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Pledgeability, Industry Liquidity, and Financing Cycles

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Abstract

Why are downturns following prolonged episodes of high valuations of firms so severe and prolonged? Why do firms promise high external payments when they anticipate high valuations, and underperform subsequently? In this paper, we propose a theory of financing cycles that features overhang from general financial contracts. In our theory, the control rights to enforce claims in an asset price boom (rights to sell assets) differ from the control rights used in more normal times (rights over cash flows that we term "pledgeability"). Firm management's limited incentive to enhance pledgeability in an asset price boom can have long-drawn adverse effects in a downturn, which may not be resolved by renegotiation. This can also explain why asset turnover to outsiders is high in a downturn as well as why industry productivity falls.

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Why do downturns following prolonged episodes of high firm valuations prove to be detrimental to growth and result in more protracted recessions (see Krishnamurthy and Muir (2015) and López-Salido, Stein and Zakrajšek (2015))? One traditional rationale is based on the idea of "debt overhang" – the debt built up during the boom serves to restrict investment and borrowing during the bust. However, if everyone, including the debt holders, knows that debt is holding back investment, they have an incentive to write down the debt in return for a stake in the firm's growth. For debt overhang to be a serious concern, the firm and debt holders must be unable to undertake value enhancing contractual bargains. Another view is that borrowers cannot be trusted to take only value enhancing investments, even in a downturn. So debt overhang is needed to constrain the borrower's investment – overhang is a second best solution to a fundamental moral hazard problem (see Hart and Moore (1995)). The immediate question raised by such an analysis is why we want to constrain borrowers more in bad times when the constraints imposed by debt are especially high. Why would the moral hazard problem be so much more serious in a downturn which follows high valuations?

In this paper, we provide an explanation of the causes and consequences of financial contract overhang (including debt overhang) and explain why it is more acute following periods of high valuations and rational optimism about the future values of firms. In doing so, we differentiate between the control rights that are due to high resale prices for assets, which enable external claims to be enforced in a boom, and control rights based on pledging of cash flows, which facilitate the enforcement of external claims at other times, including downturns. The transition between these regimes, in which different types of control rights are operational, causes the external claim build up during the boom to have long-drawn adverse effects in the downturn.

Let us be more specific. Consider an industry that requires special managerial knowledge. Within the industry, there are firms run by incumbents. There are also industry insiders (those who know the industry well enough to be able to run firms as efficiently as the incumbents). Industry outsiders (financiers who don't really know how to run industry firms but have general managerial/financial skills) are the other agents in the model. We first examine the effects of financing firms with fully state-contingent financial contracts, and then we turn to standard debt with a constant payment in a given period. Financiers have two sorts of control rights; first, control through the right to repossess and sell the underlying asset being financed if payments are missed and, second, control over cash flows generated by the asset. The first right only requires the frictionless enforcement of property rights in the economy, which we assume. It has especial value when there are a large number of capable potential buyers willing to pay the full price for the firm's assets. Greater wealth amongst industry insiders (which we term industry *liquidity*) increases the availability of this *asset-sale-based* financing. Because we analyze a single industry, high levels of this industry liquidity can be interpreted as an economy-wide boom.

The second type of control right is more endogenous, and conferred on creditors by the firm's incumbent manager as she makes the firm's cash flows more appropriable or pledgeable – for example, by improving accounting standards and transparency, by setting up escrow accounts and monitoring arrangements, by including debt covenants and conditions on dividend payments, or even by standardizing managerial procedures so as to make herself more replaceable as a manager. From the incumbent manager's perspective, enhancing cash flow *pledgeability* is a double-edged sword. It makes it easier for the incumbent to sell the firm when she is no longer fit to run it, because new buyers can borrow against future pledgeable cash flows to finance the acquisition. However, it also enables existing creditors to collect more when the incumbent stays in control. Thus cash flow pledgeability is subject to additional moral hazard, over and above the intrinsic reluctance of the incumbent to repay outside financiers. This limits the external financing capacity of the firm. The advantages of high pledgeability for financial capacity have been studied by Holmström and Tirole (1998). We examine the tradeoff between the advantages and disadvantages of increased pledgeability for the incumbent.

Our goal is to understand how the external obligations built up in a boom affect a firm's pledgeability choice, and its subsequent access to financing. When markets are buoyant and industry insiders have plenty of cash, repayment is enforced by the high resale value of assets and not by any pledging of cash flows by the incumbent. Industry assets trade for fundamental value (with no underpricing), as in Shleifer and Vishny (1992). The most efficient users hold the assets because they have enough cash and borrowing capacity up front to buy. The high anticipated resale value increases the amount of financing that a firm can credibly repay and thus the potential leverage of the firm. Meanwhile, firm's incentive to enhance cash flow pledgeability diminishes since an alternative means of obtaining financing is available.

If under these circumstances, competitive pressures force the firm to lever up, a little anticipated downturn can impair firm performance severely. Industry insiders, also hit by the downturn, no longer have personal wealth to buy assets, nor does the low cash flow pledgeability of the firm allow them to borrow against future cash flows to pay for purchases. Since external claims are high in these episodes, the firm may be sold to outsiders. While industry outsiders have little ability to run the asset themselves, this may be a virtue – they have a strong incentive to improve asset pledgeability, because they do not want to own the asset long term, but instead want to sell the asset back to industry insiders at a high price. Outsiders play a critical role, therefore, not because they are flush with funds but because they are not subject to moral hazard over pledgeability. Importantly, financiers have little incentive to renegotiate down fixed debt claims in a downturn, since the reallocation of the firm to industry outsiders may be the outcome that maximizes their claims, given past pledgeability choices. Consequently, in a downturn following a boom, a larger number of the new asset owners will be less-productive industry outsiders, reducing average productivity. Eisfeldt and Rampini (2006, 2008) provide evidence consistent with this.

Eventually, as the economy recovers, outsiders sell the assets back to the more productive industry insiders, as the higher pledgeability increases the insiders' ability to raise money against future cash flows. Recoveries following periods of an asset price boom and high leverage are thus delayed, not just because debt has to be written down – and undoubtedly frictions in writing down debt would increase the length of the delay – but also because corporations have to restore the pledgeability of their cash flows to cope with a world where liquidity is more scarce. It is the latter which may make the debt hangover more prolonged.

High anticipated liquidity, therefore, not only leads to greater financial leverage, but also the combination leads to low pledgeability being chosen. This then leads to distortions in allocation, as unproductive users of the asset take control in a downturn from more productive users. The liquidity-leverage overhang on pledgeability choice resembles traditional debt-overhang (Myers (1977)), where firm decisions are distorted whenever the decision causes an increase in the value of outstanding debt. However, it differs in important ways. The outside claim in our model could be any claim whose value is bolstered by the threat of outside sale or takeover in times of strong liquidity, as well as internally-set governance improvements in more normal times. So while the fixed nature of the outside claim helps in making the point, the effect generalizes to other variable (but not fully state-contingent) outside claims like equity. Moreover, the "underinvestment" is in pledgeability or governance, and the inefficiency is observed ex post, not ex ante, as assets go into the hands of low-productivity outsiders. The effects of this underinvestment are observed primarily after booms which give way to downturns that were known to be possible but were rationally neglected. In that sense, external-claim overhang is an industry or economy-wide effect, whereas traditional debt overhang is caused by a single firm as it levers up excessively.

Our paper explains why asset price booms based on a combination of liquidity and credit can be fragile (see, for example, Borio and Lowe (2002), Adrian and Shin (2010), and Rajan and Ramcharan (2015)). It also suggests a reason why credit cycles emerge, though a dynamic extension to the model is needed to explain the properties of such cycles fully (see, for example, Kiyotaki and Moore (1997)).[2] More broadly, it suggests theoretical underpinnings for financing cycles (Borio (2012)).

[2] See Benmelech and Bergman (2011), Coval and Stafford (2007), and Shleifer and Vishny (2011) for comprehensive reviews.

Our paper builds on Shleifer and Vishny (1992), where the high net worth of industry participants allows assets to sell for their fundamental value because the best user of an asset can outbid less efficient users, which leads to efficient reallocation. In their paper, reallocation to inefficient users takes place only when industry insiders are less liquid (traditional debt overhang effect) than outsiders. Eisfeldt and Rampini (2008) develops a theory where capital reallocation is more efficient in good times, with key ingredients being private information about managerial ability and cyclical effects of labor market competition for managers. Good times lead to high required cash compensation to managers because reservation managerial wages become elevated. As a result, high ability managers can accept lower wages in return for the benefits of managing more assets. They use the differential compensation to bribe low ability managers to give up their assets. In bad times, managerial compensation is lower and even if high ability managers accepted zero cash compensation, it would not be sufficient to bribe low ability managers to give up their assets. This leads to a more efficient reallocation of capital in good (high compensation) times and less in bad.

In both Shleifer and Vishny (1992) and Eisfeldt and Rampini (2008), adjusting for current conditions (such as industry net worth or compensation), past conditions do not affect financial capacity or the efficiency of current reallocation of capital. This is unlike our model, where history matters, allowing us to explain prolonged downturns following booms, and sketch the possibility of financing cycles. Moreover, outsiders in our model are not necessarily more liquid, but still play an important role because they do not suffer from moral hazard over pledgeability. They take over the firm temporarily so as to raise future pledgeability, even though they cannot generate cash flow.

The rest of the paper is as follows. In Section I, we describe the basic benchmark model of pledgeability choice and the timing of decisions in a three-period model. In Section II, we analyze the implications of pledgeability choice when financial contracts are fully state contingent and pledgeability can be chosen flexibly in response to the state. The maximum amount that can be pledged to outside investors is characterized, and the fundamental tradeoffs in the model are explained in a simple two-period version of the model. We then add the additional period to the model so as to permit the sale to outsiders, and analyze when these would be observed. In Section III, we examine the implications of standard debt contracts and persistent pledgeability choices that are made before uncertainty is fully revealed. Once again, we start with the two period model and add an additional period. In Section IV, we discuss some extensions, and in Section V, the implications of the model.

I. The Framework

A. The Industry and States of Nature

Consider an industry with 4 dates (-1, 0, 1, 2) and 3 periods between these dates, with date t marking the end of period t. A period is a phase of the financing cycle (see Borio (2014) for example), and extends over several years. The state of the industry is realized at the beginning of every period. In the *good* state G, the industry prospers. In the *bad* state B, industry-wide distress occurs. In period 0, the industry is in state $s_0 \in \{G, B\}$, with the probability of state G being q^G (see Figure 1). Similarly in period 1, the probability of state G is $q^{s_0 G}$. In period 2, we assume the industry returns to state G for sure – this is meant to represent the long run state of the industry (we model economic fluctuations and not apocalypse). A full description of the state in period t includes the states that were realized in previous periods, but where this is unnecessary we will skip it for convenience.

