debt level that still incentivizes high pledgeability choice, the incumbent can only repay 0.45. To the extent that the incumbent needs to borrow a lot to invest up front, *liquidity enhances leverage, which crowds out the need for pledgeability*. There is now no need for the bank to screen to find a reliable manager, since higher pledgeability does not contribute to additional debt capacity. So *high anticipated liquidity crowds out intermediation services*.

We now analyze the model more generally, starting with the interaction between the reliable expert and the bank in section III. In section IV, we analyze the banks' decision on certification and lending, and its associated liability structure.

III. Liquidity, Leverage and Pledgeability Choices

We first examine how the face value of debt affects how much can be raised under different date-1 liquidity conditions. The analysis in period 2 is straightforward. Non-incumbent experts as well as the incumbent who retains ability can only commit to repay $D_2 = \gamma_2 C_2$ in period 2, where γ_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 incumbent, since no further pledgeability choice will be made.

We now proceed to the analysis during period 1, with the focus on how the promised payment D_1 affects the incumbent's pledgeability decision. Some parametric restrictions are needed to focus on the most relevant case once we introduce bank certification.

Assumption 1:

- a. $\omega_1^{I,G} \geq \omega_1^{E,G}$, $\omega_1^{I,B} = \omega_1^{E,B} = 0$
- b. $\omega_1^{E,G} + \underline{\gamma} C_2 > \bar{\gamma} C_2$
- c. $q < \theta$

Assumption 1a stipulates that in both states, the incumbent has weakly more wealth than non-incumbent experts at date 1. Assumption 1b ensures the difference in non-incumbent expert wealth (that is, anticipated 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 1c requires the probability of the good state be lower than the probability of the incumbent keeping her ability, θ . Because higher θ increases the disincentive of an incumbent expert to improve pledgeability, this is in part an assumption that the disincentive is relatively high. We will discuss how results change if 1b and 1c are violated.

A non-incumbent expert's bid in a possible date-1 auction is determined by ω_1^{E,s_1} , her wealth in state s_1 , as well as what she can borrow against future cash flows, which is determined by γ_2 . Since the value of the future cash flows is C_2 , an expert's date-1 bid will be

$B_1^{E,s_1}(\gamma_2) = \min\{\omega_1^{E,s_1} + \gamma_2 C_2, C_2\}$. Similarly, 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 $B_1^{E,s_1}(\gamma_2)$, we see that the

incumbent will outbid non-incumbent experts whenever she has (weakly) more wealth ($\omega_1^{I,s_1} \geq \omega_1^{E,s_1}$), since both parties can borrow up to $\gamma_2 C_2$ if needed. Under Assumption 1a, the incumbent can retain control in both states by outbidding experts in any possible date-1 auction if she retains ability. Since the continuation value of the firm, C_2 , is identical for the incumbent and experts, the incumbent is always willing to retain the firm if she retains ability. To do so, she either pays the amount outstanding on debt or outbids experts. That is, she pays $\min\{D_1, B_1^{E,s_1}(\gamma_2)\} = \min\{D_1, \omega_1^{E,s_1} + \gamma_2 C_2, C_2\}$. Clearly, through the choice of pledgeability, γ_2 , the incumbent could potentially affect what she needs to pay to stay in control.

A few points that we illustrated in the examples are worth noting here. First, the greater the anticipated liquidity, ω_1^{E,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 γ_2 chosen, the greater again the enforceability of debt payments. Finally, no rational bidder will pay more than the residual value of the firm, C_2 . So when liquidity is sufficiently high (that is, $\omega_1^{E,s_1} \geq (1-\underline{\gamma})C_2$), 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 $V_1^{I,s_1}(D_1, \gamma_2)$ be the incumbent's payoff when she chooses γ_2 , given the debt payment D_1 . In state s_1

$$V_1^{I,s_1}(D_1, \gamma_2) = \theta \left(C_2 - \min\{D_1, B_1^{E,s_1}(\gamma_2)\} \right) + (1-\theta) \left(B_1^{E,s_1}(\gamma_2) - \min\{D_1, B_1^{E,s_1}(\gamma_2)\} \right) - \varepsilon 1_{\{\gamma_2 > \underline{\gamma}\}},$$

The terms on the right-hand side are straightforward. With probability θ , the incumbent retains her ability and needs to pay $\min\{D_1, B_1^{E,s_1}(\gamma_2)\}$ to retain control and receive cash flows C_2 in period 2. With probability $1-\theta$, the incumbent loses her ability, in which case she has to sell the asset at price $B_1^{E,s_1}(\gamma_2)$, repay creditors $\min\{D_1, B_1^{E,s_1}(\gamma_2)\}$, and keep the remaining proceeds. A cost ε is incurred whenever she sets pledgeability γ_2 above $\underline{\gamma}$.

Note that the incumbent faces a tradeoff in raising pledgeability. A higher γ_2 (weakly) increases the amount the incumbent has to pay the financier when she retains ability 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 γ_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 θ , the more the costs loom large relative to the benefits, and higher is the moral hazard associated with raising pledgeability.

The level of debt 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 $\Delta_1^{s_1}(D_1) = V_1^{I,s_1}(D_1, \bar{\gamma}) - V_1^{I,s_1}(D_1, \underline{\gamma})$, which (weakly) decreases in D_1 . The reason is straightforward. If the incumbent retains her ability, she has to pay the banker 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. So higher outstanding debt reduces the incumbent's incentive to raise pledgeability. Proposition 3.1 summarizes the incumbent's incentive from state s_1 for any given D_1 .

Proposition 3.1: Under Assumption 1,

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

$$\text{is } \Delta_1^{s_1}(D_1) = \begin{cases} -\theta [B_1^{E,s_1}(\bar{\gamma}) - B_1^{E,s_1}(\underline{\gamma})] - \varepsilon & \text{if } D_1 > B_1^{E,s_1}(\bar{\gamma}) \\ \theta B_1^{E,s_1}(\underline{\gamma}) + (1-\theta) B_1^{E,s_1}(\bar{\gamma}) - \varepsilon - D_1 & \text{if } B_1^{E,s_1}(\underline{\gamma}) < D_1 \leq B_1^{E,s_1}(\bar{\gamma}) \\ (1-\theta) [B_1^{E,s_1}(\bar{\gamma}) - B_1^{E,s_1}(\underline{\gamma})] - \varepsilon & \text{if } D_1 \leq B_1^{E,s_1}(\underline{\gamma}). \end{cases}$$

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 Diamond, Hu, and Rajan (2019), where we also cover cases in which Assumption 1 is violated. Let us graph $\Delta_1^{s_1}$ as a function of D_1 as described in Proposition 3.1.

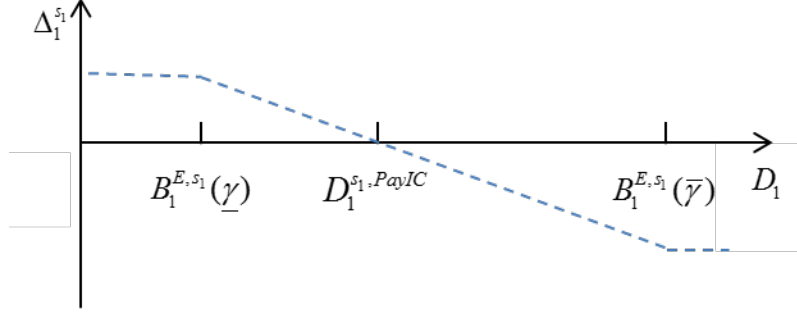


Figure 3: The net payoff to high pledgeability

For $D_1 \leq B_1^{E,s_1}(\underline{\gamma})$, debt repayment is not increased by higher pledgeability because the face value of outstanding debt is low. Instead higher pledgeability only increases outside bids, which is beneficial to the incumbent only when the incumbent loses ability and sells the asset. The benefits of high pledgeability are $(1-\theta)[B_1^{E,s_1}(\bar{\gamma}) - B_1^{E,s_1}(\underline{\gamma})] - \varepsilon$, which is the difference between the price that the incumbent can sell the asset at by setting pledgeability high versus setting it low. When D_1 rises above $B_1^{E,s_1}(\underline{\gamma})$, the incumbent has to pay more in expectation to debt holders when she raises pledgeability. So as the face value of debt increases further, $\Delta_1^{s_1}(D_1)$ falls to zero and then goes negative. When $D_1 > B_1^{E,s_1}(\bar{\gamma})$, 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. At the same time, she has to pay debt $B_1^{E,s_1}(\bar{\gamma})$ instead of $B_1^{E,s_1}(\underline{\gamma})$ if she retain ability. Hence there is no benefit but only cost to the incumbent of increasing pledgeability, and the expected cost is capped at $\theta[B_1^{E,s_1}(\bar{\gamma}) - B_1^{E,s_1}(\underline{\gamma})] - \varepsilon$.

Note also that if liquidity in the G state, $\omega_1^{E,G}$, gets sufficiently high such that $\omega_1^{E,G} \geq (1-\underline{\gamma})C_2$, non-incumbent 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 bid for the full fundamental

value of the asset. In that case, both $B_1^{E,G}(\bar{\gamma})$ and $B_1^{E,G}(\underline{\gamma})$ equal C_2 , and $\Delta_1^G(D_1) = -\varepsilon$ for any D_1 . 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 $\omega_1^{E,G}$, i.e., if $\omega_1^{E,G} < (1-\underline{\gamma})C_2$, Proposition 3.1 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, $D_1^{s_1, PayIC} = \theta B_1^{E,s_1}(\underline{\gamma}) + (1-\theta) B_1^{E,s_1}(\bar{\gamma}) - \varepsilon$, is obtained by setting $\Delta_1^{s_1}(D_1^{s_1, PayIC}) = 0$. Note that the higher the probability the incumbent retains ability, θ , the higher the moral hazard associated with pledgeability, and the lower is $D_1^{s_1, PayIC}$. Since $\omega_1^{E,G} > \omega_1^{E,B}$, it is easily checked that $D_1^{G, PayIC} > D_1^{B, PayIC}$.

These state-contingent incentive constraints allow us to determine the condition for a reliable incumbent to increase pledgeability, given that she chooses before the period-1 state is known. The risk-neutral incumbent will choose high pledgeability for any given D_1 if and only if $q\Delta_1^G(D_1) + (1-q)\Delta_1^B(D_1) \geq 0$, where q is the probability of state G. Let D_1^{IC} be the value of D_1 which makes this weak inequality equal zero. At D_1^{IC} , when pledgeability is raised, the expected (across the two states) increase in payments when the incumbent retains ability equals the expected increase in proceeds from selling the firm when she loses ability. Since $\Delta_1^{s_1}$ is weakly decreasing in D_1 , it must be that D_1^{IC} , the threshold of debt below which high pledgeability is incentivized given the incumbent knows the probabilities of each future state, lies between $D_1^{B, PayIC}$ and $D_1^{G, PayIC}$. If $\omega_1^{E,G} \geq (1-\underline{\gamma})C_2$, all the incentive to raise pledgeability comes from state B so that $D_1^{IC} = D_1^{B, PayIC}$. Very high liquidity, by reducing the need for pledgeability in that state, reduces the incentive compatible level of debt.

This implies the maximum expected payments that a borrower can commit to repay may not be achieved by D_1^{IC} , the promised payment that provides incentives for high pledgeability. Even with low pledgeability choice, the incumbent is able to credibly promise expected repayment of $\underline{l} = qB_1^{E,G}(\underline{\gamma}) + (1-q)B_1^{E,B}(\underline{\gamma})$ at date 1. By contrast, to incentivize high pledgeability, the promised payment cannot exceed D_1^{IC} , which will imply an expected

repayment of $\bar{l} = qD_1^{IC} + (1-q) \min\{D_1^{IC}, B_1^{E,B}(\bar{\gamma})\}$. If $B_1^{E,G}(\underline{\gamma})$ is much larger than D_1^{IC} (either because liquidity in the G state is high or the moral hazard associated with pledgeability is high so that D_1^{IC} is low) and if the probability of the good state q is sufficiently high, the incumbent could pledge more repayment (and thus raise more) by setting $D_1 = B_1^{E,G}(\underline{\gamma})$.

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. 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 needs to raise money at date 0 to invest in 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 even zero. Importantly, this will also crowd out the need for intermediary certification.

Corollary 3.1: Under Assumption 1, the date-1 face value that enables the incumbent manager to repay the most is either $D_1 = B_1^{E,G}(\underline{\gamma})$ or $D_1 = D_1^{IC}$, where

$$D_1^{IC} = D_1^{B,PayIC} + \frac{q(1-\theta)}{1-q} [B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})]$$

is the maximum level of the face value under

which the incumbent still chooses high pledgeability. Moreover, $D_1^{IC} < B_1^{E,B}(\bar{\gamma}) < B_1^{E,G}(\underline{\gamma})$

Proof: See appendix.

The result $D_1^{IC} < B_1^{E,B}(\bar{\gamma}) < B_1^{E,G}(\underline{\gamma})$ implies if a reliable expert takes out a loan at face value $D_1 = D_1^{IC}$, she is able to repay in both states so that the loan is safe. If an expert takes out a loan at face value $D_1 = B_1^{E,G}(\underline{\gamma})$, however, she is only able to fully repay in state G but not in state B so the loan is risky. As a result, firm leverage will be low when high pledgeability is induced, in which case the incumbent can repay $\bar{l} = D_1^{IC}$. By contrast, high firm leverage induces low pledgeability, in which case the incumbent can repay $\underline{l} = qB_1^{E,G}(\underline{\gamma}) + (1-q)B_1^{E,B}(\underline{\gamma})$.