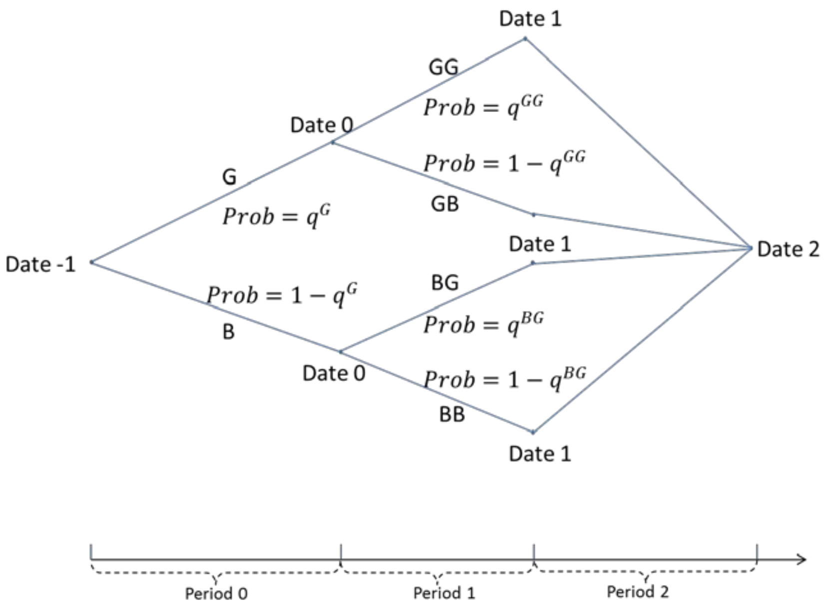

Figure 1: States of Nature in the Basic Model beginning from G or B

B. Agents and the Asset

There are two types of agents in the economy: *High* types (H) are *industry insiders* with high ability to produce with an asset, which we call the firm. There is some mutual specialization established over the period between the incumbent manager and the firm[3] that creates a value to incumbency. When the state is G, only a high type manager in place at the beginning of a period *t* can produce cash flows C_t with the asset over the period. In the B state, however, even a high ability manager cannot produce cash flows. A *low* type (L) manager has no ability to produce cash flows regardless of the state. These could be *industry outsiders* such as *financiers* who hold the asset for the purpose of reselling, or industry insiders who have lost their ability (see below). Financiers also have funds, which they will lend to others managing the firm if they expect to break even. A fixed cost of operation, F, is incurred by the incumbent every period (C_t is net of F if the realized state is G). All

[3] Or more broadly, between the management team and the un-modeled organization that is needed to operate the firm.

agents are risk neutral. We ignore time discounting, which is just a matter of rescaling the units of cash flows.

A high ability manager retains her ability into the next period only with probability $\theta^H < 1$. Think of this as the degree of stability of the industry. Intuitively, the critical capabilities for success are likely to be stable in a mature industry or in an industry with little technological innovation. However, in an industry which is young and unsettled, or in an industry with significant innovation, the critical capabilities for success can vary over time. A manager who is very appropriate in a particular period may be ineffective in the next. This is the sense in which an incumbent can lose ability and this occurs with higher probability in a young or changing industry.

The incumbent's loss of ability in the next period becomes known to all shortly before the end of the current period. Loss of ability is not an industry wide occurrence and is independent across managers. So even if a manager loses her ability, there are a large number of other industry insider managers equally able to take her place next period. If a new high ability manager takes over at the end of the current period, she will shape the firm towards her idiosyncratic management style, so she can produce cash flows with the firm's assets in future periods in good states.

C. Financial Contracts

Any manager can raise money from financiers against the asset by writing one period financial contracts. Although our ultimate goal is to understand the effects of debt contracts, we begin by analyzing an economy in which contracts are allowed to be state contingent, so promised payments at the end of period *t* are $D_t^{s_t}$.

Having acquired control of the firm, a manager would like to keep the realized cash flow for herself rather than share it with financiers. Two sorts of control rights force the manager to repay the external claims. First, the financier automatically gets paid a portion that we call "*pledgeable*" of the cash flows produced over the period. Second, just before the end of the period, the financier gets the right to auction the firm to the highest bidder if he has not been paid in full. Below we describe the two control rights in detail.

D. Control Rights over Cash Flow: Pledgeability

Let us define pledgeability as the fraction of realized cash flows that are automatically directed to an outside financier. In practice, it is determined by a variety of factors: the information possessed by the financier and hence the nature of the financier ("arm's length" like a bond investor or "relationship" like a banker); the nature of financing (for example, concentrated or dispersed); the quality of the accounting systems in place; the transparency of the organizational structure and the system of contracting (e.g., the absence of pyramids, the rules governing related party transactions, etc.); and the checks and balances that are imposed on the manager by the organization (the quality and independence of the board, the replaceability of the CEO, the independence of the auditor and the audit committee, etc.).

The incumbent chooses pledgeability this period, but it takes time to get embedded (only by next period), and will then persist for some time (over the entire period). So *pledgeability* γ_{t+1} chosen in period *t* is the fraction of period *t+1*'s cash flows that can be automatically paid to outside financiers. $\gamma_{t+1} \in [\underline{\gamma}, \overline{\gamma}]$, where the range of feasible values is determined by the economy or industry's institutions supporting corporate governance (such as regulators and regulations, investigative agencies, laws and the judiciary). Also, $0 \le \underline{\gamma} < \overline{\gamma} \le 1$. To set $\gamma^g_{t+1} > \underline{\gamma}$, it costs ε≥0, where ε is the cost of actions such as hiring a reputable accountant. Our results will be presented primarily for the case where $\varepsilon \to 0$, and a positive ε will only alter the results quantitatively.

While a low-type incumbent cannot generate cash flows, he can set next period's pledgeability– he does not have industry-specific managerial capabilities but has governance capabilities.

E. Control Rights over Assets: Auction and Resale

If the financier has not been paid in full from the pledged cash flow and any additional sum the incumbent voluntarily pays, then the financier gets the right to auction the firm to the highest bidder at date t. One can think of such an auction as a form of bankruptcy. Therefore, the incumbent can retain control by either paying off the financier in full (possibly by borrowing once again against future pledgeable cash flows) or by paying less than the full contracted amount and outbidding other bidders in the auction.

F. Initial Conditions and Wealth

At date 0, the incumbent has initial wealth $\omega_0^{i,s_0} \ge 0$. Let industry insiders start out with wealth $\omega_0^{H,s_0} \ge 0$, which we refer to as industry liquidity. If the state is good in period t, we assume that both the wealth of the incumbent and industry insiders go up by ρC_t (the industry boom lifts the private income of all insiders whether owning a firm or working as contractors, consultants or employees). Furthermore, the wealth of the incumbent increases by an additional $(1-\gamma_t)C_t$, the unpledged cash flow she generates within the firm.

G. Efficiency

The measure of unconstrained economic efficiency we use through the rest of this paper is the ability to keep the asset in the hands of the most productive owner. We do not model investment, instead assuming that the asset exists and is owned by an incumbent. Alternatively, we can put a minimum scale on the value of real inputs to be assembled into the firm at the initial date -1, and assume the firm starts at that date only if enough funding is available. As a result, underinvestment may occur if incentives to make cash flows pledgeable or to transfer the firm to more efficient producers are sufficiently weak, for bids may be reduced at date -1 below this floor.

H. Timing

We will start by examining incentives in period 1. The timing of events is described in Figure 2. We assume that the incumbent learns the state, then sets pledgeability γ_2, knowing the amount of payment that is due at date 1. Next, her ability in period 2 is realized. Subsequently, production takes place and the pledgeable fraction γ_1 of cash flows (set in the previous period) goes to financiers automatically. At date 1, she either pays the remaining due or enters the auction.

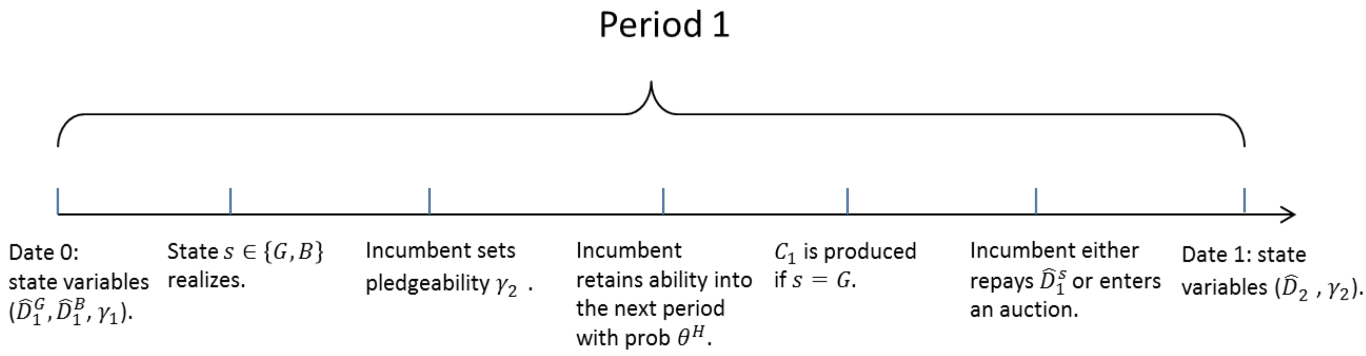

Figure 2: Timing and Decisions in Period 1

II. Pledgeability Choice with State-Contingent Contracts

We now focus on decisions in period 1. What determines pledgeability? How does the level of promised payment $D_t^{s_t}$ influence the incumbent's incentive to set pledgeability? We will show that both the choice of pledgeability and the maximum state-contingent payments are determined by two forms of interacting moral hazard. First, incumbents can withhold cash flows from financiers except for what they are forced to pay by pre-set pledgeability or the financier's threat to seize and auction assets. Second, the incumbent can choose future pledgeability, potentially influencing the amount that financiers are able to collect. We assume that period 1 starts with a high type manager in place. In this setting, all outcomes will be efficient, and many of our positive implications will be clear. In Section 2.5, we extend the analysis to period 0 and show an inefficient real outcome: asset can possibly be sold to a low type at date 0.

2.1. Date 2

Since the economy ends at date 2 and there is no uncertainty over the state in period 2, a high type industry insider who bids for control at date 1 can borrow up to $D_2 \equiv \gamma_2 C_2$ where γ_2 is preset by the incumbent in period 1. The incumbent can also borrow up to $\gamma_2 C_2$ at date 1 if she remains a high type and bids to retain control into period 2.

2.2. Date 1

Let $D_1^{s_1}$ be the promised payment to the financier at date 1 in state s_1, $s_1 \in \{G, B\}$. If the incumbent in period 1 is an industry insider and s_1 =G, cash $\gamma_1 C_1$ goes directly to the financier (up to the value of her promised claim), where γ_1 is pledgeability that was set in period 0. The remaining payment due is $\widehat{D}_1^{s_1} = D_1^{s_1} - Min[\gamma_1 C_1, D_1^{s_1}]$. If s_1 = B, then $\widehat{D}_1^{s_1} = D_1^{s_1}$.

In any date 1 auction for the firm, industry outsiders or financiers do not bid to take direct control of the firm since the firm generates no cash flow in their hands in the last period and the firm has no residual value. Industry insiders bid using their date 1 wealth and any amount that can be borrowed at date 1 by pledging period 2's output. Their wealth increases by ρC_1 in state G, and remains unchanged in state B, i.e., $\omega_1^{H,G} = \omega_0^{H,s_0} + \rho C_1$ and $\omega_1^{H,B} = \omega_0^{H,s_0}$. Together with the amount $\gamma_2 C_2$ they can borrow, the total amount that they can pay is $\omega_1^{H,s_1} + \gamma_2 C_2$. Of course, they do not bid more than the total value of cash flow, C_2. So the maximum auction bid at date 1 is $B_1^{H,s_1}(\gamma_2) = Min[\omega_1^{H,s_1} + \gamma_2 C_2, C_2]$.

A measure which will help understanding the model is *potential underpricing*, which is the difference between the present value of future cash flows accruing to an industry insider if he buys the firm and the amount that he can bid if the incumbent sets pledgeability to be low. It equals $C_2 - B_1^{H,s_1}(\underline{\gamma})$ at date 1. By choosing different levels of pledgeability, the incumbent can vary industry insiders' bids between $B_1^{H,s_1}(\underline{\gamma})$ and $B_1^{H,s_1}(\overline{\gamma})$, thus altering the *realized underpricing*, which is the difference between the present value of future cash flows and the actual bid.

The incumbent has to repay the financier in full or outbid others in an auction if she wants to retain control into period 2. That is, she pays $Min\,[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)]$. The cash she has at date 1 is the initial wealth level, ω_0^{i,s_0},[4] plus the non-pledgeable portion of cash flows generated during period 1, less the fixed cost F in state B. At date 1, the incumbent has cash $\omega_1^{i,G} = \omega_0^{i,s_0} + (1-\gamma_1 + \rho)C_1$ if the period 1 state is G, and $\omega_1^{i,B} = \omega_0^{i,s_0} - F$ if the state is B. In addition, if she knows she is going to keep her ability in period 2, she can also raise funds against period 2's output, $\gamma_2 C_2$. Therefore, the incumbent can pay as much as $B_1^{i,s_1} = \min\{\omega_1^{i,s_1} + \gamma_2 C_2, C_2\}$ to the financier. The incumbent will retain control if the amount she can pay is (weakly) greater than $Min\,[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)]$. Since the continuation value of the asset, C_2, is identical for the incumbent and industry insiders, the incumbent is always willing to hold on to the asset if she is able to outbid. Of course, if the incumbent realizes she has lost her ability, or she is a low type to begin with, she will want to sell out since she cannot generate cash flow next period.

Regardless of who wins, if the incumbent in period 1 is a high type, the financier recoups $Min[\gamma_1 C_1, D_1^{s_1}] + Min\,[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)]$ if the state is G and $Min\left[D_1^{s_1}, B_1^{H,s_1}(\gamma_2)\right]$ if the state is B. The financier's threat of seizing and selling assets is therefore a powerful instrument for him to extract repayment. The value of that threat depends on the bid $B_1^{H,s_1}(\gamma_2)$ by industry insiders, which in turn depends on the wealth of industry insiders and the future pledgeability of the asset γ_2.

The incumbent's choice of pledgeability γ_2 and the maximal credible payment, $\widehat{D}_1^{s_1,Max}$, are jointly determined, depending on whether the incumbent can outbid industry insiders. It is easily shown that because of linearity, the incumbent never sets pledgeability at an interior level in the range. We identify three cases: (i) Pledgeability does not matter for repayment. (ii) The incumbent can never outbid industry insiders. (iii) The incumbent can always outbid industry insiders. We solve explicitly for the maximal credible payment $\widehat{D}_1^{s_1,Max}$ in all these cases.

(i) Pledgeability does not matter for repayment (no potential underpricing)

When $B_1^{H,s_1}(\underline{\gamma}) = C_2$, industry liquidity is sufficiently high that high-type insiders can pay the full price of the asset, even if the incumbent has chosen low pledgeability, so $\widehat{D}_1^{s_1,Max} = C_2$. In this case, there is no potential underpricing and pledgeability does not matter for repayment. As a

[4] The notation is a bit different from that on date 1 to simplify the expressions. ω_0^{i,s_0} is the incumbent's wealth *after* the date-0 payments and auction, where ω_1^{i,s_1} is the incumbent's wealth *before* date-1 payments are made and auction is run.

result, the incumbent will set pledgeability to be low. External payments are committed to through the high resale price of the asset. High pledgeability is neither needed nor desired by anyone in this case.

(ii) Incumbent cannot outbid industry insiders in an auction

Let $C_2 > B_1^{H,s_1}(\underline{\gamma})$ so there is potential underpricing. When $B_1^{H,s_1}(\underline{\gamma}) > B_1^{i,s_1}(\underline{\gamma})$, the industry insider can always outbid the incumbent no matter what level pledgeability is set at. By setting payments at $\widehat{D}_1^{s_1,Max} = B_1^{H,s_1}(\overline{\gamma}) - \varepsilon$, the incumbent is incentivized to set next period's pledgeability at $\overline{\gamma}$.[5] She recoups the cost ε of setting pledgeability high because the promised payment is ε below the auction bid. It is easy to check that the incumbent's payoff would never increase if she set pledgeability lower.

(iii) Incumbent always can outbid industry insiders

Now let $B_1^{i,s_1}(\underline{\gamma}) \geq B_1^{H,s_1}(\underline{\gamma})$ so that the incumbent can outbid the industry insider regardless of her choice of pledgeability. She chooses $\gamma_2 = \overline{\gamma}$ iff

$$\begin{aligned}&\theta^H(C_2 - Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\overline{\gamma})]) + (1-\theta^H)(B_1^{H,s_1}(\overline{\gamma}) - Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\overline{\gamma})]) - \varepsilon \\ &\qquad \geq \theta^H(C_2 - Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\underline{\gamma}))]) + (1-\theta^H)(B_1^{H,s_1}(\underline{\gamma}) - Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\underline{\gamma}))])\end{aligned} \tag{1}$$

The left hand side is the incumbent's continuation value if she chooses $\gamma_2 = \overline{\gamma}$, while the right hand side is the one if she chooses $\gamma_2 = \underline{\gamma}$. The first term on each side of (1) is the residual amount the incumbent expects if she remains a high type in period 2. The second term on each side is the expected residual amount if she loses her ability, and has to auction the firm at date 1. Note that a higher γ_2 (weakly) increases the amount the incumbent has to pay the financier when she retains capability and control, therefore (weakly) decreasing the first term, while it (weakly) increases the amount the incumbent gets in the auction if she loses capability, thus (weakly) increasing the second term. The incumbent therefore trades off higher possible repayments against higher possible resale value in choosing γ_2.

[5] This case also includes $C_2 = B_1^{H,s_1}(\overline{\gamma}) = B_1^{i,s_1}(\overline{\gamma})$ and $B_1^{H,s_1}(\underline{\gamma}) > B_1^{i,s_1}(\underline{\gamma})$. In other words, the incumbent retains control if she chooses high general pledgeability and continues to be a high type, because she is able to pay the full value of the asset C_2.By contrast, if she chooses low pledgeability, she loses control because the high promised payment is enforceable and higher than what she can pay.

Higher outstanding promised payment reduces the incumbent's incentive to choose higher γ_2 because more of the pledgeable cash flows are captured by financiers if the incumbent stays in control, and more of the resale value also goes to financiers if the asset is sold. The maximum level of promised payment $\widehat{D}_1^{s_1,Max}$ that still gives her an incentive to choose $\gamma_2 = \overline{\gamma}$ is $D_1^{s_1 \text{ PayIC}} = \theta^H B_1^{H,s_1}(\underline{\gamma}) + (1-\theta^H) B_1^{H,s_1}(\overline{\gamma}) - \varepsilon$. The superscript "PayIC" follows as in this case pledgeability choice only influences how much the incumbent must pay to retain the asset (or how much is paid when it is sold after she loses her skills). This higher industry insider bid is good for the incumbent when skills are lost (probability $1-\theta^H$) and is bad when skills are retained. This is the maximum incentive-compatible payment that the incumbent can commit to under condition (iii).

Lemma 2.1 summarizes the results when $s_1 = s \in \{G, B\}$.

<u>Lemma 2.1</u>

(i) If $B_1^{H,s}(\underline{\gamma}) = C_2$, $\widehat{D}_1^{s,Max} = C_2$ and $\gamma_2 = \underline{\gamma}$. For any promised payment $\widehat{D}_1^s \le \widehat{D}_1^{s,Max}$, the incumbent expects $V_1^{i,s}(\widehat{D}_1^s) = C_2 - \widehat{D}_1^s$.

(ii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) < B_1^{H,s}(\underline{\gamma})$, $\widehat{D}_1^{s,Max} = B_1^{H,s}(\overline{\gamma}) - \varepsilon$ and $\gamma_2 = \overline{\gamma}$. For any promised payment $\widehat{D}_1^s \le \widehat{D}_1^{s,Max}$, the incumbent expects $V_1^{i,s}(\widehat{D}_1^s) = B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon$ if $B_1^{i,s}(\overline{\gamma}) < \widehat{D}_1^s \le \widehat{D}_1^{s,Max}$, and expects
$V_1^{i,s}(\widehat{D}_1^s) = \theta^H C_2 + (1-\theta^H) B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon$ if $\widehat{D}_1^s \le B_1^{i,s}(\overline{\gamma})$.

(iii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) \ge B_1^{H,s}(\underline{\gamma})$, $\widehat{D}_1^{s,Max} = D_1^{s \text{ PayIC}}$ and $\gamma_2 = \overline{\gamma}$. For any promised payment $\widehat{D}_1^s \le \widehat{D}_1^{s,Max}$, incumbent expects

$$V_1^{i,s}(\widehat{D}_1^s) = \theta^H C_2 + (1-\theta^H) B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon.$$

Proof: See Appendix.

In Case (i), there is no potential underpricing and the choice of pledgeability does not matter for payment. In Case (ii), the incumbent loses .control whenever she enters an auction. The maximal promised payment is set by industry liquidity and the need to compensate the incumbent for incurring the cost of setting pledgeability high. In case (iii), however, the incumbent is able to hold onto the asset for any choice of pledgeability, provided she retains capability. Therefore, the maximal promised payment is significantly lower to incentivize high pledgeability choice – the ability to retain control makes a higher bid price unattractive and increases the moral hazard with respect to outside claims.

This is why, as illustrated by Figure 3a, the maximum credible payment $\widehat{D}_1^{s,Max}$ decreases (weakly) with incumbent wealth ω_1^{i,s_1}. When ω_1^{i,s_1} is low as in case (ii), the promised payments can be set as high as $B_1^{H,s}(\overline{\gamma})-\varepsilon$. However, as ω_1^{i,s_1} increases and the incumbent has the chance to maintain control, her incentives start mattering, resulting in a lower credible payment $D_1^{s\ \text{PayIC}}$. Of course if there is no potential underpricing to begin with, the incumbent's wealth does not matter for repayment. Although $\widehat{D}_1^{s,Max}$ decreases with ω_1^{i,s_1}, the continuation value for a given payment $\widehat{D}_1^{s}$ always increase with ω_1^{i,s_1} (Figure 3a, right panel).