IV. Intermediation and the Bank's Liability Structure

Now that we have described the effect of the outstanding face value of the bank loan as well as prospective liquidity on the reliable expert incumbent's incentive to increase pledgeability, let us turn to the bank's intermediation function – its incentive to screen and certify experts who apply,

the kind of loan terms it offers to reliable and unreliable experts, and the security it sells against these loans to investors. Let us start by first describing the bank's structure.

A. The Bank's Structure

We assume without loss of generality that each bank sets up a separate capital structure for each loan it makes (equivalently, each bank makes only one loan). Results stay unchanged when banks can write securities backed by an entire pool of loans, since there is no residual risk that could benefit from pooling before tranching.

Given that banks have an alternative investment with return $R > 1$, they would like to “sell” the entire loan to outside investors. However, banks may need to retain some of the loan to *commit* to incur the cost of screening loan applicants and selecting the appropriate contract after they learn an expert's type. We assume any claim they retain is residual and junior – so they issue a debt contract to investors with face value F , where the payoff to investors is $\text{Min}[F, x]$ where x is the cash flow collected from loan repayments. Given that banks may choose different asset and liability structures depending on whether the screened expert is reliable or unreliable, we assume that before lending to the initial bidder, each competitive bank announces a menu $\{(l_0^r, D_1^r, F^r, \sigma^r), (l_0^u, D_1^u, F^u, \sigma^u)\}$, where l_0 is the size of the loan, D_1 the face value of the loan, F the security issued (and therefore the retention), and σ the probability of issuing a loan to a specific type (after possible screening).⁸ The superscripts refer to the contract that is intended to be offered to different types of experts. The equilibrium offer l_0 , D_1 , and F are verifiable and therefore must be either (l_0^r, D_1^r, F^r) or (l_0^u, D_1^u, F^u) . However, the probabilities σ^r, σ^u are not verifiable (the bank cannot commit to lotteries), but will be determined in equilibrium.⁹

⁸ When the bank securitizes its loans, this can be thought of as shelf registration where the securitizer files statements with the Securities and Exchange Commission (the “SEC”) to register securities it will issue. 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).

⁹ Because there is no commitment, whenever σ is neither zero or one, the bank must be indifferent between lending and not lending.

B. Competitive Financial Intermediation: Certification and Lending

We now turn to the initial loan at date 0 and study a competitive bank's decision on certification, knowing how prospective liquidity and leverage affect the reliable expert incumbent's incentive to choose pledgeability. We make the following additional assumption on parameters.

Assumption 2:

$$(qC_1 + C_2 - I) - (1 - \theta) \left[q(C_2 - B_1^{E,G}(\bar{\gamma})) + (1 - q)(C_2 - B_1^{E,B}(\bar{\gamma})) \right] \geq \bar{l} - (I - \omega_0)$$

Note that $(qC_1 + C_2 - I)$ is the NPV of the project, whereas

$(1 - \theta) \left[q(C_2 - B_1^{E,G}(\bar{\gamma})) + (1 - q)(C_2 - B_1^{E,B}(\bar{\gamma})) \right]$ is the expected amount of cash flows that will accrue to the future incumbent in case this reliable incumbent loses her ability and high pledgeability is chosen. On the right-hand side, \bar{l} is the expected repayment from a reliable incumbent under high pledgeability, whereas $I - \omega_0$ is the size of the funding gap, which is also the minimum size of the loan needed for the project to be taken. Assumption 2 therefore requires the (private) return to a reliable incumbent's investment to be higher than the maximum over-payment she will make to the bank. This assumption is neither restrictive nor crucial for the main result, but it simplifies analysis later on.

Let us refer to a bank that screens and lends to a reliable expert as a certifying bank. Clearly, the loan's face value cannot exceed D_1^{IC} if the certifying bank intends to encourage reliable experts to enhance pledgeability. A bank may also lend to an unreliable expert, either because the bank didn't screen to begin with, or it still decided to lend after detecting the unreliable expert during screening. In the *subgame* after screening, the bank offers a specific structure (loan terms (l_0, D_1) and the face value F it will issue to investors) from the menu announced earlier. In this subgame, the candidate equilibrium could be either pooling (where all expert types receive the same structure, but screening may be used to impact the probability of receiving a loan) or separating (different expert types get different structures). We will first describe both types of equilibria and compare experts' expected payoff. Then we turn to the initial stage where bank competition forces them to offer the menu of contracts that maximizes experts' expected payoff.

B.1 Separation after Screening: Bank Lending with Loan Sales

In a separating equilibrium, the contracts offered by banks will differ by the types of experts and in at least one of the three terms so that $l_0^r \neq l_0^u$, $D_1^r \neq D_1^u$, or $F^r \neq F^u$. Let us first solve the separating equilibrium in which banks also choose to lend to unreliable experts after screening. This requires that an unreliable expert can repay enough to borrow more than the funding gap:

$$\underline{l} \geq I - \omega_0 \quad (1).$$

The contract the bank offers to unreliable experts is straightforward: $l_0^u = \underline{l}$, $D_1^u = B_1^{E,G}(\underline{\gamma})$, $F^u = B_1^{E,G}(\underline{\gamma})$, and $\sigma^u \equiv 1$ ¹⁰. The bank, after knowing the borrower is unreliable, will lend at face value $D_1^u = B_1^{E,G}(\underline{\gamma})$ and subsequently sell the entire loan. The size of the loan satisfies $l_0^u = \underline{l}$ so that the bank breaks even in expectation (these are also the terms investors will set as they lend without screening).¹¹

Let us now turn to the informed bank's loan to a reliable expert. Without loss of generality, let us assume the face value of the loan to a reliable expert is $D_1^r = D_1^{IC}$. A few incentive constraints need to be satisfied for the bank. First, the bank must be incentivized to choose the appropriate contract, having screened. In particular, if the expert turns out unreliable, the bank must offer (l_0^u, D_1^u, F^u) instead of (l_0^r, D_1^r, F^r) , which leads to the following self-selection constraint:

$$0 \geq [-l_0^r + P(F^r)]R + q(D_1^{IC} - F^r) + (1-q)\max\{B_1^{E,B}(\underline{\gamma}) - F^r, 0\}, \quad (2)$$

where $P(F^r) = F^r$ is the price of the security sold to investors for $F^r \leq D_1^{IC}$. By lending (l_0^u, D_1^u, F^u) to the unreliable expert, the bank receives an ex-post payoff of zero (given that the screening cost is sunk). By lending (l_0^r, D_1^r, F^r) to the unreliable expert, the bank incurs a cost of

¹⁰ In the separating equilibrium, loans to the unreliable are breakeven, and σ^u does not matter because if the unreliable take the outside option of borrowing directly from investors, everyone gets the same payoff.

¹¹ If the size of the loan \underline{l} is strictly higher than the funding gap, $I - \omega_0$, it is without loss of generality to assume that the unreliable expert will take it and consume the extra liquidity at the initial date 0.

net invested funds of $\left[-l_0^r + P(F^r)\right]R$. Moreover, the loan has face value of only

$D_1^r = D_1^{IC} < D_1^u = B_1^{E,G}(\underline{\gamma})$ – recall the face value D_1 is verifiable – and it is repaid in full only in state G, whereas in state B, it only gets repaid up to $B_1^{E,B}(\underline{\gamma})$. The self-selection constraint requires the loaned amount l_0^r to be high but the securities sold F^r to be low (so that the bank has substantial skin in the game) to discourage the bank from lending on the wrong terms.

The second incentive constraint requires the bank to screen borrowers rather than lend to all without screening and offering terms intended for reliable borrowers, (l_0^r, D_1^r, F^r) :

$$-\psi R + \mu \left\{ \left[-l_0^r + P(F^r) \right] R + (D_1^{IC} - F^r) \right\} \geq \left[-l_0^r + P(F^r) \right] R + q(D_1^{IC} - F^r) + (1-q) \max \left\{ B_1^{E,B}(\underline{\gamma}) - F^r, 0 \right\}. \quad (3)$$

The left-hand-side of this incentive constraint is the bank's payoff from incurring the screening cost ψR and making a profit off the reliable expert in all states (and none off the unreliable expert). The right-hand-side is the payoff without screening, in which case the expert will behave unreliably for sure. Therefore, if state B is realized, the bank only gets repaid up to $B_1^{E,B}(\underline{\gamma})$.

The final incentive constraint requires a bank to be better off screening and lending rather than behaving as an uninformed investor. So

$$-\psi R + \mu \left\{ \left[-l_0^r + P(F^r) \right] R + (D_1^{IC} - F^r) \right\} \geq 0 \quad (4)$$

Clearly, (3) is implied by (2) and (4).¹² Constraint (4) requires l_0^r to not be too high and F^r to be high enough so that the expected profits a bank receives from screening and securitization/outside borrowing will outweigh the costs.

Next, we turn to the borrowers' participation constraints. We know the unreliable expert is as well off borrowing from outside investors conditional on being found unreliable. The outside option of reliable experts is also to borrow from outside investors on the same terms as the

¹² Intuitively, (4) shows that it pays to screen, making a profit from loans to reliable borrowers, and breaking even on loans to unreliable. The payoff in (3) compares the payoff from screening and choosing the proper loan to the option in (4) but also making unprofitable loans to unreliaables (instead of breaking even on those loans in (4)). This deviation is undesirable by condition (2) which shows that having screened it pays to choose the proper face value and retention.

unreliable. If she borrows from a bank, however, the reliable expert is able to raise cash flow pledgeability so that when she loses her ability, she is able to sell the asset at a higher price. In Appendix, we formally derive a reliable expert's participation constraint, which turns out as

$$l_0^r - \bar{l} + \Delta V \geq 0, \quad (5)$$

where $\Delta V = (1 - \theta) \left[q \left(B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma}) \right) + (1 - q) \left(B_1^{E,B}(\bar{\gamma}) - B_1^{E,B}(\underline{\gamma}) \right) \right]$ is the additional value of high pledgeability to the reliable expert – from being to sell the firm for more when she loses ability.¹³ Intuitively, this constraint requires a reliable expert's overpayment $\bar{l} - l_0^r$ is offset by the benefits to her of certification.

Lastly, the feasibility constraint requires the size of the loan to the reliable expert must exceed the funding gap:

$$l_0^r \geq I - \omega_0. \quad (6)$$

Due to ex-ante competition, the bank will offer the contract with the highest expected utility to experts. Since the expert who turns out to be unreliable is no better off than going directly to investors, the bank that wants to maximize attractiveness to an expert (who does not know which type she will be) will maximize l_0^r , subject to constraints (1) – (6). Proposition 4.1 describes the equilibrium.

Proposition 4.1: the separating equilibrium with screening and lending to unreliable experts is a

candidate equilibrium if $\Delta V \geq \frac{\psi(R-q)}{\mu(1-q)}$ and $I - \omega_0 \leq \min \left\{ \underline{l}, D_1^{IC} - \frac{\psi(R-q)}{\mu(1-q)} \right\}$. In this

equilibrium, $F^r = D_1^{IC} - \frac{\psi R}{\mu(1-q)}$, and $l_0^r = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q)$.

¹³ Note that $\Delta V \in [\Delta \underline{V}, \Delta \bar{V}]$, where $\Delta \bar{V} = (1 - \theta)(\bar{\gamma} - \underline{\gamma})C_2$ and $\Delta \underline{V} = (1 - \theta)(1 - q)(\bar{\gamma} - \underline{\gamma})C_2$. Intuitively, $\Delta \bar{V}$ is the maximum benefit derived from high pledgeability, which enables the incumbent expert to sell the asset by an additional amount $(\bar{\gamma} - \underline{\gamma})C_2$ in both future state G and B. Meanwhile, $\Delta \underline{V}$ is the minimum benefit derived from high pledgeability, in which case the additional selling proceeds is only accrued in the bad state B, since pledgeability does not enhance bids in the G state.