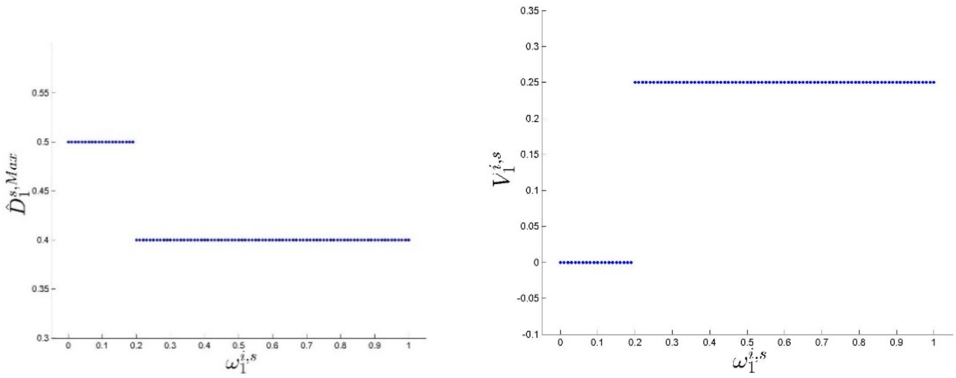

Figure 3a: $\widehat{D}_1^{s,\max}$ **(left) and** $V_1^{i,s}\left(\widehat{D}_1^{s}\right)$ **(right) as functions of** $\omega_1^{i,s}$

Other parameters: $\omega_1^{H,s}=0.2, \overline{\gamma}=0.3, \underline{\gamma}=0.1, C_2=1, \theta^H=0.5, \varepsilon=0, \widehat{D}_1^{s}=0.6$

A related result is that an increase in stability θ^H weakly decreases $\widehat{D}_1^{s,Max}$ and a higher chance to retain control increases the moral hazard with respect to outside claims. To see this, note that the maximum incentive compatible payment $D_1^{s_1\ \text{PayIC}}$ falls in stability, θ^H, since $B_1^{H,s_1}(\underline{\gamma})<B_1^{H,s_1}(\overline{\gamma})$. Intuitively, the higher is stability, lower the likelihood that different management capabilities will be needed and a forced sale will occur. For any debt level, this increases the attractiveness for the incumbent manager to choose low pledgeability to reduce the enforceable

payment.[6]

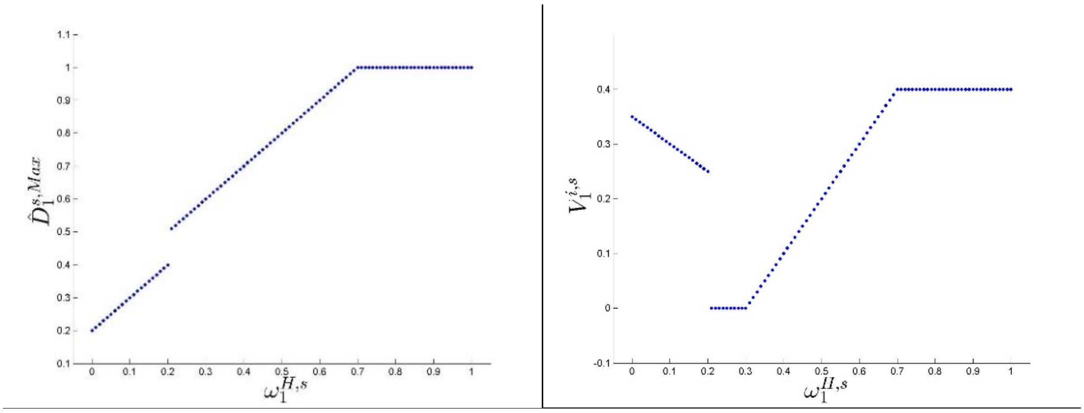

Figure 3b: $\widehat{D}_1^{s,\max}$ **(left) and** $V_1^{i,s}\left(\widehat{D}_1^s\right)$ **(right) as functions of** $\omega_1^{H,s}$

Other parameters: $\omega_1^{i,s} = 0.2, \overline{\gamma} = 0.3, \underline{\gamma} = 0.1, C_2 = 1, \theta^H = 0.5, \varepsilon = 0, \widehat{D}_1^s = 0.6$

Second, an increase in *industry liquidity* ω_1^{H,s_1} always raises $\widehat{D}_1^{s,Max}$ .There are two channels at work here. An increase in industry liquidity pushes up the amount industry insiders can pay, $B_1^{H,s}(\gamma_2)$, for any level of pledgeability. It also expands the parameter ranges in which either there is no potential underpricing or the incumbent cannot retain control. Consequently, the maximum pledgeable payment increases. Figure 3b illustrates this by plotting $\widehat{D}_1^{s,\max}$ against $\omega_1^{H,s}$.

However, $V_1^{i,s}\left(\widehat{D}_1^s\right)$ varies with ω_1^{H,s_1} in a non-monotonic manner for a fixed $\widehat{D}_1^s$. When $\omega_1^{i,s} \geq \omega_1^{H,s}$, there is underpricing and the incumbent can retain the asset for sure. In this case, $V_1^{i,s}(\widehat{D}_1^s) = \theta^H C_2 + (1-\theta^H) B_1^{H,s}(\overline{\gamma}) - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\} - \varepsilon.$ As ω_1^{H,s_1} increases so that $\omega_1^{i,s} < \omega_1^{H,s}$, the incumbent cannot outbid industry insiders, and $V_1^{i,s}(\widehat{D}_1^s)$ drops to $B_1^{H,s}(\overline{\gamma}) - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\} - \varepsilon$. As ω_1^{H,s_1} further increase such that there is no potential

[6] There is a parallel here to Jensen (1986)'s argument that free cash flows in mature industries lead to greater waste. In his view, the paucity of investment needs in mature industries results in firms generating substantial free cash flows (and hence poorer governance because of a lower need to return to the market for funding). In our model, the lower probability of the need to sell the firm to managers with different capabilities (or equivalently, the lower need to issue financial claims to raise finance for unmodeled investment) in a mature or stable industry reduces the need to maintain better outside pledgeability.

underpricing. $V_1^{i,s}(\widehat{D}_1^s)$ increases again to $C_2 - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\}$. Corollary 2.1 formalizes the above results.

Corollary 2.1: $\widehat{D}_1^{s_1,Max}$ increases (weakly) with ω_1^{H,s_1}, decreases (weakly) in θ^H and ω_1^{i,s_1}. $V_1^{i,s}(\widehat{D}_1^s)$ increases with ω_1^{i,s_1}, and varies non-monotonically with ω_1^{H,s_1} .

2.3. Financing Cycles with State-contingent Contracts

Define an involuntary turnover as one where an incumbent who retains ability has to sell an underpriced firm. We now study how pledgeability, financing capacity, and involuntary management turnover depends on the sequence of states. The initial state $s_0 \in \{G, B\}$ summarizes the entire history before date 0, and respectively represents the industry having experienced a boom or a recession before date 0. Therefore, the state in period 1 has four possible realizations.

As we just saw, Lemma 2.1 indicates equilibrium outcomes are determined by two state variables: industry liquidity, and the difference between the incumbent's wealth and industry liquidity. Industry liquidity, ω_0^{H,s_0}, fully determines pledgeability choice: low pledgeability is chosen if and only if there is no potential underpricing. Industry-wide liquidity is unambiguously the highest in state GG, which is meant to capture long-term booms. It is easy to see that,

Proposition 2.1: If $\left(1-\underline{\gamma}\right)C_2 > \omega_0^{H,G} \geq \left(1-\underline{\gamma}\right)C_2 - \rho C_1 > \omega_0^{H,B}$, low pledgeability is chosen if and only if the state is GG.

If industry liquidity is so high that there is no potential underpricing, as in state GG ($\omega_0^{H,G} \geq \left(1-\underline{\gamma}\right)C_2 - \rho C_1$), the second state variable, which is the difference between incumbent liquidity and industry liquidity, does not matter for equilibrium outcomes. If there exists potential underpricing—as in all other states (guaranteed by $\left(1-\underline{\gamma}\right)C_2 > \omega_0^{H,G}$ and $\left(1-\underline{\gamma}\right)C_2 - \rho C_1 > \omega_0^{H,B}$), however, the second state variable becomes crucial for financing capacity and involuntary management turnovers.

Note that even in the absence of any moral hazard over pledgeability, credit capacity is capped by $B_1^{H,s_0 s_1}\left(\overline{\gamma}\right)$—the maximal possible bid that an incumbent encounters in an auction. This necessarily implies that credit capacity is low when industry liquidity is low, such as in state BB. Second, the need to provide incentives for the incumbent to choose high pledgeability will further reduce financial capacity. If the incumbent either cannot retain the asset or can only retain by paying the full price (case (ii) in Lemma 2.1), credit capacity is reduced by a small amount, ε. If the incumbent can retain the asset (case(iii)), the credible amount that she can promises is reduced from $B_1^{H,s_0 s_1}(\overline{\gamma})$ to $D_1^{s,PayIC}$. The amount of reduction, as well as the severity of the incentive problem depends on the comparison between incumbent's wealth and industry liquidity.

To see how this changes over states, suppose both the incumbent and industry insiders start with the same liquidity ω_{-1} at date -1, and the incumbent pays B_{-1} upfront to acquire the asset. It follows that $\omega_0^{i,G} - \omega_0^{H,G} = -B_{-1} + (1-\gamma_0)C_0$ which is greater than $\omega_0^{i,B} - \omega_0^{H,B} = -B_{-1} - F < 0$.

Table 1 shows the comparison in all states.

Table 1: Wealth Comparison (incumbent minus industry insiders) in Different States

State	GG	GB
$\omega_1^{i,s_1} - \omega_1^{H,s_1}$	$(\omega_0^{i,G} - \omega_0^{H,G}) + (1-\gamma_1)C_1$	$(\omega_0^{i,G} - \omega_0^{H,G}) - F$
State	**BG**	**BB**
$\omega_1^{i,s_1} - \omega_1^{H,s_1}$	$(\omega_0^{i,B} - \omega_0^{H,B}) + (1-\gamma_1)C_1$	$(\omega_0^{i,B} - \omega_0^{H,B}) - F$
State	**G**	**B**
$\omega_0^{i,s_0} - \omega_0^{H,s_0}$	$\omega_0^{i,G} - \omega_0^{H,G}$	$\omega_0^{i,B} - \omega_0^{H,B}$

Table 1 shows that the difference between incumbent's wealth and an industry insider's wealth is the highest in state GG, followed by G and GB. In boom times, incumbent's wealth increases more than that of insiders, who work as consultants, sub-contractors or employees. Conversely, the difference is the most negative in BB, followed by B and BG. In a bad state, the incumbent does not generate any internal cash flow but incurs a fixed cost. In addition, she has paid up front for buying the firm (a price which may include expected cash flow from the unrealized good state). As a result, she is least likely to hold on to control in an auction in a bad state. Involuntary turnovers occur in those states. Deep and long-term recessions reinforce the effects.

Since $B_0^{H,B}(\overline{\gamma})$ and $B_1^{H,BB}(\overline{\gamma})$ are both low due to low industry liquidity, financing capacity is low. If at intermediate states—GB and BG—the incumbent is able to retain control, turnovers occur if and only if the incumbent loses her ability. However, financing capacity $D_1^{s,PayIC}$ is still low due to moral hazard in setting pledgeability. Proposition 2.2 formalizes the above results. We do not explicitly compare financing capacity across states other than GG, as it involves more restrictions on parameters such as stability, θ^H , and the magnitude of the payoffs $\{C_t\}_{t=0,1,2}$.

Assumption 2.1: $\omega_0^{i,B} + (1-\gamma_1) C_1 > \omega_0^{H,B}$ $\omega_0^{i,B} + (1-\gamma_1) C_1 > \omega_0^{H,B}$ $\omega_0^{i,G} - F > \omega_0^{H,G}$, and $\omega_0^{H,B} + \overline{\gamma} C_2 < C_2$.