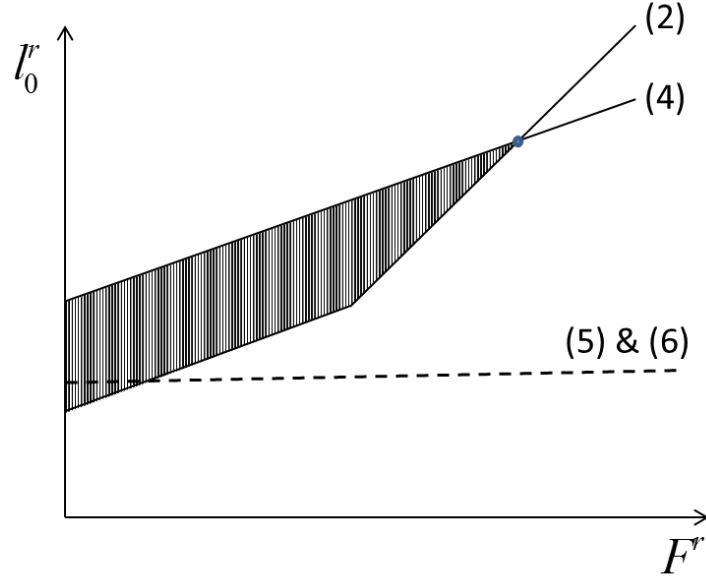


Figure 4: Equilibrium in the Separation after Screening Equilibrium

While we leave the formal proof in the appendix, let us offer a graphical illustration. Constraint (2) requires l_0^r be sufficiently high, whereas (4) requires it to be sufficiently low, giving rise to the shaded intersection region in the figure if and only if $\Delta V \geq \frac{\psi R}{\mu}$ (see Lemma 4.1 in the appendix). Note that the competitive bank's (ex-ante) problem is to maximize l_0^r so that the northeast corner of the intersection set (the blue dot) $l_0^r = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q)$ will be chosen if and only if it the point lies above constraints (5) and (6). Constraint (5) requires $l_0^r - \bar{l} + \Delta V \geq 0$ or $l_0^r - D_1^{IC} + \Delta V \geq 0$. Substituting for l_0^r , this requires $\Delta V \geq \frac{\psi(R-q)}{\mu(1-q)}$. Similarly, feasibility requires $\text{Min}[l_0^r, \underline{l}] \geq I - \omega_0$. Note that in this case, a reliable expert might receive a loan below \underline{l} and therefore raises even less than an unreliable expert (but she still chooses a bank because raising pledgeability is beneficial).

Discussion

This equilibrium is suggestive of a bank originating and retaining loans to reliable experts and maintaining appropriate levels of inside capital to commit to screening. Simultaneously, it will sell all loans made to unreliable experts. To an outside casual observer, it may seem that the bank has little "skin in the game" in the loans sold or, equivalently, that the loans sold are an attempt at

arbitraging capital regulation. Our model would suggest that the sold loans, even if riskier, are ones where ex post monitoring is unnecessary because it is ineffective.

An alternative interpretation of the intermediary (to that of a bank) is it is a securitizer, who sets up a vehicle where it retains a junior claim on loans to reliable experts and also sells loans to the unreliable, or sets up another vehicle to retain those loans. Interestingly, retention does give incentives for the securitizer to perform intermediation services, but it is not necessary that the securitizer retain claims in every such vehicle even if it seems that retention is associated with less risk. Indeed, a policy requiring greater intermediary retention on the vehicle packaged with loans to unreliable experts will increase the intermediary's costs of lending, and may indeed result in these loans becoming unviable. Theoretically, retention is important only when it incentivizes intermediation services, not just because loans are risky. This is especially if the risk in those loans is irreducible through intermediation-based certification.

B.2 Separation and Loan Rejections after Screening: Bank lending with no loan sales

In the previous candidate equilibrium, $\underline{l} \geq I - \omega_0$ so that it is weakly profitable to lend to an unreliable expert. If this condition fails, however, known unreliable experts can no longer borrow from investors, and in a separating equilibrium, banks will no longer find it profitable to lend to them after screening. In this case, banks' incentive constraints (2)-(4) stay unchanged, since they can never profit by lending to an unreliable expert. By contrast, a reliable expert's participation constraint is different. If she makes the initial investment, her payoff should exceed her outside option if the bank refuses to lend, which is to simply consume all the current liquidity ω_0 . Therefore, her participation constraint becomes

$$\omega_0 + \underbrace{(l_0^r - \bar{l})}_{\text{borrow-repay}} + \underbrace{(qC_1 + C_2 - I)}_{\text{NPV}} - \underbrace{(1-\theta) \left[q(C_2 - B_1^{E,G}(\bar{\gamma})) + (1-q)(C_2 - B_1^{E,B}(\bar{\gamma})) \right]}_{\text{lost rents to future incumbent}} \geq \omega_0$$

or

$$(l_0^r - \bar{l}) + (qC_1 + C_2 - I) - (1-\theta) \left[q(C_2 - B_1^{E,G}(\bar{\gamma})) + (1-q)(C_2 - B_1^{E,B}(\bar{\gamma})) \right] \geq 0. \quad (7)$$

Assumption 2 implies condition (7) is always slack conditional on $l_0^r \geq I - \omega_0$ so that we can ignore it. Intuitively, the (private) return of investment to the reliable expert is sufficiently high that she would invest whenever feasible. The competitive bank's problem is again to maximize l_0^r , subject to constraint (2), (4), and (6).

Proposition 4.2: Under Assumption 1 and 2, the separating equilibrium where the bank screens but does not lend to unreliable experts is a candidate equilibrium if $\Delta V \geq \frac{\psi R}{\mu}$,

$\underline{l} < I - \omega_0$, and $I - \omega_0 \leq D_1^{IC} - \frac{\psi(R-q)}{\mu(1-q)}$. In equilibrium, $F^r = D_1^{IC} - \frac{\psi R}{\mu(1-q)}$, and

$$l_0^r = D_1^{IC} - \frac{\psi(R-q)}{\mu(1-q)}.$$

Figure 4 offers a similar graphical illustration for this proposition. Note that the participation constraint is slack so the requirement $\Delta V \geq \frac{\psi(R-q)}{\mu(1-q)}$ is no longer needed. Instead, we only

require $\Delta V \geq \frac{\psi R}{\mu}$ so that (2) starts out below (4) and the shaded intersection region in Figure 4

is non-empty.

Discussion

The bank here screens, retains loans to reliable experts, and completely rations credit to unreliable experts. Investors do not lend directly. So this suggests when current and future liquidity conditions are tight (low levels of ω_0 and $\omega_1^{E,G}$), unmonitored lending is not viable. Only bank lending to reliable borrowers is available, after screening. Debt has to be set so that reliable borrowers choose high pledgeability. These conditions are reminiscent of a bank-dependent underdeveloped economy, or of a developed economy in recessionary conditions where direct lending and lending to riskier companies dries up.

Note that even though an unreliable expert cannot borrow in a separating equilibrium under these conditions, she may be able to borrow in a pooling equilibrium, which we will study the next.

B.3 Bank Screening with Partial Pooling: Lending with internal cross-subsidies

In a pooling equilibrium, banks only offer one type of contract so $l_0^r = l_0^u = l_0$, $D_1^r = D_1^u = D_1$, and $F^r = F^u = F$. In this case, banks will lend for sure to the reliable with positive ex-post profits. If an expert turns out unreliable, banks will lend, with a positive probability, exactly the same amount at face value $D_1 = D_1^{IC}$ and sell securities against part of its balance sheet. In a pooling equilibrium, the bank still faces a few IC constraints. First, it must be

ex-post indifferent between lending to an unreliable expert or not, given that it cannot commit to σ^u .

$$[-l_0 + P(F)]R + \{q(D_1^{IC} - F) + (1-q)\max\{B_1^{E,B}(\underline{\gamma}) - F, 0\}\} = 0. \quad (8)$$

Note that in the pooling equilibrium the price of a sold loan with face F , $P(F)$, differs from F since the amount collected from the unreliable expert may not always be enough to pay security holders F . If condition (8) holds, the probability, σ^u , of making a loan to an unreliable expert can be any number between zero and one. In this case, let $\lambda = \frac{\mu}{\mu + \sigma^u(1-\mu)} \in [\mu, 1]$ be the equilibrium average quality of experts who receive loans, then

$$P(F) = [\lambda + (1-\lambda)q]F + (1-\lambda)(1-q)\min\{B_1^{E,B}(\underline{\gamma}), F\}. \quad (9)^{14}$$

The second IC constraint requires the bank to screen borrowers and then lend based on the screening, rather than not screen and lend:

$$\begin{aligned} [-\psi - l_0 + P(F)]R + [\mu + (1-\mu)q](D_1^{IC} - F) + (1-\mu)(1-q)\max\{B_1^{E,B}(\underline{\gamma}) - F, 0\} \geq \\ [-l_0 + P(F)]R + q(D_1^{IC} - F) + (1-q)\max\{B_1^{E,B}(\underline{\gamma}) - F, 0\}. \end{aligned} \quad (10)$$

Finally, screening and lending must be profitable ex-ante:

$$[-\psi - l_0 + P(F)]R + [\mu + (1-\mu)q](D_1^{IC} - F) + (1-\mu)(1-q)\max\{B_1^{E,B}(\underline{\gamma}) - F, 0\} \geq 0, \quad (11)$$

which is immediately implied by (8) and (10).

Next, we turn to the experts' participation constraint. Again, if (1) holds such that unreliable experts can borrow from investors, the reliable expert's participation constraint is

¹⁴ In equilibrium, it will be the case that $F \geq B_1^{E,B}(\underline{\gamma})$ so that

$P(F) = [\lambda + (1-\lambda)q]F + (1-\lambda)(1-q)B_1^{E,B}(\underline{\gamma})$. The reason is, any equilibrium contract in which $F < B_1^{E,B}(\underline{\gamma})$ is dominated by one that $F = B_1^{E,B}(\underline{\gamma})$. In both cases the bank's claim F is riskless and sells for par, the incentive constraints and participation constraint stay the same. However, the bank is always able to lend more when it offloads more of the loan.

characterized by (5). Otherwise, her participation constraint is characterized by (7), with l_0^r replaced by l_0 . Finally, the feasibility constraint requires $l_0 \geq I - \omega_0$.

Proposition 4.3: Under Assumption 1 and 2, $F = D_1^c - \frac{\psi R}{\mu(1-q)}$ in the pooling equilibrium

1) If $\underline{l} \geq I - \omega_0$, the equilibrium is a candidate equilibrium if $\Delta V \geq \frac{\psi R}{\mu}$ and there exists

$$\lambda \in [\mu, 1] \text{ such that } l_0 = P(F) + \frac{q\psi}{\mu(1-q)} \geq \max\{I - \omega_0, \bar{l} - \Delta V\}.$$

2) If $\underline{l} < I - \omega_0$, the equilibrium is a candidate equilibrium if $\Delta V \geq \frac{\psi R}{\mu}$ and there exists

$$\lambda \in [\mu, 1] \text{ such that } l_0 = P(F) + \frac{q\psi}{\mu(1-q)} \geq I - \omega_0.$$

Intuitively, in the pooling equilibrium, the unreliable expert effectively gets subsidized by the high price paid for securities by the uninformed investors. This then serves as a form of ex-ante insurance, for it ensures that some of the unreliaables get funding for the project. Pooling can be socially efficient, for it allows experts who might turn out to be unreliable to get funding with some probability for a privately valuable project that would not otherwise be funded because the returns to the lender, absent pooling, are less than breakeven.

The bank here provides the valuable service of certification (for the reliable), but also does not reveal the information it acquires during screening. It thus is able to credibly provide credit to the unreliable also. The bank shares the rents it gets from certifying the reliable with the unreliable (through the pooled price it issues securities at). By offering terms which commit it to pool, we will see the pooling bank could attract experts away from separating but rationing banks because the pooling bank offers the uninformed expert a higher probability of getting funding for the project. From the uninformed expert's perspective, the pooling bank offers insurance against the expert turning out to be unreliable. This result -- that the bank's information about the creditworthiness of individual borrowers is not fully used in lending, thus providing insurance to borrowers -- is related to the ideas in Dang, Gorton, Holmstrom and Ordoñez (2017). In their paper, banks keep the details about their borrowers secret, which keeps the bank total net worth secret (pooled) over time, allowing the bank to sometimes issue new and overpriced claims. This keeps their old claims safe. The bank is assumed benevolent, and has no conflict of interest which

need to be resolved (unlike in our model). In both models, the pooling contract allows banks to fund themselves on different terms than if all of their information was known by outside investors.

The ability to cross-subsidize imperfectly correlated projects within an institution is used in the theories of banks as delegated monitors (Diamond, 1984), where private information is ex-post. It is also seen in models where a diversified firm uses internal capital markets to allocate funding to ex-ante relatively good projects within the firm (Stein, 1997). The cross subsidy allows internal capital markets to provide more efficient project funding within an institution. Somewhat similarly, pooling in our model works because the claim issued to outside investors is priced to reflect the equilibrium probabilities that loans will be made to a mix of experts, such that the intermediary finds it just profitable to make a loan to unreliable (and strictly profitable to make a loan to reliable) experts. This is a decentralized way of providing greater ex-ante access to funding

B.4. Direct lending or lending without screening

If $\underline{l} \geq I - \omega_0$ but other conditions in Proposition 4.1 and 4.3 are not satisfied, then in equilibrium, banks will lend without screening. In this case, all banks offer the same contract $l_0^u = \underline{l}$, $D_1^u = B_1^{E,G}(\underline{\gamma})$, $F^u = B_1^{E,G}(\underline{\gamma})$, and the loan is sold entirely to investors. Intuitively, the cost of screening is too high relative to the benefits such that banks cannot commit to both screening and self-selecting the appropriate contracts. In particular, for the bank to select the appropriate contract ex-post, the loan size to a reliable expert, l_0^r , has to be sufficiently high. However, in this case, the expected profits extracted by the informed bank cannot compensate for its screening cost. Put differently, no contract (l_0^r, D_1^r, F^r) is able to satisfy both the self-selection IC constraint and the screening IC constraint. Therefore, the equilibrium is necessarily one with lending and no screening. Banks retain no claim at all, so this is equivalent to direct lending. Note that this can occur if the cost of screening is high relative to the benefits of intermediation – the latter are likely to be small if anticipated future liquidity is high – but intermediation is not needed for credit to flow – typically the case if current liquidity is high.