The first and the second equation basically guarantee that in state BG and GB, the incumbent has more wealth than industry insiders and thus can retain control. The last one ensures that industry liquidity is so low that there exists rents to acquirers even with high pledgeability $\overline{\gamma}$.

Proposition 2.2: Under Assumption 2.1,

1) Financing capacity is lower in all states other than GG: $\widehat{D}_1^{s,Max} = D_1^{s\ \mathrm{PayIC}}$ in state GB and BB and $\widehat{D}_1^{s,Max} = B_1^{H,BB}(\overline{\gamma}) - \varepsilon$ in state BB.
2) Involuntary management turnover always occur in state BB.

2.4. Discussion

We have outlined two kinds of moral hazard – moral hazard over repayment, and moral hazard over setting pledgeability. The two are connected. When the economy is in a prolonged boom, industry insiders can pay full value for the firm even when pledgeability is set at a minimum level. There is no need to reduce the moral hazard over repayment by increasing pledgeability since creditors can extract full repayment through the threat of asset sales. However, when industry wide liquidity is lower, industry insider bids for the firm are lower than the future cash flows it generates. This underpricing means that their bid can be raised by setting pledgeability higher. Not only does this raise what the incumbent can get if she has to sell the firm, it also increases the financier's ability to extract repayment from her if she does not. Thus when the firm finances in the midst of industry illiquidity, it is important to raise pledgeability to reduce moral hazard over repayment. At the same time, the incumbent also faces the possibility of moral hazard over pledgeability. Interestingly, this moral hazard is quite different than the effects of fixed payments in the standard debt overhang models. Instead, it stems from any pre-committed payment.

The past and the future of the industry thus interact in interesting ways. When the industry experiences past good outcomes, and the future is also expected to be good enough that there is no potential underpricing, financing capacity is the highest. Not only is the firm likely to generate more in the future, but financiers can expect to recover what they lent through the threat of selling the fully priced asset. So they are willing to lend large amounts. For intermediate levels of past industry performance, industry bidders cannot bid full value for the firm's future cash flows out of their accumulated liquidity, so pledgeability of future cash flows becomes important to getting high outside bids and repayment. But because moral hazard over pledgeability kicks in, committed payments cannot be too high so as to not discourage high pledgeability. A fall in industry performance therefore has the double whammy effect on financing of both increasing the underpricing of the firm's asset by other industry bidders (because of their reduced liquidity) and also reducing the maximum possible committed payment as a fraction of that lower value (because of moral hazard over pledgeability).

Finally, there is an additional twist because the incumbent's liquidity generally fluctuates more with industry performance than other industry insiders, because she has paid out her cash up front to take control over the firm. This means that if the industry has a sequence of bad outcomes, the incumbent would be unable to retain control in the face of higher industry bids for the firm. Interestingly, this will reduce moral hazard over pledgeability since the incumbent, with no hope of retaining control, focuses on getting the maximum bid for the firm. The payments that can be committed to lenders will now be a higher fraction of firm resale value, even though intrinsic firm value itself is low. Indeed, this aspect of the model is reminiscent of Jensen's Free Cash Flow Theory (Jensen (1986)), where lower cash with the incumbent reduces moral hazard.

In the model thus far, we have shown that management turnover is higher in persistent downturns, because in addition to voluntary turnovers due to the incumbent losing ability, there are also involuntary turnovers due to the incumbent not being able to outbid other industry insiders for control. We have, however, ignored another form of voluntary turnover – when the incumbent retains ability but wants to retire from the business at some time of their choosing. If incumbents can choose the timing of their leaving the business, they would certainly prefer to sell out when the asset is fully priced than when the asset is priced at a fraction of its fundamental value. This effect of exit through retirement would increase the turnover in times of high liquidity (persistent industry up turns) relative to other times. We would see voluntary mergers in acquisitions increase when asset prices are high (i.e., are not underpriced).

2.5. Date 0 and the Prolonged Recovery

Let us turn now to date 0 and the incentives that determine how γ_1 is set in period 0. There are two crucial differences between the date 1 and date 0 analyses. First, financiers may be able win a bid at date 0 with the purpose of reselling the asset at date 1, while they want to bid at date 1. Second, and perhaps less obviously, the continuation value of the asset from date 0 onwards to the period-0 incumbent may be different from that to an industry insider, whereas it equaled C_2 to both at date 1. Let $\tilde{C}_1^{i,s_0}(\hat{D}_1^G, \hat{D}_1^B)$ and $\tilde{C}_1^{H,s_0}(\hat{D}_1^G, \hat{D}_1^B)$ be the date-0 *expected* continuation value of the asset to the incumbent (continued incumbent) and industry insiders. (new incumbent), where $\widehat{D}_1^G$ and $\widehat{D}_1^B$ are due on date 1 in state s_0G and s_0B respectively. Both continuation values share the same expression: $q^{s_0G}\left(C_1+\widehat{D}_1^G+V_1^{i,G}(\widehat{D}_1^G)\right)+(1-q^{s_0G})\left(\widehat{D}_1^B+V_1^{i,B}(\widehat{D}_1^B)-F\right)$.[7] The incumbent will borrow different $\left(\widehat{D}_1^G,\widehat{D}_1^B\right)$ in general.

Let $B_0^{i,s_0}(\gamma_1)$, $B_0^{H,s_0}(\gamma_1)$, and B_0^{L,s_0} be respectively the incumbent's, the insider's, and the outsider/financier's bid at date 0. As before, $B_0^{i,s_0}(\gamma_1)$ is the minimum of the incumbent's ability to pay and the asset's continuation value to the incumbent:

$$B_0^{i,s_0}(\gamma_1)=\underset{\substack{\widehat{D}_1^G\le\widehat{D}_1^{G,Max}\\ \widehat{D}_1^B\le\widehat{D}_1^{B,Max}}}{Max}\quad Min\left[(1-\gamma_0+\rho)C_0\mathbb{1}_{s_0=G}+q^{s_0G}\left(\gamma_1C_1+\widehat{D}_1^G\right)+(1-q^{s_0G})\widehat{D}_1^B,\tilde{C}_1^{i,s_0}(\widehat{D}_1^G,\widehat{D}_1^B)\right]$$

Similarly, the insider will bid.

$$B_0^{H,s_0}(\gamma_1)=\underset{\substack{\widehat{D}_1^G\le\widehat{D}_1^{G,Max}\\ \widehat{D}_1^B\le\widehat{D}_1^{B,Max}}}{Max}\quad Min\left[\omega_0^{H,s_0}+q^{s_0G}\left(\gamma_1C_1+\widehat{D}_1^G\right)+(1-q^{s_0G})\widehat{D}_1^B,\tilde{C}_1^{H,s_0}(\widehat{D}_1^G,\widehat{D}_1^B)\right].$$

Financiers can bid up to $B_0^{L,s_0}=q^{s_0G}B_1^{H,G}(\overline{\gamma})+(1-q^{s_0G})B_1^{H,B}(\overline{\gamma})-F-\varepsilon$. Note that this value is always strictly less than either $\tilde{C}_1^{i,s_0}(\widehat{D}_1^G,\widehat{D}_1^B)$ or $\tilde{C}_1^{H,s_0}(\widehat{D}_1^G,\widehat{D}_1^B)$. Intuitively, the asset is always valued more in the hands of people who are capable of producing cash flows. Therefore, financiers can only acquire the firm if neither the incumbent nor industry insiders can raise sufficient liquidity. Interestingly, the reason the latter may not be able to raise as much liquidity as the financier is because the latter suffer from moral hazard in setting pledgeability, while the financier does not – he only wants to increase the saleability of the firm at date 2 since he can produce nothing from running it.

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[7] $\left(\widehat{D}_1^G,\widehat{D}_1^B\right)$ are in general different since the incumbent may borrower more or less than industry insiders. The reason is that the incumbent's wealth level (0 or $(1-\gamma_0+\rho)C_0$ if $\widehat{D}_0^{s_0}>0$) is usually different from that of industry insiders (ω_0^{H,s_0}) at date 0. Note that $\widehat{D}_1^{s_1}+V_1^{i,s_1}(\widehat{D}_1^{s_1})$ can potentially take three values , , and : C_2, $\theta^HC_2+\left(1-\theta^H\right)B_1^{H,s_1}\left(\overline{\gamma}\right)-\varepsilon$, and $B_1^{H,s_1}\left(\overline{\gamma}\right)-\varepsilon$, depending on whether the period-1 incumbent can make the payments or outbid industry insiders. The possibility of losing control at date 1 decreases the expected continuation value at date 0, and such decreases are strict whenever underpricing is realized. Suppose industry insiders have higher wealth on date 0 than the incumbent such that they can also retain control in period 2 once they acquired the firm in period 1, whereas the old incumbent has to lose the firm on date 1 if she retains control on date 0. In that case, we will have $\tilde{C}_1^{H,s_0}$ is strictly higher than $\tilde{C}_1^{i,s_0}$.

Let $B_0^{\min,s} = \max\{B_0^{L,s}, B_0^{H,s}(\underline{\gamma})\}$ be the minimum bid the incumbent will face in the date-0 auction, and $B_0^{\max,s} = \max\{B_0^{L,s}, B_0^{H,s}(\overline{\gamma})\}$ be the maximum bid the incumbent will face. We can easily follow the four cases analyzed in Section 2.2 and arrive at Lemma .32.2 below. The payoff functions are omitted for simplicity.

Lemma 2.2

Let $s_0 = s$,

(i) If $B_0^{\max,s} = B_0^{\min,s}$, $\widehat{D}_0^{s,Max} = B_0^{\min,s}$,and $\gamma_1 = \underline{\gamma}$.

(ii) If $B_0^{\max,s} > B_0^{\min,s}$, $B_0^{i,s_0}\left(\overline{\gamma}\right) < B_0^{\max,s}$, and $B_0^{i,s_0}\left(\underline{\gamma}\right) < B_0^{\min,s}$, $\widehat{D}_0^{s,Max} = B_0^{\max,s}$, and $\gamma_1 = \overline{\gamma}$.

(iii) If $B_0^{\max,s} > B_0^{\min,s}$, $B_0^{i,s_0}\left(\overline{\gamma}\right) \geq B_0^{\max,s}$, and $B_0^{i,s_0}\left(\underline{\gamma}\right) \geq B_0^{\min,s}$, $\widehat{D}_0^{s,Max} = D_0^{s,PayIC}$, and $\gamma_1 = \overline{\gamma}$.

(iv) If $B_0^{\max,s} > B_0^{\min,s}$, $B_0^{i,s_0}\left(\overline{\gamma}\right) \geq B_0^{\max,s}$, and $B_0^{i,s_0}\left(\underline{\gamma}\right) < B_0^{\min,s}$, $\widehat{D}_0^{s,Max} = D_0^{s,\text{ControlIC}}$, and $\gamma_1 = \overline{\gamma}$.

Proof: See Appendix for details, including the value function, $D_0^{s\ \text{Pay IC}}$ and $D_0^{s,\text{ControlIC}}$.