If $\underline{l} < I - \omega_0$ but other conditions in Proposition 4.2 and 4.3 (essentially $l_0^r < I - \omega_0$) fail, then in equilibrium no expert would be able to borrow. This would be the case if current liquidity is low relative to funding needs, as is future liquidity and any possible value enhancement from high pledgeability.

B.5 Ex-ante Equilibrium

In this subsection, we compare the candidate pooling and separating equilibria and therefore solve for the equilibrium contracts offered by banks at the initial date 0. Our first result is if condition (1) holds so that an unreliable expert can always borrow from investors, the equilibrium is one with separation.

Proposition 4.4: The pooling equilibrium is never chosen by competitive banks if there is a separating equilibrium with banks lending ex-post to unreliable experts.

Proof: See appendix.

Intuitively, no matter whether reliable or not, the expert will always be able to finance the initial investment. Therefore, she prefers the contract that offers a larger loan if she turns out reliable. Note that both separating and pooling equilibria have the same face values for the debt security issued to investors – the requirements to incentivize banks to screen are identical. In the pooling equilibrium, however, the bank raises less proceeds from selling the same security to investors, because some fraction of borrowers being funded are unreliable. Therefore, more of the initial funding comes from the bank's own funds, which is costlier. As a result, the size of the loan offered in the pooling equilibrium is lower and thus dominated by that offered in the separating equilibrium.

Next, we consider the case when condition (1) fails and the expert who is determined to be unreliable cannot borrow in the separating equilibrium.

Proposition 4.5: If both the pooling equilibrium and the separating equilibrium in which banks do not lend to unreliable experts exist, the pooling equilibrium always dominates the separating equilibrium.

Proof: see appendix.

In the pooling equilibrium where λ is the expected share of reliable experts in the pool of experts who get a loan, the loan size satisfies

$$L^p(\lambda) = l_0 = \left\{ \left[\lambda + (1-\lambda)q \right] F + (1-\lambda)(1-q)B_1^{E,B}(\underline{\gamma}) + \frac{q\Psi}{\mu(1-q)} \right\}.$$

Ex-ante, the expected size of the loan that an expert receives is

$$\left[\mu + \sigma^u(1-\mu) \right] L^p(\lambda) = \frac{\mu}{\lambda} \left\{ \left[\lambda + (1-\lambda)q \right] F + (1-\lambda)(1-q)B_1^{E,B}(\underline{\gamma}) + \frac{q\Psi}{\mu(1-q)} \right\}, \text{ which}$$

clearly decreases with λ . Intuitively, an increase in λ reduces the unreliable's hazard rate of receiving a loan $\frac{1-\lambda}{\lambda}$, reducing the expected size of the loan. Therefore, an expert is able to take out a larger loan in expectation in the pooling equilibrium compared to the separating equilibrium. Moreover, the expert is more likely to be funded in the pooling equilibrium (if she turns out to be unreliable) and therefore enjoy rents from investment, further dominating the separating equilibrium.

Discussion

When the unreliable expert obtains financing in the separating equilibrium, the separating equilibrium is more attractive to the expert who does not know her type. This is then the package the bank offers – effectively holding skin in the game in loans to reliable borrowers, while refinancing loans to unreliable borrowers entirely with the investor. When the unreliable borrower is rationed in the separating equilibrium, the bank knows the uninformed expert prefers the pooling equilibrium, where the bank holds part of all the loans it makes, effectively cross-subsidizing loans to unreliable experts by passing on some of the benefits from raising money at the pooled interest rate. No loans are fully sold to investors (or equivalently, refinanced entirely with them), and all lending is through intermediaries.

B.6. The Effect of Liquidity

Our interest is in how an increase in anticipated future liquidity $\omega_1^{E,G}$ or an increase in current liquidity ω_0 affect the type of equilibrium and the leverage taken by the expert as well as the bank. Throughout, we will discuss book leverage so that D_1 and F can be considered as the leverage of the firm and the bank, respectively. Our statements of high and low leverage will be made in terms of relative comparison. For example, high firm leverage refers to $D_1 = B_1^{E,G}(\underline{\gamma})$, whereas low leverage refers to $D_1 = D_1^C$. Similarly, high bank leverage refers to $F = D_1$, whereas low leverage refers to $F < D_1$.

We offer the details in the Appendix for the type of equilibrium when the cost of screening ψ varies between 0 and infinity. It turns out that the results only differ qualitatively over the entire parametric space. Let us illustrate by the following parameters which are identical to those in section II:

$$q=0.4, \theta=0.5, \bar{\gamma}=0.6, \underline{\gamma}=0.3, \varepsilon \rightarrow 0, \omega_1^{I,G}=C_1=0.8, C_2=1, \omega_1^{I,B}=0, \omega_1^{E,B}=0, \gamma_1=0, \mu=0.5, \psi=0.05, I=1, R=1.02,$$

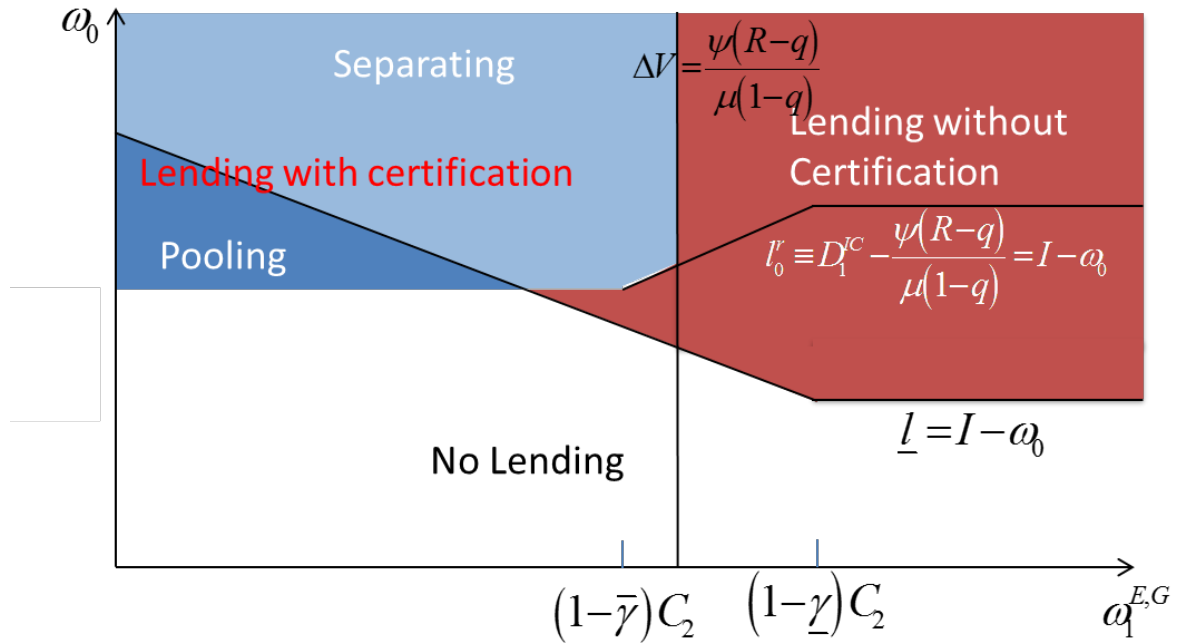


Figure 5: Type of equilibrium and liquidity

In Figure 5, we plot the equilibrium for different levels of current and prospective liquidity. Consider first changes in future liquidity. An increase in $\omega_1^{E,G}$ (a movement to the right in Figure 5) is more likely to induce an equilibrium in which banks choose not to certify. Instead, they simply sell the loans to investors – this could be thought of as direct issuance of bonds to investors, loans sold in full by the originating bank, or full securitization of loans by a securitizer with no retention of securities. In this case, to the extent that the originating intermediary retains loans on their balance sheet or in securitization vehicles, they will be full “pass-throughs”, with the intermediary retaining no skin in the game. Intermediary leverage is effectively very high. Firm leverage will also be high: when $\omega_1^{E,G}$ is high, experts will be funded initially with loans that

have high face value $D_1 = B_1^{E,G}(\underline{\gamma})$. For lower values of $\omega_1^{E,G}$ (to the left of Figure 5), if $\underline{l} < I - \omega_0$ so that the equilibrium could be ex-post pooling, an increase in $\omega_1^{E,G}$ will make the condition $\underline{l} < I - \omega_0$ less likely to hold, and make the separating equilibrium the preferred one. This will lead the intermediary to make larger loans to the reliable at lower interest rates, and issue safer intermediary claims backed by loans to reliable experts. Loans to the unreliable experts will be sold, or be made through pass-through vehicles with the intermediary retaining no skin in the game.

An increase in current liquidity ω_0 is more likely to induce an equilibrium in which banks choose to lend – since higher initial liquidity diminishes the amount that has to be borrowed. When future liquidity is low (going up on the left side of Figure 5), this implies moderate lending with screening. There will be no direct bond issuance to investors, and because the intermediary has to hold skin in the game, intermediary leverage will be moderate. In contrast, when future liquidity is high, an increase in current liquidity (going up on the right side of Figure 5) is likely to induce lending without screening. Again, this will lead to high firm and bank leverage, direct issuance of bonds to investors, loans sold in full by the originating bank, or full securitization of loans

B.7. Discussion

Our analysis suggests that both the necessity for certification by intermediaries and the intermediary's capital structure are affected by liquidity conditions, both current and future, that are likely to prevail in the economy. As liquidity conditions change – for example, through an increase in prospective liquidity and thus a movement to the right in Figure 5 – the need for intermediation services diminishes significantly. This would be associated with either entry by highly levered intermediaries who do not screen or monitor, or a switch by banks to higher leverage and a suspension of certification. In a more realistic and dynamic model, banks with screening and monitoring staffs would not change business models and lever up or go out of business at these times, knowing there would be intermediation opportunities if conditions change back. That is, if a bank had a cost of adjusting its screening and monitoring, a temporary change in the need for these services (or a need to hire appropriate labor based on a forecast of the need for services) might lead them to hoard the labor needed for them. However, rather than keep staff idle, banks might stretch to make loans they would not ordinarily make because of the high costs of intermediation. These could be screened loans made at a loss or unscreened, and thus riskier, loans. Of course, if the environment conducive to lending without certification persists for a

considerable period, the banking sector with legacy screening and monitoring costs will become distressed, in part because it has few activities that are legitimately remunerative, and in part because it has taken on activities that are not profitable at such times.

If the need for intermediary services emerges once again as the liquidity environment changes back, a lot will depend on whether there is sufficient intermediation capacity still in the system, or whether financial intermediaries have shrunk, both in terms of personnel and in terms of capital, during the extended period when their services were not needed. Thus a contraction in anticipated future liquidity, after an extended period of easy future liquidity, may result in a severe contraction in credit – not just because of low pledgeability set in the past but because intermediation capacity has shrunk. These issues are worth exploring in future work.

V. Extensions, Empirical Relevance, and Related Literature

In this section, we discuss extensions and robustness, some empirical implications, and the related literature.

A. Monopolistic Bank

We have assumed in the previous section that banks are competitive – so they offer experts the contract that maximizes experts' utility. We now study the equilibrium under a monopolistic bank. After all, in practice, some banks have local market power. A comparison with the previous results shows the effect of bank competition on the type of intermediation service provided by banks.

The monopolistic bank's goal is to maximize its own profits, subject to the IC constraints in screening, borrowers' participation constraints, and the feasibility constraint. Below, we discuss the equilibrium in all the three cases and compare them ex-ante.

Proposition 5.1: The conditions for the existence of different types of equilibrium are unchanged from Proposition 4.1 to 4.3. The highest possible profit (attained if

$l_0^r = \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma})$ is $\mu \left(\Delta V - \frac{\psi R}{\mu} \right)$. If $\underline{l} \geq I - \omega_0$, the equilibrium contract is

$l_0^r = \max \left\{ \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma}), \bar{l} - \Delta V, I - \omega_0 \right\}$. Otherwise, the equilibrium contract is

$l_0^r = \max \left\{ \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma}), I - \omega_0 \right\}$.

Proof: see appendix.

Because the monopolist bank extracts as much as possible from experts, we show that in equilibrium, the bank lends less than a competitive bank. Interestingly, the monopolist does not choose the pooling equilibrium, which offers insurance to the experts (a non-zero probability of funding even when found unreliable), even when it is beneficial to borrowers (that is, when it exists along with separation with rationing). Intuitively, the pooling equilibrium involves a cross-subsidy from a reliable expert to an unreliable expert, and lending to an unreliable expert is never ex-post profitable. Since the monopolist bank wants to offer the most profitable contract, we have:

Proposition 5.2: Under monopolistic banking, the bank weakly prefers separation with rationing to the pooling contract in the parameter space where both separation with rationing and pooling equilibria are feasible.

Proof: see appendix.