The cases in Lemma 3.1 are similar to those in Lemma 2.1, with some small differences. Case (i) includes three subcases: (a) There is no potential underpricing at date 0 so that ; $B_0^{\min,s} = q^{sG}C_1 + C_2$; (b) There may be realized underpricing at date 0, but $B_0^{L,s} \geq B_0^{H,s}(\overline{\gamma}) \geq B_0^{H,s}(\underline{\gamma})$ so that industry insiders are constrained by the amount of liquidity they can raise, and thus, they are outbid by financiers at date 0. (c) There is realized underpricing at date 0 because $B_0^{L,s} < B_0^{H,s}(\underline{\gamma}) = B_0^{\min,s} = B_0^{H,s}(\overline{\gamma}) = B_0^{\max,s} < q^{sG}C_1 + C_2$, but the incumbent cannot raise the insider bid at date 0 by setting γ_1 higher because the insider is already able to pay for all the limited rents she can appropriate with her existing liquidity, and will not raise her date-0 bid. In all three subcases, high pledgeability does not increase the bid that the incumbent faces at date 0, so low pledgeability is chosen.

Case (ii) and (iii) are identical to those in Lemma 2.1. Case (iv) is once again different and relies on the fact that a choice of low pledgeability may turn the firm over to an insider who acquires control at the date 0 auction.

The interesting change at date 0 is that a financier may acquire control without any capacity to produce cash flows over period 1 if $B_0^{L,s} > B_0^{H,s}(\overline{\gamma}) \geq B_0^{H,s}(\underline{\gamma})$. Instead, he makes the firm more pledgeable over the period. The likelihood of this happening is particularly acute when industry liquidity is low (low $\omega_0^{H,s}$) and period-1 moral hazard over pledgeability (choice of γ_2) is high, so industry insiders or the incumbent cannot raise much finance. (low $\widehat{D}_1^G$ and $\widehat{D}_1^B$).

While the shift in assets to the outsider or financier is inefficient in the sense that outsiders cannot produce cash flows with the assets (and total surplus is not maximized), they can restore pledgeability of the firm. Anticipating restored pledgeability, and thus higher eventual access to finance, initial bids (B_{-1}) may be higher. If these higher bids are beneficial, for example to permit a minimum quantum of investment to be raised, then temporary outsider control is constrained efficient. In periods of low liquidity, assets will move into the control of those producing less output, and economic recoveries from such states will be slow.

Outsider control is also reminiscent of leveraged buyout transactions (see, for example, Jensen (1997)), where firms in stable industries (where moral hazard over pledgeability is high) are taken over, and the management team, which is motivated by the prospect of going public soon, focuses on finding free cash flow that has been eaten up either through inefficiency or misappropriated by staff (the proverbial company jet). The management team does not really make fundamental changes to the firm's earning prospects in the time the firm is private, but it significantly enhances the pledgeability of future cash flows, thus enhancing bids for the firm when it goes public. Our model suggests that leveraged buyouts is a means to check moral hazard, as opposed to outright takeovers, which are more likely when liquidity is lower.

Example:

Suppose the parameters are as follows:

q^G=0.8, q^{GG}=0.9, q^{BG}=0.1, F=0, θ^H=0.7, ρ=0.1, $\overline{\gamma}=0.6$, $\underline{\gamma}$=0.3, $C_0=C_1=C_2=1$

$\omega_0^{H,G}$=0.1, $\omega_0^{H,B}$=0, ε=0, $\gamma_0=\overline{\gamma}$.

2.6. Example

In this example, if the incumbent in period 1 were a high type, she loses control on date 1 in state GB, but not any other state. This necessarily implies that in states other than GB, she suffers from moral hazard problems and can raise at most $\widehat{D}_1^{s,PayIC}$, which is significantly less than $B_1^{H,s}(\overline{\gamma})$.

Meanwhile, since $\omega_0^{H,B}$ is also very low, a high-type industry insider does not have much liquidity in state B on date 0. In this case, the highest amount she can raise is $B_0^{H,B}\left(\gamma_1=\overline{\gamma}\right)$=0.46. However, a financier who does not suffer from moral hazard issues in setting pledgeability can raise as much as $B_0^{L,B}$=0.61. Therefore, if the period-0 incumbent has to sell the firm— due to either high payment ($\widehat{D}_0^B > B_0^{i,B}\left(\overline{\gamma}\right)$) or losing capabilities, a financier will acquire the firm. As a result, recovery is prolonged.

A. Incumbent Pledgeability and General Pledgeability

We have assumed future pledgeability is common to both the incumbent and the industry insider. What if the incumbent can costlessly choose a separate level of incumbent pledgeability which applies only to her: $\gamma^i \in \left[\underline{\gamma}^i, \overline{\gamma}^i\right]$ independent of her choice on γ. Incumbent pledgeability could come from monitoring or a lending relationship. Our main results continue to hold: the incumbent will always want to set incumbent pledgeability at its maximum ($\gamma^i = \overline{\gamma}^i$) because it increases the amount she can bid without raising the bids of competing industry insiders. The analysis then reduces to comparing a choice of general pledgeability with the maximum incumbent pledgeability. As before, the choice of pledgeability is relevant only when there is potential underpricing.

When increased general pledgeability allows an incumbent to be outbid, there is one more case added to Lemma 2.1. In this case, reducing pledgeability serves as an entrenchment device for incumbents: the incumbent can retain control with realized underpricing with low pledgeability but not high. Consequently, a new type of IC constraint restricts the financing capacity to an even lower level than $D_1^{s,PayIC}$. Intuitively, financing capacity is even lower because high pledgeability causes the incumbent to lose control and associated rents, and even greater incentives (that is, low required payments) are needed for her to choose it. The Appendix formalizes the analysis and provides the relevant algebra.

B. Ex-ante Pledgeability Choice with State-Contingent Contracts

Thus far, the incumbent set pledgeability after the state in period 1 was already realized (*ex-post* choice). This reflects short term attributes of pledgeability which can be changed rather quickly (such as a more reputable accountant). Now let us briefly see what happens when the incumbent chooses pledgeability based on the probability distribution of the states, before the state for the period is known. This situation represents more durable pledgeability choices such as the specificity of the production technique or the internal organization of a firm, and implies rigidity of pledgeability across future states. The point of this section is to show that with state-contingent contracts, there is little difference between the two levels of pledgeability.

Figure 4 below shows the timing. The incumbent makes decision based on the probabilities of each state. If the cost, ε, is sufficiently small, there is no effect on real outcomes. High pledgeability is chosen *ex-ante* if the incumbent had the incentive to choose high pledgeability *ex-post* in at least one of the two subsequent states.

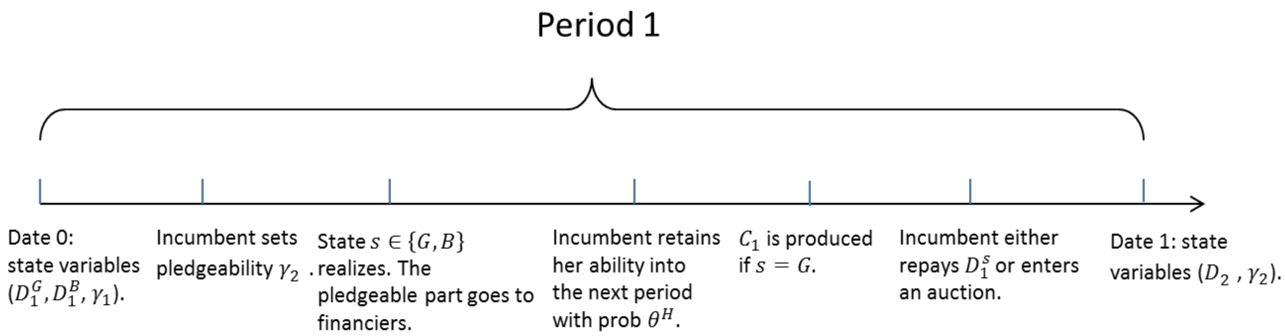


Figure 3: Timing and Decisions with *ex-ante* Pledgeability Choice

Next, we analyze what happens when ε is significantly positive .   If the incumbent had the incentive to choose high pledgeability in both the subsequent states when she was making the choice *ex post* the knowledge of the state, then she would choose high pledgeability *ex ante*. The state-continent payments would be identical (because the payments set when choice is *ex-post* give an incentive to choose high pledgeability in both states). However, if liquidity is so high in one of the states (say s_0G) that there is no potential underpricing (or potential underpricing of less than ε), and hence there was no incentive to increase pledgeability anticipating the outcome in that state, then there must be a lower state-contingent payment in the other state (say s_0B) so that the incumbent has sufficient rents to cover the cost of choosing high pledgeability before the state is known[8]. This means the incumbent's ability to raise funding will (weakly) fall relative to when pledgeability is chosen *ex post* if the cost ε is significant. If the probability of the fully liquid state and the cost ε are both sufficiently high, the incumbent may even choose low pledgeability *ex ante*. First, it may not be worthwhile to lower the promised payment enough in the unlikely other state to give her the incentive to incur cost ε. Second, the benefit to the incumbent of choosing high relative to low pledgeability has an upper limit, which may fall below ε when ε is large. This is very similar to traditional debt overhang.

---

[8] The maximal payment in state s_0B is $\widehat{D}_1^{s_0B,Max} - \dfrac{q^{s_0G}}{1-q^{s_0G}}\varepsilon$ for small ε .

In sum, in the baseline case of our model where ε is small and contracts are state contingent, the timing of pledgeability choice is not very important, so both quickly changeable aspects and durable aspects of pledgeability can be similarly incentivized.

III. Debt Contracts

Our analysis of state-contingent contracts serves as a building block to understand the effects of industry liquidity and promised payments on pledgeability choices. However, financial contracts used by most borrowers less than fully state-contingent and are much closer to simple debt contracts, which specify a constant promised payment on a given date in all states s such that $D_t^s = D_t$. In this section, we study such debt contracts and focus on how they can limit pledgeability. We will assume that pledgeability in a period is chosen *before* the state in that period is realized and persists over the next period – we therefore focus on durable aspects of pledgeability consistent with the financial cycle. For simplicity, we do not add explicit frictions to make debt the optimal contract, such as costs of verifying the state.

With state-contingent contracts, no one has an interest to overpromise, thus inducing low pledgeability and increasing potential underpricing. With debt contracts, however, if the incumbent must raise a large amount initially at date -1 (to fund the investment or to outbid others to become the new incumbent), it is possible that a larger amount can be raised by making a high promised payment, even if it leads to excessively low pledgeability in some states.

Section 3.1 formalizes the analysis of period with debt contracts and pledgeability set *ex ante*. With state-contingent contracts, we have shown that both past and current states affect the equilibrium outcomes. With debt contracts, we will show that expectations about future states, and thus the spillover between future states, also affect pledgeability choices, and thus asset allocation and financing capacities. In Section 3.2, we consider period 0. Similar to the case with state-contingent contracts, at date 0 the asset can be sold to a financier who has no production capabilities. With state-contingent contracts, the asset is sold inefficiently only when industry liquidity is at its very lowest levels. With debt contracts, however, such inefficiency occurs even at moderate levels of industry liquidity because the low prior pledgeability chosen in the face of debt will make it hard for industry insiders to raise finance. This will suggest why recoveries from debt-fueled, asset-price-based expansions are slow.