What this implies is that with monopoly banking, the pooling equilibrium is never chosen over the parameter space, and instead, separation with rationing will dominate. The banking system will be safer in this equilibrium, but a number of screened unreliable experts will be denied credit. Interestingly, in a more competitive system, banks will do what is best for experts, which means banks will be riskier, but will offer more credit to the experts, and there will be more investment. Banks are a particularly valuable structure when the market is competitive because they have the incentive to choose the pooling equilibrium, thus passing through the cross-subsidies from investors that alleviate credit rationing.

B. High future liquidity versus optimism about the probability of good times.

Our analysis has highlighted three important variables: q , the probability of the G state; θ the probability the expert will retain ability; and $\omega_1^{E,G}$, the future liquidity in the G state. Clearly, the G state has higher liquidity than the B state. How important, though, are beliefs on the level of $\omega_1^{E,G}$ relative to beliefs about the level of q ? Both variables matter quantitatively, but for both leverage and the value of intermediation services, prospective liquidity is critical.

Let us examine this in greater detail. If industry liquidity is so high in the G state at date 1 that the firm will always be fully priced, there is no impact of high pledgeability on bids in that state. Since incentives for high pledgeability cannot come from that state, they have to come from

the B state only. The incentive compatible debt level is $D_1^{B,PayIC}$, but issuing only this much may not raise enough for the upfront investment. The higher is q , the more attractive it will be to set firm leverage higher at $D_1 = B_1^{E,G}(\underline{\gamma}) = C_2$, and dispense with incentivizing pledgeability and thus also with intermediary certification. If so, the intermediary will be fully levered.

Now consider lower levels of liquidity in the prospective G state. Under assumption 1c, $q < \theta$, so moral hazard is high. To maintain incentives for pledgeability the expert requires debt to be set low such that $D_1^{IC} < B_1^{E,B}(\bar{\gamma})$. If screening costs are high, the intermediary will have to maintain more skin in the game, especially if q is high (since $F^r = D_1^{IC} - \frac{\psi R}{\mu(1-q)}$, with the screening costs recouped only by lowering default rates in the B state). Put differently, intermediation in this case allows only modest amounts of lending to experts with substantial skin in the game for the intermediary. The comparison to unintermediated or direct lending is especially unfavorable when q is high (but still lower than θ). So even for moderate prospective liquidity in the G state, intermediation can be dominated if moral hazard is high and q is high,

Now drop assumption 1c, so the probability q of the G state exceeds θ . In this case, moral hazard associated with pledgeability is lower, so a higher face value of debt is still incentive compatible. When liquidity in the prospective G state is moderate (say $\omega_1^{E,G} \leq (1-\bar{\gamma})C_2$), D_1^{IC} , the highest debt face value that still incentivizes high pledgeability, will be such that $D_1^{IC} > B_1^{E,G}(\underline{\gamma}) > B_1^{E,B}(\bar{\gamma})$. Intermediated lending is more attractive given that it allows experts to borrow more. Furthermore, an unreliable incumbent cannot repay D_1^{IC} even in state G. As a result, increased optimism about q , the probability of the good state need not remove the demand for certification and although both firm and intermediary leverage will increase with q , both will remain moderate. Indeed, for a sufficiently low θ , optimism will not lead to excessive leverage and eliminate the certification role of intermediaries, unless the liquidity in good times is so large that there is no underpricing. This re-emphasizes the point that increased optimism about q , by itself, need not lead to high leverage (in excess of that associated with high pledgeability and certification) and disintermediation unless there is very high liquidity in good times or there is high moral hazard over pledgeability.

C. Certification v.s. Screening

We have assumed that high pledgeability requires the joint effort of the incumbent expert and the financial intermediary, i.e., a reliable incumbent expert can choose high pledgeability only if she borrows from the bank that has screened her early on. This joint effort assumption is made largely for simplicity, so that we can avoid the lengthy discussion on off-equilibrium beliefs about borrowers that turn to other banks after being screened by a first bank. Under the joint effort assumption, this borrower who turns away will be always unreliable and therefore cannot increase cash flow pledgeability.

Our results will carry over if pledgeability is solely determined by the incumbent, in which case we should interpret the financial intermediary's effort as screening. In that case, we need to impose the off-equilibrium belief that any borrower who seeks financing from banks that haven't already screened her will be an unreliable borrower for sure. Note that if so, a reliable borrower will always stay with the same bank that has screened her to begin with.

Some other equilibrium structures can emerge without this refinement on off-equilibrium belief. For example, suppose instead we assume the off-equilibrium belief takes the other extreme: any borrower who seeks financing from other banks will be deemed a reliable borrower for sure. In this case, all borrowers will switch to other banks upon screening and knowing so, the initial bank will never screen to begin with. This equilibrium is uninteresting and unrealistic, as it crucially depends on the strong belief imposed off the equilibrium path.

D. Empirical Relevance on Securitization

Fluctuation in the demand for screening and certification by financial intermediaries has implications for the capital structure of traditional banks, of banks that sell syndicated loans and of non-bank intermediaries such as securitization structures. Reduced demand for screening reduces the need for intermediary capital and this would show up as respectively as increased bank leverage, lead banks retaining a smaller fraction of their syndicated loans and a reduced fraction of junior claim retained as "skin in the game" by sponsors of loan securitization vehicles. This would imply commonality in changes in these data. For instance, it is not surprising that just before the Global Financial Crisis, retention levels on securitization structures went down even as bank leverage increased. Our model would suggest the common factor driving both was expectations of high prospective liquidity.

Bord and Santos (2015) use data from 2004 to 2008 and find loans sold to collateralized loan obligations (CLOs) underperform unsecuritized loans originated by the same bank. On the other

hand, 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) on mortgage-backed securities, they suggest that structuring helped give originators the right incentives; CLOs primarily held syndicated loans, where lead bank loan originators retained substantial skin in the game by holding on to a fraction of the originated loans on their balance sheets.

Changes in the underlying liquidity for the assets being securitized may explain some of the differences in the empirical evidence described above. 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 (see Taylor (2010)), liquidity increased, and the need for screening diminished, until very little screening was done just before the crisis, as suggested by Benmelech et al. (2012) and 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, reducing the demand for screening and certification. 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.

VI. Conclusion

While this paper has been written to describe how financial 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 firm can be seized and sold for full repayment in a chapter 11 bankruptcy. 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 firm 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 and certifying intermediaries in this paper. We can also examine monitoring intermediaries – for example, those that can enhance 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.

One interesting aspect of our paper is that intermediary inside 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.¹⁵ 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.

¹⁵ Key studies of the effects of varying supply of intermediary capital are Holmstrom-Tirole (1997), He- Krishnamurthy (2013) and Rampini-Vishwanthan (2018).

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Appendix

Proof of Corollary 3.1

Under Assumption 1, in expectation, the maximum benefit of high pledgeability in state G is dominated by the maximum cost of high pledgeability in state B since

$q(1-\theta)[B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})] < (1-q)\theta[B_1^{E,B}(\bar{\gamma}) - B_1^{E,B}(\underline{\gamma})]$. Therefore, it must be that $D_1^{IC} < B_1^{E,B}(\bar{\gamma})$ so as to reduce the cost. Equating expected benefits of raising pledgeability and costs, it must be that

$$q(1-\theta)[B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})] - (1-q)\theta[D_1^{IC} - B_1^{E,B}(\underline{\gamma})] + (1-q)(1-\theta)[B_1^{E,B}(\bar{\gamma}) - D_1^{IC}] = 0$$

Substituting $D_1^{B,PayIC} = \theta B_1^{E,B}(\underline{\gamma}) + (1-\theta)B_1^{E,B}(\bar{\gamma})$, we get the explicit expression for D_1^{IC} .

Q.E.D.

Formal derivation of a reliable expert's participation constraint

The table below describes an unreliable expert's cash flows at each date in every state. On date 0, the expert borrows l_0 and therefore consumes $\omega_0 + l_0 - I$. The incoming cash flows on date 1 depends on the state and whether the expert keeps ability. For example, in state G when he keeps ability, he receives cash flows C_1 from the project and repay debt $B_1^{E,G}(\underline{\gamma})$. In state G when he loses ability, he still receives cash flows C_1 , sell the asset for $B_1^{E,G}(\underline{\gamma})$ to repay the debt. In this case, however, he doesn't receive the cash flows C_2 in date 2.

Date 0	Date 1	Date 2
$\omega_0 + l_0 - I$	G/Keep: $C_1 - B_1^{E,G}(\underline{\gamma})$	C_2
	G/Lose: $C_1 + B_1^{E,G}(\underline{\gamma}) - B_1^{E,G}(\underline{\gamma})$	0

B/Keep: $-B_1^{E,B}(\underline{\gamma})$	C_2
B/Lose: $B_1^{E,B}(\underline{\gamma}) - B_1^{E,B}(\underline{\gamma})$	0

Given the cash flows in each state, the total payoff to the unreliable expert is

$$\begin{aligned}
& (\omega_0 + l_0^u - I) + q\theta [C_1 - B_1^{E,G}(\underline{\gamma}) + C_2] + q(1-\theta) [C_1 + B_1^{E,G}(\underline{\gamma}) - B_1^{E,G}(\underline{\gamma})] \\
& \quad + (1-q)\theta [C_2 - B_1^{E,B}(\underline{\gamma})] + (1-q)(1-\theta) [B_1^{E,B}(\underline{\gamma}) - B_1^{E,B}(\underline{\gamma})] \\
= & \omega_0 + \underbrace{(l_0^u - \underline{l})}_{\text{borrow-repay}} + \underbrace{(qC_1 + C_2 - I)}_{\text{NPV}} - \underbrace{(1-\theta) [q(C_2 - B_1^{E,G}(\underline{\gamma})) + (1-q)(C_2 - B_1^{E,B}(\underline{\gamma}))]}_{\text{rents to future incumbent}}.
\end{aligned}$$

Let us also describe a reliable expert's cash flows at each date in every state.

Date 0	Date 1	Date 2
$\omega_0 + l_0 - I$	G/Keep: $C_1 - D_1^{IC}$	C_2
	G/Lose: $C_1 + B_1^{E,G}(\bar{\gamma}) - D_1^{IC}$	0
	B/Keep: $-D_1^{IC}$	C_2
	B/Lose: $B_1^{E,B}(\bar{\gamma}) - D_1^{IC}$	0

The total payoff to the reliable expert is

$$\begin{aligned}
& (\omega_0 + l_0^r - I) + q\theta [C_1 - D_1^{IC} + C_2] + q(1-\theta) [C_1 + B_1^{E,G}(\bar{\gamma}) - D_1^{IC}] \\
& \quad + (1-q)\theta [C_2 - D_1^{IC}] + (1-q)(1-\theta) [B_1^{E,B}(\bar{\gamma}) - D_1^{IC}(\underline{\gamma})] \\
= & \omega_0 + \underbrace{(l_0^r - \bar{l})}_{\text{borrow-repay}} + \underbrace{(qC_1 + C_2 - I)}_{\text{NPV}} - \underbrace{(1-\theta) [q(C_2 - B_1^{E,G}(\bar{\gamma})) + (1-q)(C_2 - B_1^{E,B}(\bar{\gamma}))]}_{\text{rents to future incumbent}}.
\end{aligned}$$

Taking the difference, and recognizing that $l_0^u = \underline{l}$, a reliable expert's participation constraint becomes $\Delta V + l_0^r - \bar{l} \geq 0$.

Proof of Proposition 4.1

Let us first use Lemma 4.1 to describe the set of contracts that satisfying the bank's incentive constraints.

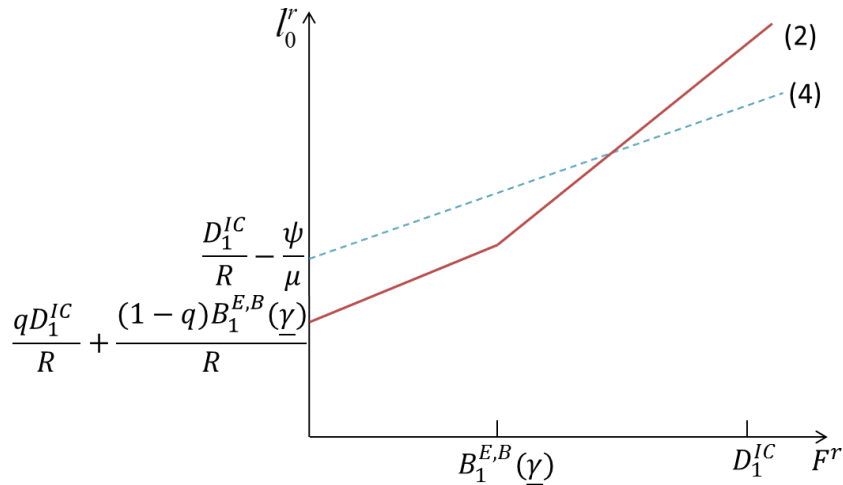
Lemma 4.1: The set of contracts (l_0^r, D_1^{IC}, F^r) satisfying (2) and (4) are non-empty if and only if it is non-empty under $F^r = 0$.