3.1 Debt Contracts with Ex-ante Pledgeability Choice

The timing of events in the period is identical to Figure 4, with the exception that the promised payment is a constant, $D_1^G = D_1^B$. Because there is a single state in period 2, the promised payment when contracts are restricted to simple debt contracts will be identical to that for state-contingent contracts. Next, we turn to period 1. We define $\Delta^{s_0 s_1}\left(\widehat{D}_1\right)$ as the difference in state $s_0 s_1$ between the borrower's payoff from choosing high pledgeability and low pledgeability, given residual required payment $\widehat{D}_1$. Let $V_1^{i,s_0 s_1}\left(\widehat{D}_1, \gamma_2 = \overline{\gamma}\right)$ and $V_1^{i,s_0 s_1}\left(\widehat{D}_1, \gamma_2 = \underline{\gamma}\right)$ respectively be the incumbent's payoff when she chooses high and low pledgeability. $\Delta^{s_0 s_1}\left(\widehat{D}_1\right) = V_1^{i,s_0 s_1}\left(\widehat{D}_1, \gamma_2 = \overline{\gamma}\right) - V_1^{i,s_0 s_1}\left(\widehat{D}_1, \gamma_2 = \underline{\gamma}\right)$. In the baseline model when pledgeability is chosen ex-post with state-contingent contracts, the maximal promised payment $\widehat{D}_1^{s_0 s_1, Max}$ satisfies $\Delta^{s_0 s_1}\left(\widehat{D}_1^{s_0 s_1, Max}\right) = 0$ if there is potential underpricing.With a constant payment, and *ex-ante* choice, the expected difference in payoff must be non-negative to provide incentives for high pledgeability.

Lemma 3.1 describes $\Delta^{s_0 s_1}\left(\widehat{D}_1\right)$ for any level of $\widehat{D}_1$.

Lemma 3.1

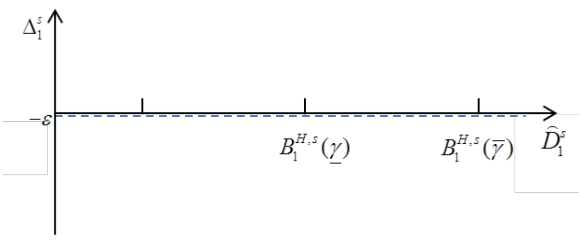
(i) If $B_1^{H,s}(\underline{\gamma}) = C_2$, $\Delta^{s_0 s_1}\left(\widehat{D}_1\right) \equiv -\varepsilon$.

(ii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) < B_1^{H,s}(\underline{\gamma})$

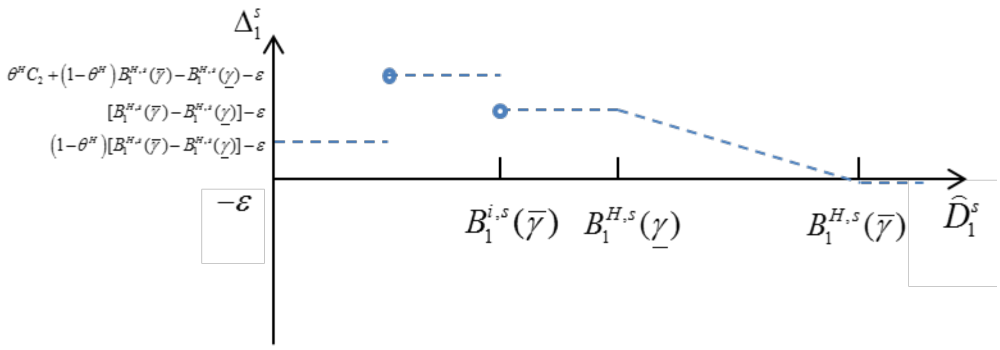
$$\Delta^{s_0 s_1}\left(\widehat{D}_1\right)\begin{cases} = \min\left\{-\varepsilon, B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1 - \varepsilon\right\} & \text{if } \widehat{D}_1 \geq B_1^{H,s}(\overline{\gamma}) - \varepsilon \\ > 0 & \text{if } \widehat{D}_1 < B_1^{H,s}(\overline{\gamma}) - \varepsilon. \end{cases}$$

(iii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) \geq B_1^{H,s}(\underline{\gamma})$,

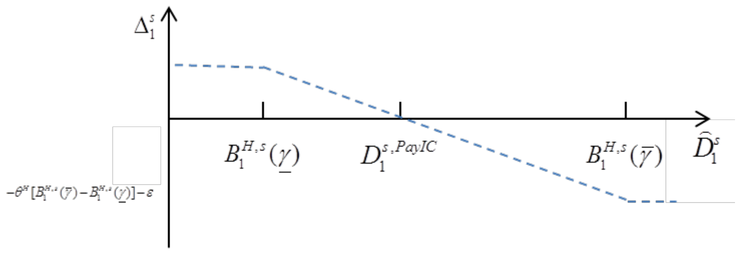
$$\Delta^{s_0 s_1}\left(\widehat{D}_1\right)\begin{cases} \leq 0 & \text{if } \widehat{D}_1 \geq D_1^{PayIC} \\ > 0 & \text{if } \widehat{D}_1 < D_1^{PayIC}. \end{cases}$$



(i)



(ii)



(iii)

Figure 4: $\Delta^{s_0 s_1}\left(\widehat{D}_1\right)$ **in Different Cases**

The detailed expressions for Lemma 3.1 are available in the Appendix. Figure 5 characterizes the function $\Delta^{s_0 s_1}\left(\widehat{D}_1\right)$ in different cases. If there is no potential underpricing in state $S_0 S_1$, $\Delta^{s_0 s_1}\left(\widehat{D}_1\right) \equiv -\varepsilon$ for all values of $\widehat{D}_1$ because high pledgeability does not change enforceable payments but results in cost ε. If there is potential underpricing, however, and the incumbent can outbid outsiders (case (iii)), $\Delta^{s_0 s_1}\left(\widehat{D}_1\right) = 0$ for $\widehat{D}_1 = \widehat{D}_1^{s_0 s_1, Max}$, negative for higher values of $\widehat{D}_1$ and strictly positive for all lower values of $\widehat{D}_1$. Higher committed payments depresses the incentive to increase pledgeability, since the incumbent retains control whenever she retains her ability. Finally, if there is potential underpricing and the incumbent has no hope of retaining control at even moderate levels of debt (Case (ii)), $\Delta^{s_0 s_1}\left(\widehat{D}_1\right) \geq -\varepsilon$: the incumbent sees only the upside of increasing pledgeability since the asset invariably will be sold. Even for very high promised values of $\widehat{D}_1$, above the most the asset could be sold for, the only disadvantage of choosing high pledgeability is its cost, ε.

With one single face value $D_1 = D_1^G = D_1^B$ and *ex-ante* pledgeability choice, there is a single incentive constraint across states. In particular, there exists a unique $D_1^{s_0, IC}$ satisfies

$q^{s_0G}[\Delta^{s_0G}(D_1^{s_0,IC}-\gamma_1 C_1)]+(1-q^{s_0G})[\Delta^{s_0B}(D_1^{s_0,IC})]=0$ such that high pledgeability is chosen if and only if the face value of debt $D_1 < D_1^{s_0,IC}$.[9] In general, $D_1^{s_0,IC}$ lies in the range $\widehat{D}_1^{s_0B,Max}$ and $\widehat{D}_1^{s_0G,Max}+\gamma_1 C_1$.

Two special cases deserve further attention, as summarized by Lemma 3.2.

Lemma 3.2

(i) If there is no potential underpricing in state G, $D_1^{s_0,IC} \to \widehat{D}_1^{s_0B,Max}$ (the lowest possible value) as $\varepsilon \to 0$.

(ii) If the incumbent has no hope of retaining control in state B, $D_1^{s_0,IC} \to \gamma_1 C_1 + \widehat{D}_1^{s_0G,Max}$ (the highest possible value) as $\varepsilon \to 0$.

Intuitively, in Lemma 3.2 (i), there is no incentive to increase pledgeability coming from state G, so the incentives have to be set via state B. In Lemma 3.2 (ii), there is no incentive to increase pledgeability coming from state B if debt is set high enough that the incumbent enjoys no residual value after the auction of assets, so incentives have to be set in state G by setting debt appropriately.

Unlike with state-contingent contracts, the level of debt, $D_1^{s_0,IC}$, which provides incentives for high pledgeability keeping in mind both future states, may not be the face value that enables the incumbent to credibly commit to repay the most. Another candidate is $B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1$ if $B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1 > D_1^{s_0,IC}$.[10] In this case, setting promised payment at $B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1$ leads the incumbent to choose low pledgeability, and pay $B_1^{H,B}\left(\underline{\gamma}\right)$ in state B and $B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1$ in state G. This can provide a larger expected payment if

$$q^{s_0G}\left[B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1 - D_1^{s_0,IC}\right]+(1-q^{s_0G})\left[B_1^{H,B}(\underline{\gamma})-\min\left\{B_1^{H,B}(\overline{\gamma}), D_1^{s_0,IC}\right\}\right]>0. \quad (2)$$

Lemma 3.3 indicates $D_1^{s_0,Max}$, the level of promised date-1 debt that can raise the most, corresponding to the cases in Lemma 3.2.

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[9] In general, the solution is not unique, as $\Delta\left(\widehat{D}_1^{s}\right)$ could be non-monotonic, suggested by Case (ii) of Lemma 3.1. In our application, it is unique though, for two reasons. 1) $\varepsilon \to 0$. 2) If Case (ii) happens in state sG, it happens in sB for sure. Then $D_1^{s_0,IC}$ is unique and equals $B_1^{sG}\left(\overline{\gamma}\right)-\varepsilon$. If Case (ii) only happens in sB but not in sG, $D_1^{s_0,IC}$ is unique as well, as analyzed in Case (ii) of Lemma 3.2.

[10] Any $D_1^{s_0} > B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1$ cannot be credibly repaid.

Lemma 3.3

When $\varepsilon = 0$,

(i) If $B_1^{H,s_0B}(\underline{\gamma}) \le B_1^{i,s_0B}(\underline{\gamma}) < C_2$ and $B_1^{H,s_0G}(\underline{\gamma}) = C_2$, then $D_1^{s_0,IC} = D_1^{s_0B,PayIC}$.

a) If $q^{s_0G}\left(C_2 + \gamma_1 C_1 - D_1^{s_0B,PayIC}\right) + (1 - q^{s_0G})\left(B_1^{H,B}(\underline{\gamma}) - D_1^{s_0B,PayIC}\right) > 0$, then

$D_1^{s_0,Max} = \gamma_1 C_1 + C_2$. For any promised payment $D_1^{s_0B,PayIC} < D_1^{s_0} \le D_1^{s_0,Max}$, $\gamma_2 = \underline{\gamma}$.

For any promised payment $D_1^{s_0} \le D_1^{s_0B,PayIC}$, $\gamma_2 = \overline{\gamma}$.

b) If $q^{s_0G}\left(C_2 + \gamma_1 C_1 - D_1^{s_0B,PayIC}\right) + (1 - q^{s_0G})\left(B_1^{H,B}(\underline{\gamma}) - D_1^{s_0B,PayIC}\right) \le 0$, then

$D_1^{s_0,Max} = D_1^{s_0,IC} = D_1^{s_0B,PayIC}$. For any promised payment $D_1^{s_0} \le D_1^{s_0,Max}$, $\gamma_2 = \overline{\gamma}$.