Proof:

The following figure offers a graphical illustration of the proof. Note that we can rewrite constraint (2) as:

$$\begin{cases} l_0^r \geq F^r \left(1 - \frac{q}{R}\right) + \frac{q}{R} D_1^{IC} & \text{if } F^r \geq B_1^{E,B}(\underline{\gamma}) \\ l_0^r \geq F^r \left(1 - \frac{1}{R}\right) + \frac{qD_1^{IC} + (1-q)B_1^{E,B}(\underline{\gamma})}{R} & \text{if } F^r < B_1^{E,B}(\underline{\gamma}). \end{cases}$$

Similarly, constraint (4) can be written as $l_0^r \leq F^r \left(1 - \frac{1}{R}\right) + \frac{D_1^{IC}}{R} - \frac{\psi}{\mu}$. The figure below plots the two constraints. Our goal is to find the set of parameters such that the intersection of the two constraints is non-empty. First, note that when $F^r = D_1^{IC}$, clearly no l_0^r can ever satisfy the constraint since (2) requires $l_0^r \geq D_1^{IC}$, whereas (4) requires $l_0^r \leq D_1^{IC} - \frac{\psi}{\mu}$. Second, note that when $F^r \leq B_1^{E,B}(\underline{\gamma})$, the two constraints are parallel with each other. As a result, we only need to evaluate both constraints at $F^r = 0$. If there exists l_0^r that satisfies both constraints at $F^r = 0$, then the intersection is non-empty.



Q.E.D.

It follows from the proof of Lemma 4.1 that a necessary and sufficient condition is

$$(1-q)\left[D_1^{IC} - B_1^{E,B}(\underline{\gamma})\right] \geq \frac{\psi R}{\mu} \quad (12)$$

Substituting for D_1^{IC} , this implies

$$q(1-\theta)\left[B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})\right] + (1-q)(1-\theta)\left[B_1^{E,B}(\bar{\gamma}) - B_1^{E,B}(\underline{\gamma})\right] = \Delta V \geq \frac{\psi R}{\mu} \quad (13).$$

Intuitively, the private gain to the reliable incumbent expert from being certified and being able to get a higher price for the firm when she loses ability – a form of insurance – should exceed the expected cost to the bank of screening, else there are no gains to intermediation. Clearly, an increase in anticipated future liquidity $\omega_1^{E,G}$ makes condition (13) less likely to hold (since it weakly reduces the gains to pledgeability $B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})$). For more stable industries (higher θ), this condition is also more likely to fail, since the borrower has a lower probability of having to sell. In addition, the condition is also less likely to hold when q increases so that booms are more likely (since the value of additional pledgeability is likely to be lower in booms when liquidity is already high).

With constraint (2) and (4) binding, we can derive the solution that maximizes l_0^r

$$\begin{cases} F^r = D_1^{IC} - \frac{\psi R}{\mu(1-q)} \\ l_0^r = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q). \end{cases}$$

Intuitively, F^r requires banks to have enough skin in the game such that they will choose to screen. In this case, the expected repayment from state B, $(1-q)(D_1^{IC} - F^r)$, is just enough to compensate the bank's expected screening cost $\frac{\psi R}{\mu}$. Since banks screen in equilibrium, they can get fully repaid even in state B. Ex-ante competition therefore forces them to lend more than F^r .

Indeed, $l_0^r = F^r + \frac{\psi q}{\mu(1-q)}$. Put differently, the bank has to put up some funds up front (book capital) to pay for the rents it will extract ex-post.

Finally, if $l_0^r = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q)$ further satisfies (5) and (6), then such a separating equilibrium exists, which gives rise to the second condition for equilibrium existence:

$$\max\{\bar{l} - \Delta V, I - \omega_0\} \leq l_0^r = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q) \quad (14)$$

It is easily shown that (14) is more likely to fail when anticipated future liquidity $\omega_1^{E,G}$ increases. When current liquidity ω_0 increases, this equilibrium is more likely to exist.

Q.E.D.

Proof of Proposition 4.3:

Clearly, constraints (8) and (10) imply (11). Constraint (10) can be easily reduced to

$$(1-q)\left[(D_1^{IC} - F) - \max\{B_1^{E,B}(\underline{\gamma}) - F, 0\}\right] \geq \frac{\psi R}{\mu},$$

which again only admits a solution if condition (12) holds. If so, the face value of the security issued in the pooling equilibrium is identical to that in the separating equilibrium,

$F = D_1^{IC} - \frac{\psi R}{\mu(1-q)}$. The size of the initial loan, however, is lower because the security is now

sold at a lower price because some of the loans are issued to the unreliable,

$$l_0 = P(F) + \frac{q\psi}{\mu(1-q)}.$$

Q.E.D.

Proof of Proposition 4.4:

In the separating equilibrium, the size of the loan received by the expert in expectation is

$$L^s = \mu l_0^r + (1-\mu)l_0^u = \mu \left[D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q) \right] + (1-\mu)\underline{l}.$$

In the pooling equilibrium, the expert receives

$$L^p = l_0 = \left[\mu + (1-\mu)q \right] F + (1-\mu)(1-q)B_1^{E,B}(\underline{\gamma}) + \frac{q\psi}{\mu(1-q)}.$$

Taking the difference, we can see

$$L^s - L^p(\mu) = (1 - \mu)q \left(B_1^{E,G}(\underline{\gamma}) - D_1^{IC} + \frac{(R-1)\psi}{\mu(1-q)} \right) > 0.$$

Therefore, the pooling equilibrium is never preferred if an unreliable expert is able to borrow more from investors in the separating equilibrium.

Q.E.D.

Proof of Proposition 4.5:

In the separating equilibrium, the expert receives an expected loan size that is equal to

$$L^s = l_0^s = D_1^{IC} - \frac{\psi}{\mu(1-q)}(R-q).$$

In the pooling equilibrium, where λ is the expected share of reliable experts who get a loan, the loan size is

$$L^p(\lambda) = l_0 = \left\{ \left[\lambda + (1-\lambda)q \right] F + (1-\lambda)(1-q)B_1^{E,B}(\underline{\gamma}) + \frac{q\psi}{\mu(1-q)} \right\}.$$

If the expert turns out to be unreliable, she receives the value of making the investment, which is

$$O^p = \left[\underbrace{-\frac{l}{\mu}}_{\text{repay if face value } B_1^{E,G}(\underline{\gamma})} + \underbrace{q(B_1^{E,G}(\underline{\gamma}) - D_1^{IC})}_{\text{rents cannot be pledged because face value } D_1^{IC}} \right] + \underbrace{(qC_1 + C_2 - I)}_{\text{NPV}} \\ - \underbrace{(1-\theta) \left[q(C_2 - B_1^{E,G}(\underline{\gamma})) + (1-q)(C_2 - B_1^{E,B}(\underline{\gamma})) \right]}_{\text{rents to future incumbent}}$$

The pooling equilibrium will be preferred if and only if

$$\left[\mu + (1-\mu)\sigma^u \right] L^p(\lambda) + (1-\mu)\sigma^u O^p > \mu L^s.$$

An expert's overall payoff in a pooling equilibrium is

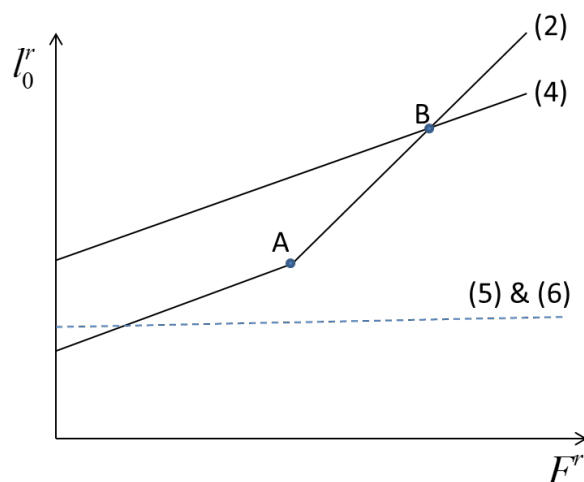
$$\left[\mu + (1-\mu)\sigma^u \right] L^p(\lambda) + (1-\mu)\sigma^u O^p = \frac{\mu}{\lambda} L^p(\lambda) + \mu \left(\frac{1}{\lambda} - 1 \right) O^p \\ = \mu \left\{ \left[1 + \frac{(1-\lambda)}{\lambda} q \right] F + \frac{(1-\lambda)}{\lambda} (1-q) B_1^{E,B}(\underline{\gamma}) + \frac{q\psi}{\lambda\mu(1-q)} \right\} + \mu \frac{1-\lambda}{\lambda} O^p,$$

which clearly decreases with λ . Note that as $\lambda \rightarrow 1$, the pooling equilibrium converges to the separating equilibrium without lending to unreliable experts ex-post. Therefore, when both exist, pooling equilibrium always dominates the separating one.

Q.E.D.

Proof of Proposition 5.1

Let us first examine the equilibrium of separation after screening, which corresponds to the one in subsection III.B.1. The bank's problem is to maximize its profit subject to constraints (1)-(6). Once again, constraint (2) and (4) constitute the following intersection set as illustrated graphically below.



The iso-profit lines for the bank are lines parallel to (4), and the bank's profit increases as they move down (lower l_0^r and higher F^r). Graphically, the monopolistic bank's objective is to pick a point in the intersection set that is on the lowest iso-profit line and also satisfies (5) and (6).

Clearly, no contract could lead to a higher profit than $l_0^r = \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma})$ (point A in

the graph). If $l_0^r = \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma})$ does not satisfy constraint (5) and (6), then the

optimal contract will be the lowest point along line AB that intersects lines (5) and (6).

Following the same logic as earlier, we can solve for the separating equilibrium in which banks do not lend to unreliable experts. Once again, we can ignore the borrower's participation

constraint, which is slack under Assumption 2. Therefore, the equilibrium contract is

$$l_0^r = \max \left\{ \frac{q}{R} D_1^{IC} + \left(1 - \frac{q}{R}\right) B_1^{E,B}(\underline{\gamma}), I - \omega_0 \right\}.$$

Q.E.D.

Proof of Proposition 5.2:

We offer a graphical explanation, with (s) and solid lines standing for a constraint in the separating equilibrium and (p) and dashed lines denoting a constraint in the pooling equilibrium.

We know (2)s and (8)p have the same functional form

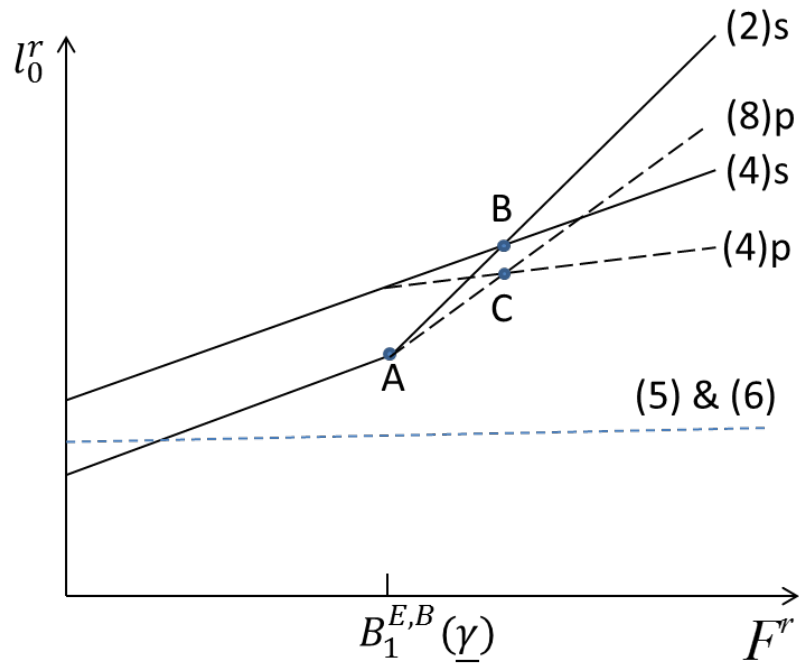
$$\left[-l_0 + P(F)\right]R + \left\{q(D_1^{IC} - F) + (1-q)\max\left\{B_1^{E,B}(\underline{\gamma}) - F, 0\right\}\right\} = 0 \text{ as do (4)s and (4)p}$$

$$-\psi R + \mu \left\{\left[-l_0^r + P(F^r)\right]R + (D_1^{IC} - F^r)\right\} \geq 0. \text{ The two sets of constraints differ because of}$$

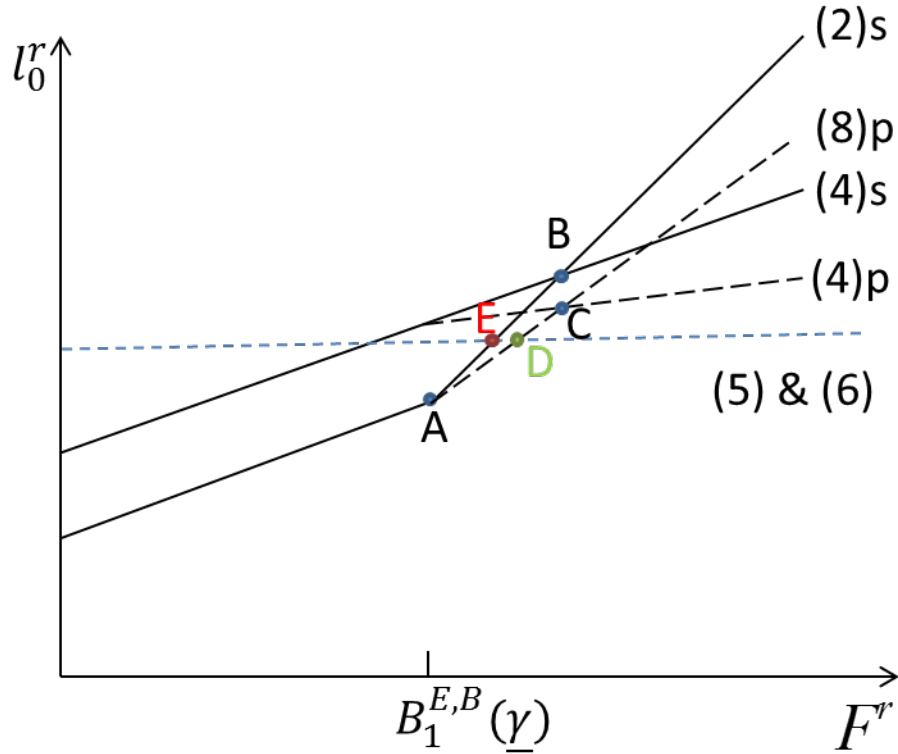
$$P(F). \text{ When } F \leq B_1^{E,B}(\underline{\gamma}), P(F^r) = F^r \text{ and } P(F) = F. \text{ When } F > B_1^{E,B}(\underline{\gamma}),$$

$P(F^r) = F^r$ and $P(F) < F$. The problem in the separating equilibrium is to pick a contract on (2)s that is the most distant from (4)s, whereas the problem in the pooling equilibrium is to pick a contract on (8)p that is the most distant from (4)p. In both problems, l_0^r needs to satisfy the feasibility constraint and the participation constraint, represented by the horizontal line (5) and (6).

In the graph illustrate below, (5) and (6) do not bind so that pooling and separating have the same optimal contract at point A. In this case, there is no difference between pooling and separating because the securities issued to investors are safe.



In the graph illustrate below, (5) and (6) bind so that pooling and separating have different optimal contracts. In the pooling equilibrium, the optimal contract is at D (green), whereas in the separating equilibrium, the optimal contract is at E (red). Since profits decrease with F , the separating equilibrium has higher profits.



Q.E.D.

Full analysis of subsection IV.B.6

Case 1: $\psi \rightarrow \infty$

Let us start with the case $\psi \rightarrow \infty$ so it can never make sense to screen. In this case, both the separating and pooling candidate equilibrium can never exist. The ex-ante equilibrium therefore is straightforward. If $\underline{l} \geq I - \omega_0$, banks lend without certification. Otherwise, no lending is accomplished at all.

Case 2: $\psi \rightarrow 0$

Next, let us turn to the other extreme case $\psi = 0$ where the screening cost is negligible. We will show that depending on the specific parameters, the ex-ante equilibrium will be one of the three cases. According to Proposition 4.1, the existence condition for the separation after screening candidate equilibrium is $I - \omega_0 \leq \min\{\underline{l}, D_1^{IC}\}$ if $\psi = 0$. Proposition 4.3 implies pooling equilibrium exists as long as $I - \omega_0 \leq D_1^{IC}$, where we have implicitly assumed $\lambda = 1$. Therefore, the two constraints $I - \omega_0 = D_1^{IC}$ and $I - \omega_0 = \underline{l}$ divide the state-space of liquidity

into different regimes which determine the equilibrium outcome. Note that we have applied the results from Proposition 4.5 and omitted candidate equilibrium with separation and loan rejections after screening.

Both $I - \omega_0 = D_1^{IC}$ and $I - \omega_0 = \underline{l}$ are piece-wise linear, with the first one weakly increasing and the second one weakly decreasing. It remains to determine where the two lines intersect with each other. Let us first consider the case $\omega_1^{E,G} = 0$ so that the prospective liquidity in future state G is also zero. We can show that the restriction of $\omega_0^r = I - D_1^{IC} < \omega_0^u = I - \underline{l}$ can be simplified to $(1 - \theta)(\bar{\gamma} - \underline{\gamma}) > 0$, which always holds. Second, let us turn to

$\omega_1^{E,G} = (1 - \bar{\gamma})C_2$. Simple calculations show that $\omega_0^r > \omega_0^u$ if and only if

$(1 - \theta)(\bar{\gamma} - \underline{\gamma}) < (1 - q)q(1 - \bar{\gamma})$. If so, the intersection point falls at $\omega_1^{E,G} \in (0, (1 - \bar{\gamma})C_2)$.

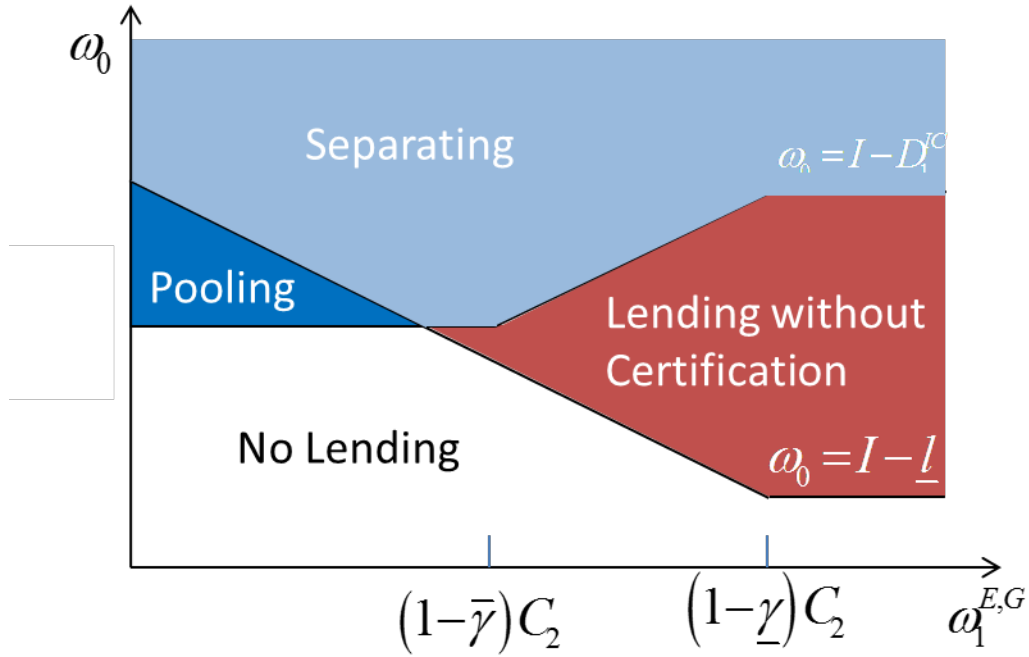
Next, let us turn to $\omega_1^{E,G} = (1 - \underline{\gamma})C_2$. Again, we can easily show that $\omega_0^r > \omega_0^u$ if and only if

$(1 - \theta)(\bar{\gamma} - \underline{\gamma}) < q(1 - \underline{\gamma})$, in which case the intersection point falls at

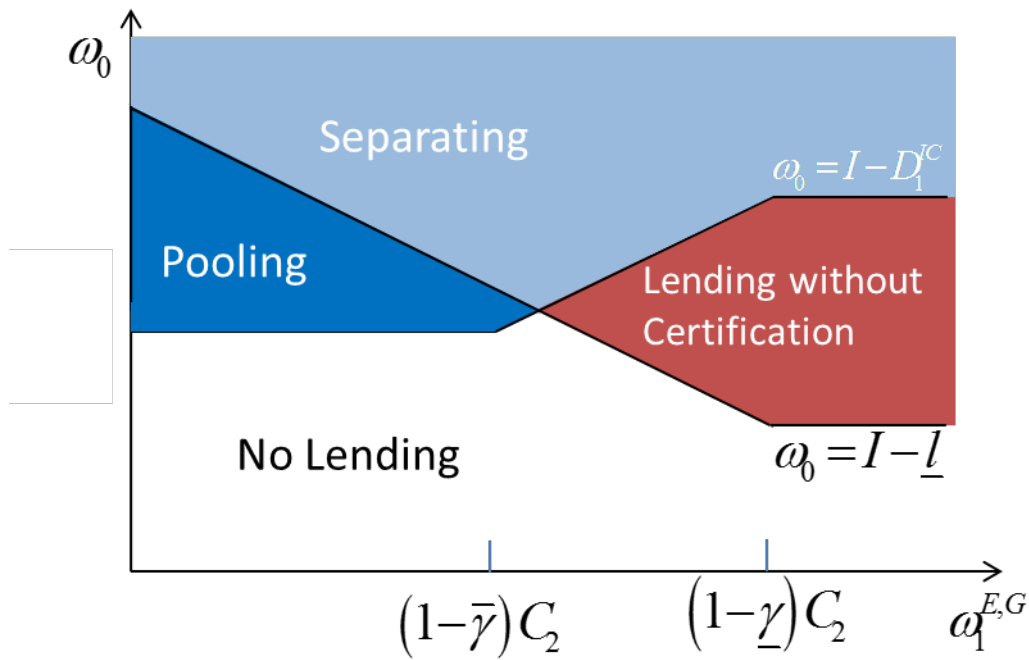
$\omega_1^{E,G} \in ((1 - \bar{\gamma})C_2, (1 - \underline{\gamma})C_2)$. Finally, if $(1 - \theta)(\bar{\gamma} - \underline{\gamma}) > q(1 - \underline{\gamma})$, the two lines never intersect.

Let us illustrate graphically the equilibrium for all the three subcases.

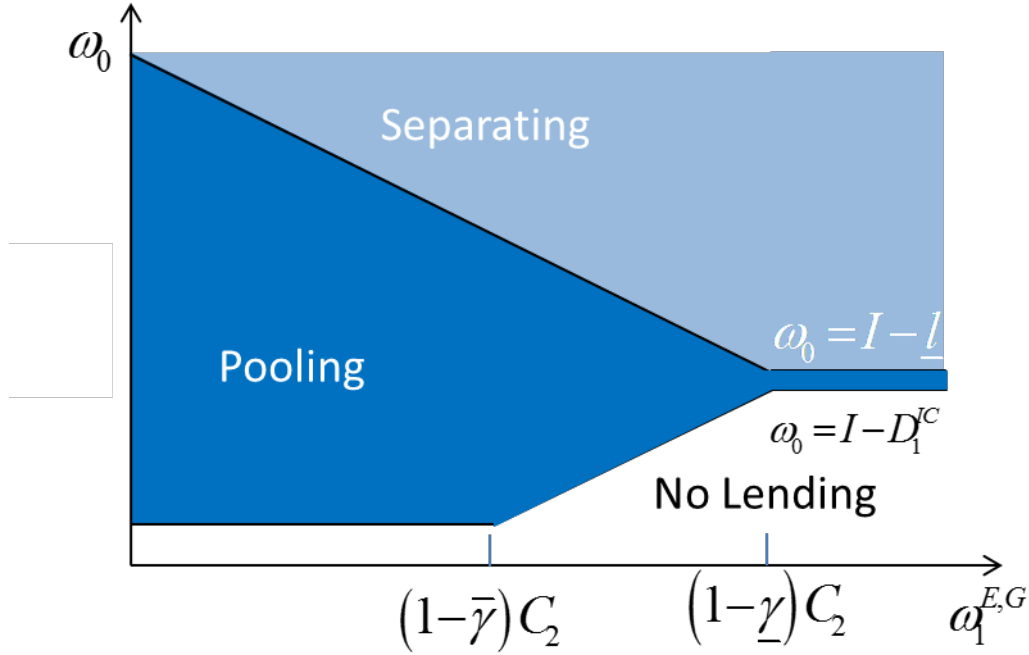
Subcase 1: $(1 - \theta)(\bar{\gamma} - \underline{\gamma}) \leq (1 - q)q(1 - \bar{\gamma})$



Subcase 2: $(1-\theta)(\bar{\gamma}-\underline{\gamma}) \in ((1-q)q(1-\bar{\gamma}), q(1-\underline{\gamma}))$



Subcase 3: $(1-\theta)(\bar{\gamma}-\underline{\gamma}) \geq q(1-\underline{\gamma})$



Case 3: intermediate ψ

With intermediate levels of ψ , the results are qualitatively similar. Now that we will look for where the $I - \omega_0 = D_1^{jC} - \frac{\psi(R-q)}{\mu(1-q)}$ and $I - \omega_0 = \underline{l}$ intersect. Similar to the previous case, we can divide it into three cases, depending on parametric values:

$$\text{Subcase 1: } (1-\theta)(\bar{\gamma} - \underline{\gamma}) \leq (1-q)q(1-\bar{\gamma}) + \frac{\psi(R-q)}{\mu C_2}$$

$$\text{Subcase 2: } (1-\theta)(\bar{\gamma} - \underline{\gamma}) \in \left((1-q)q(1-\bar{\gamma}) + \frac{\psi(R-q)}{\mu C_2}, q(1-\underline{\gamma}) + \frac{\psi(R-q)}{\mu(1-q)C_2} \right)$$

$$\text{Subcase 3: } (1-\theta)(\bar{\gamma} - \underline{\gamma}) \geq q(1-\underline{\gamma}) + \frac{\psi(R-q)}{\mu(1-q)C_2}$$

Moreover, we need to bring back the constraint $\Delta V \geq \frac{\psi(R-q)}{\mu(1-q)}$ in Proposition 4.1 and

$\Delta V \geq \frac{\psi R}{\mu}$ in 4.3. Specifically, if $\underline{l} \geq I - \omega_0$, the separating equilibrium requires

$\Delta V \geq \frac{\psi(R-q)}{\mu(1-q)}$; otherwise, the pooling equilibrium requires $\Delta V \geq \frac{\psi R}{\mu}$. Note that since

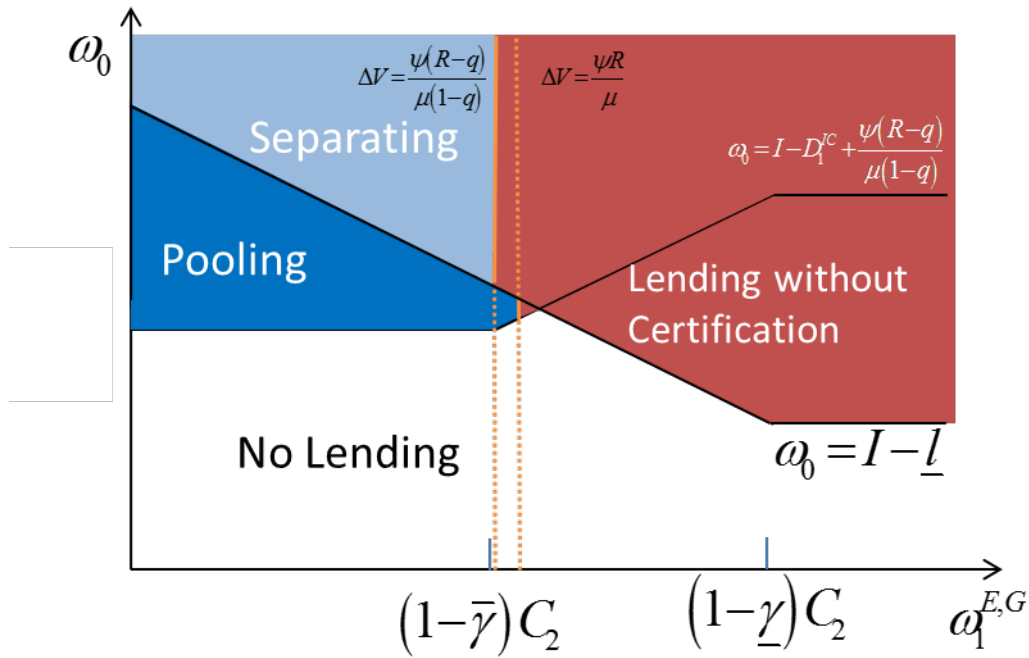
$$\Delta V = (1-\theta) \left[q \left(B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma}) \right) + (1-q) \left(B_1^{E,B}(\bar{\gamma}) - B_1^{E,B}(\underline{\gamma}) \right) \right],$$

this constraint essentially requires $\omega_1^{E,G}$ to be low enough. Otherwise, the benefit from certification cannot

justify its cost. The following figure illustrates one such case, with the two yellow vertical lines

marking the location of $\Delta V = \frac{\psi(R-q)}{\mu(1-q)}$ and $\Delta V = \frac{\psi R}{\mu}$. In this case, the equilibrium region for

both separating and pooling further shrink, whereas the region for lending without certification expands.



Full analysis of subsection V.B

For completeness, we review the remainder of the analysis is for the case, $q > \theta$. Let us define $\bar{l} = qD_1^{IC} + (1-q)B_1^{E,B}(\bar{\gamma})$ as the maximum amount of expected repayment by a reliable expert. Once again, the candidate equilibrium will include two types of separating equilibrium, pooling equilibrium, direct lending without screening, and no lending. In all cases, experts' participation constraints and the feasibility constraint stay unchanged. For the remainder of this subsection, we will focus on banks' incentive constraints in screening.

In a separating equilibrium, a certifying bank shall not find it IC-compatible to lend to an unreliable expert, implying

$$0 \geq \left[-l_0^r + P(F^r) \right] R + q \max \left\{ B_1^{E,G}(\underline{\gamma}) - F^r, 0 \right\} + (1-q) \max \left\{ B_1^{E,B}(\underline{\gamma}) - F^r, 0 \right\} \quad (15).$$

Constraint (15) corresponds to (2) in the benchmark model, with the new effect that if a bank doesn't certify, even in the good state, it does not receive full payment. Similarly, we derive a constraint that relates to (4), which requires a bank to prefer to screening and lending to reliable expert, as opposed to direct lending without screening

$$-\psi R + \mu \left\{ \left[-l_0^r + P(F^r) \right] R + q \left(D_1^{IC} - F^r \right) + (1-q) \max \left\{ B_1^{E,B}(\bar{\gamma}) - F^r, 0 \right\} \right\} \geq 0 \quad (16),$$

where $P(F^r) = qF^r + (1-q) \min \left\{ F^r, B_1^{E,B}(\bar{\gamma}) \right\}$. Note that the security issued by the bank is not riskless. Instead, investors may only get fully repaid in state B, if F^r exceeds $B_1^{E,B}(\bar{\gamma})$.

Constraint (15) and (16) define the set of contracts $\{l_0^r, F^r\}$ that offer enough incentives to screen. The solution to the candidate equilibrium is to find the maximum l_0^r that still satisfy experts' participation constraints and feasibility constraint. Now that the incentives to certify may come from both states, we have the following proposition.

Proposition 5.3: Under Assumption 1a, 1b, and $q > \theta$,

1. If $\bar{l} - \underline{l} \equiv \Delta V \geq (1-q)(\bar{\gamma} - \underline{\gamma})C_2 + \frac{\psi R}{\mu}$, then $F^r = \frac{1}{q} \left[\bar{l} - (1-q)B_1^{E,B}(\bar{\gamma}) - \frac{\psi R}{\mu} \right]$

and $l_0^r = \bar{l} - \frac{\psi R}{\mu}$. In this case, $F^r > B_1^{E,G}(\underline{\gamma}) > B_1^{E,B}(\bar{\gamma})$ so that banks incentive to certify comes solely from the good state.

2. If $\bar{l} - \underline{l} \equiv \Delta V < (1-q)(\bar{\gamma} - \underline{\gamma})C_2 + \frac{\psi R}{\mu}$, then $F^r = \frac{1}{1-q} \left[\bar{l} - qB_1^{E,B}(\underline{\gamma}) - \frac{\psi R}{\mu} \right]$ and

$$l_0^r = \frac{1-q}{1-q} \left(\bar{l} - \frac{\psi R}{\mu} \right) + \left(\frac{1}{R} - \frac{1-q}{1-q} \right) q B_1^{E,B}(\underline{\gamma}).$$

In this case,

$F^r < B_1^{E,B}(\bar{\gamma}) < B_1^{E,G}(\underline{\gamma})$ so that banks incentive to certify comes solely from the bad state.

Proof: Note that (15) requires l'_0 to be sufficiently high, whereas (16) requires l'_0 not being too high. Therefore, we can write explicitly conditions (15) and (16) as follows.

$$\begin{aligned}
0 &\geq \left[-l'_0 + P(F^r)\right]R + q \max\{B_1^{E,G}(\underline{\gamma}) - F^r, 0\} + (1-q) \max\{B_1^{E,B}(\underline{\gamma}) - F^r, 0\} \\
\Rightarrow &\begin{cases} l'_0 \geq F^r \left(1 - \frac{1}{R}\right) + \frac{l}{R} & \text{if } F^r < B_1^{E,B}(\underline{\gamma}) \\ l'_0 \geq F^r \left(1 - \frac{q}{R}\right) + \frac{q}{R} B_1^{E,G}(\underline{\gamma}) & \text{if } F^r \in [B_1^{E,B}(\underline{\gamma}), B_1^{E,B}(\bar{\gamma})] \\ l'_0 \geq F^r q \left(1 - \frac{1}{R}\right) + \frac{q}{R} B_1^{E,G}(\underline{\gamma}) + (1-q) B_1^{E,B}(\bar{\gamma}) & \text{if } F^r \in [B_1^{E,B}(\bar{\gamma}), B_1^{E,G}(\underline{\gamma})] \\ l'_0 \geq qF^r + (1-q) B_1^{E,B}(\bar{\gamma}) & \text{if } F^r > B_1^{E,G}(\underline{\gamma}) \end{cases}
\end{aligned}$$

and

$$\begin{aligned}
-\psi R + \mu \left\{ \left[-l'_0 + P(F^r)\right]R + q(D_1^{IC} - F^r) + (1-q) \max\{B_1^{E,B}(\bar{\gamma}) - F^r, 0\} \right\} &\geq 0 \\
\Rightarrow &\begin{cases} l'_0 \leq F^r \left(1 - \frac{1}{R}\right) + \frac{\bar{l}}{R} - \frac{\psi}{\mu} & \text{if } F^r < B_1^{E,B}(\bar{\gamma}) \\ l'_0 \leq F^r q \left(1 - \frac{1}{R}\right) + \frac{\bar{l} + (1-q)(R-1) B_1^{E,B}(\bar{\gamma})}{R} - \frac{\psi}{\mu} & \text{if } F^r \geq B_1^{E,B}(\bar{\gamma}). \end{cases}
\end{aligned}$$

Clearly, for both $F^r \in [0, B_1^{E,B}(\underline{\gamma})]$ and $F^r \in [B_1^{E,B}(\bar{\gamma}), B_1^{E,G}(\underline{\gamma})]$, the two

constraints are parallel to each other, as illustrate by the figures below. At $F^r = 0$, (15) requires

$l'_0 \geq \frac{l}{R}$, whereas (16) requires $l'_0 \leq \frac{1}{R} \left(\bar{l} - \frac{\psi R}{\mu} \right)$. Therefore, the intersection is non-empty if and

only if $\bar{l} - \frac{\psi R}{\mu} \geq \underline{l}$. As before, we can write

$$\begin{aligned}
\bar{l} - \underline{l} &= q(D_1^{IC} - B_1^{E,G}(\underline{\gamma})) + (1-q)(\bar{\gamma} - \underline{\gamma})C_2 \\
&= q(1-\theta) [B_1^{E,G}(\bar{\gamma}) - B_1^{E,G}(\underline{\gamma})] + (1-q)(1-\theta)(\bar{\gamma} - \underline{\gamma})C_2 \\
&\equiv \Delta V
\end{aligned}$$

so that the sufficient and necessary condition for a non-empty intersection set is $\Delta V \geq \frac{\psi R}{\mu}$. This

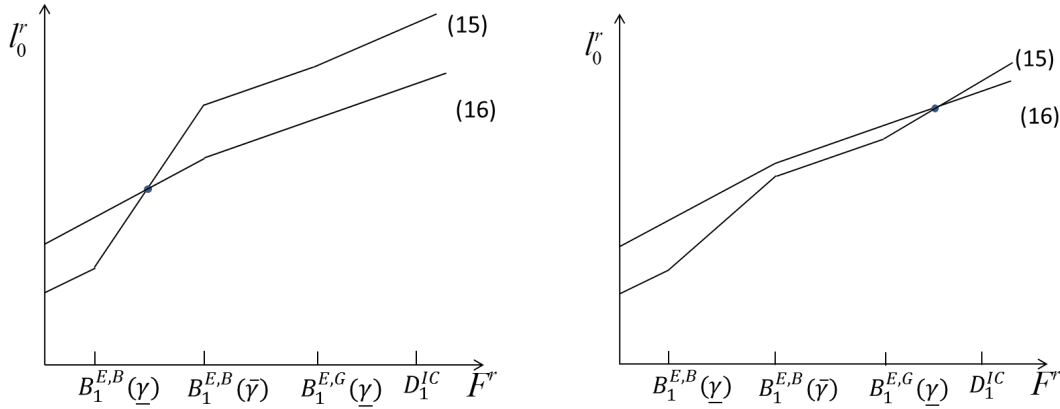
result mirrors the condition in Lemma 4.1 and equation (13). We can also check the conditions at

$F^r = D_1^{IC}$, at which (15) requires $l'_0 \geq \bar{l}$, whereas (16) requires $l'_0 \leq \bar{l} - \frac{\psi}{\mu}$. Clearly, the

intersection is empty.

Due to the parallel properties on $F^r \in [0, B_1^{E,B}(\underline{\gamma})]$ and $F^r \in [B_1^{E,B}(\bar{\gamma}), B_1^{E,G}(\underline{\gamma})]$, (15) and (16) intersects at $F^r < B_1^{E,B}(\bar{\gamma})$ if and only if the intersection at $F^r = B_1^{E,B}(\bar{\gamma})$ is empty. This is case 1 in the proposition. Otherwise, equilibrium contracts implies $F^r > B_1^{E,G}(\underline{\gamma})$, as in case 2. We can evaluate both constraints at $F^r = B_1^{E,B}(\bar{\gamma})$, and clearly the intersection is empty if and only if $\bar{l} - \underline{l} \equiv \Delta V < (1-q)(\bar{\gamma} - \underline{\gamma})C_2 + \frac{\psi R}{\mu}$.

Graphically, case 1 is illustrated as the left panel below, whereas case 2 is shown as the right panel.



Q.E.D.