(ii) If $B_1^{H,s_0G}(\underline{\gamma}) < C_2$, $B_1^{i,s_0G}(\underline{\gamma}) > B_1^{H,s_0G}(\underline{\gamma})$, and $B_1^{i,s_0B}(\underline{\gamma}) < B_1^{H,s_0B}(\underline{\gamma})$, then

$D_1^{s_0,Max} = D_1^{s_0,IC} = \gamma_1 C_1 + D_1^{s_0G,PayIC}$. For any promised payment $D_1^{s} < D_1^{s_0,Max}$, $\gamma_2 = \overline{\gamma}$.

For example, in Lemma 3.2 (i) a,), when there is no potential underpricing in state G, there is no positive incentive to choose high pledgeability coming from the G state. $D_1^{s_0,IC}$ may therefore have to be set very low to incentivize high pledgeability (weakly below the payment which would provide incentives for high pledgeability if state B was known to occur for certain). Instead, the incumbent may be able to pay out more by setting debt high, committing to pay out everything possible in the G state where pledgeability does not matter, and defaulting with low payout in state B.

The broader point is that there may be underinvestment in pledgeability in period 1, especially if high liquidity is anticipated in one of the period-1 states. The ability to commit to high debt payments in that high liquidity state without enhancing pledgeability dampens the incumbent's incentive to take on less debt so as to commit to higher pledgeability. High liquidity thus crowds in debt and crowds out pledgeability, setting the stage for more severe asset misallocation than in the case with contingent contracts.

Interestingly, debt will not be renegotiated, before or after the state is realized, even if allowed – not before because the level of debt is set to raise the maximum possible even if it results in low pledgeability, and not after because relevant parties will not write down their claims. Also, both fixed promised debt payments across states, and the act of choosing pledgeability before the state is known, have the effect of causing a spillover of effects between anticipated states. Therefore, outcomes are somewhat similar even when pledgeability is chosen after the future state is fully known, but in that case one needs to explain why the level of debt payments cannot be renegotiated once the state is known.[11]

Before we fold back to date 0, it is useful to ask what happens in one more interesting case — if incumbent liquidity is at intermediate rather than low levels ($\omega_0^{i,B} - F \geq \omega_0^{H,B}$), so that $B_1^{i,BB}(\underline{\gamma}) \geq B_1^{H,BB}(\underline{\gamma})$. Case (ii) in Lemma 3.3 is revised since the incumbent may still retain control in state BB. In that case, the incumbent will select a debt contract which leads to high pledgeability for both large and small q^{BG}, where the incumbent behaves as if she faces only a single state, with the associated state-contingent maximal payment. Therefore, $D_1^{B,IC} \rightarrow \widehat{D}_1^{BG,Max} + \gamma_1 C_1$ when $q^{BG} \rightarrow 1$, and $D_1^{B,IC} \rightarrow \widehat{D}_1^{BB,Max}$ when $q^{BG} \rightarrow 0$. In both cases, obeying the incentive constraint leads to higher ability to raise funding *ex-ante*. It is only at the intermediate level of that the incumbent might be able to commit to pay more by violating the incentive constraint. In this case, if $D_1^{B,IC}$ is significantly lower than $B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$, the incumbent can pledge more in BG by setting debt at $B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$.[12]

3.2 Date 0 Choices and Prolonged Recoveries

Let us now analyze period 0 with debt contracts. With minor notational complications, the pledgeability decision in period 0 is similar to that we have just examined for period 1. There is, however, one additional development relative to the case of state-contingent contracts. In the state-contingent case, the asset is sold to the outsider financers only if liquidity was so low (and future moral hazard so high) that industry insiders could not outbid financiers. In the previous sub-section, however, we saw that debt contracts could induce low pledgeability because of cross-state spillovers. In other words, high liquidity in one anticipated period-0 state G could induce low pledgeability set for all period-0 states, which could result in the financiers outbidding industry insiders at date 0 in state B simply because the latter had little ability to pledge. Such an outcome, that is misallocation, could occur even at moderate levels of liquidity in state B. This spillover in outcomes between anticipated states is a special property of debt. We explain all this in more detail.

[11] When the state is known and the lender gets all surplus from renegotiation, debt becomes equivalent to fully state-contingent contracts, in part because all are risk neutral. In the Appendix, we analyze non-renegotiable debt when pledgeability choice is made after the state is realized. There, we isolate the spillover just from the fixed promised payment.

[12] The results above extend to more than two states. Suppose we have a set of states, good, intermediate, and bad. There is no potential underpricing in good states, and the incumbent has no hope of retaining control in bad states. In the intermediate states, the incumbent's incentive constraints always bind. In this case also, low pledgeability is chosen if the probability of the economy entering any good state is sufficiently high, whereas high pledgeability is set if the probability of the economy entering any bad state is significant.

With a bit of abuse of notation, let $C_1^{i,s_0}(D_1)$ and $C_1^{H,s_0}(D_1)$ be the date-0 *expected* continuation value of the asset to the incumbent and industry insiders if the face value of debt is D_1. Unlike with state-contingent contracts, default is now possible on committed payments. So let $D_1^{s_0G}\left(D_1^{s_0}\right)$ and $D_1^{s_0B}\left(D_1^{s_0}\right)$ be the amount that financier recovers in two states given the face value $D_1^{s_0}$.

$$C_1^{i,s_0}(D_1)=q^{s_0G}\left(C_1+D_1^{s_0G}\left(D_1\right)+V_1^{i,G}(D_1)\right)+(1-q^{s_0G})\left(D_1^{s_0B}\left(D_1\right)+V_1^{i,B}(D_1)-F\right)$$

$$C_1^{H,s_0}(D_1)=q^{s_0G}\left(C_1+D_1^{s_0G}\left(D_1\right)+V_1^{i,G}(D_1)\right)+(1-q^{s_0G})\left(D_1^{s_0B}\left(D_1\right)+V_1^{i,B}(D_1)-F\right),$$

$B_0^{i,s_0}(\gamma_1)$, B_0^{L,s_0}, and $B_0^{H,s_0}(\gamma_1)$ are then:

$$B_0^{i,s_0}(\gamma_1)=\underset{D_1\le D_1^{s_0,Max}}{Max}\quad Min\left[\omega_0^{i,s_0}+q^{s_0G}D_1^{s_0G}\left(D_1\right)+(1-q^{s_0G})D_1^{s_0B}\left(D_1\right),C_1^{i,s_0}(D_1)\right]$$

$$B_1^{L,s_1}=q^{s_0G}\left[B_1^{H,s_0G}(\overline{\gamma})-\varepsilon\right]+(1-q^{s_0G})\left[B_1^{H,s_0B}(\overline{\gamma})-\varepsilon-F\right]$$

$$B_0^{H,s_0}(\gamma_1)=\underset{D_1\le D_1^{s_0,Max}}{Max}\quad Min\left[\omega_0^{i,s_0}+q^{s_0G}D_1^{s_0G}\left(D_1\right)+(1-q^{s_0G})D_1^{s_0B}\left(D_1\right),C_1^{H,s_0}(D_1)\right].$$

Consistent with date 1, we are able to define D_0^{IC} such that $q^G\Delta^G\left(D_0^{IC}-\gamma_0C_0\right)+\left(1-q^G\right)\Delta^B\left(D_0^{IC}\right)=0$. Lemma 3.5 is analogous to Lemma 3.2.

Lemma 3.4

i) If $B_0^{\max,s}=B_0^{\min,s}$ so that there is no potential underpricing in state G, $D_0^{IC}\to\widehat{D}_0^{B,Max}$ as $\varepsilon\to0$.

ii) If the incumbent has no hope of retaining control in state B, $D_0^{IC}\to\gamma_0C_0+\widehat{D}_0^{G,Max}$ as $\varepsilon\to0$.

We now highlight one interesting case which only occurs in the dynamic context when contracts are restricted to be debt.

Lemma 3.5

If $B_0^{H,B}(\overline{\gamma})>B_0^{L,B}>B_0^{H,B}(\underline{\gamma})$ and

$q^G\left[B_0^{H,G}(\underline{\gamma})+\gamma_0C_0-D_0^{IC}\right]+(1-q^G)\left[B_0^{H,B}(\underline{\gamma})-\min\left\{B_0^{H,B}(\overline{\gamma}),D_0^{IC}\right\}\right]>0$, then

$D_0^{Max} = B_0^{H,G}(\underline{\gamma}) + \gamma_0 C_0 > D_0^{IC} = \widehat{D}_0^{B,Max}$. For any promised payment $D_0^{IC} < D_0 \le D_0^{Max}$,

$\gamma_1 = \underline{\gamma}$.

For sufficiently high probability of state G in period 0, and sufficiently high liquidity in state G, the incumbent will set date-0 debt high enough that she chooses low pledgeability in period 0. If the realized state is G, she repays everything. If the state turns out to be B, she is forced to sell the asset and the preset low pledgeability, γ_1, restricts the amount at which she can sell, which equals $B_0^{L,B}$ — a sale to financiers. Note that if she had set pledgeability higher, she would have sold to an industry insider. The additional misallocation in an industry bust stems wholly from the anticipated high liquidity in the boom, which causes the incumbent to both promise high debt payments for date 0, and induces her to choose low pledgeability in period 0. When the expected boom (high q^G) instead turns out to be a bust, we have a prolonged recovery due to misallocation.

Note that the incumbent's decision is completely rational: she knows the probability of a bust but because the debt level has to be kept very low to induce pledgeability, she rationally ignores the consequences, even if the probability of the state is not low. By contrast, if pledgeability is selected after the state is realized, renegotiation would eliminate this type of misallocation since *ex-post*, it is in the joint interests of the incumbent and financiers to reduce debt face value and restore incentives for high pledgeability.

We have assumed in this sub-section that because of high liquidity, there is no underpricing in state G, which tends to result in lower pledgeability than is optimal (compared to that chosen in the state-contingent contract setting when the choice is made before the state is known). Note that there is not a symmetric case where the spillover between states could result in higher pledgeability than optimal with state-contingent contracts. If there is significant underpricing in state G and the increase in bid times the probability of state G exceeds the cost ε, there would be high pledgeability with state-contingent contracts, even if in state B there is no value to high pledgeability because the asset is sold to industry outsiders simply because insiders have no ability to match their bid, regardless of the level of pledgeability ω_0^{i,s_0}. With debt and *ex-ante* choice, the incumbent will choose a level of debt such that she still prefers high pledgeability even though she expects to sell the asset to an outsider when the industry enters extreme distress because pledgeability is useful during less extreme distress. The broader point is that pledgeability is typically likely to be low in the presence of debt when anticipated liquidity is high rather than when it is low and this is a distortion only when liquidity is likely to be high.

IV. Discussion and Empirical Relevance

In a boom which is likely to continue, liquidity is high and supports high debt. When borrowers finance with such high debt, however, they will choose low pledgeability, which nevertheless will be acceptable to lenders who anticipate a high probability of continued high liquidity. Liquidity, asset prices, and leverage follow each other up, while pledgeability falls. If the boom does not continue, and liquidity falls, access to finance will drop significantly. Outsiders are also more likely to take over the firm at such times.

In contrast, when lower liquidity is anticipated (normal or bad times), low pledgeability significantly reduces the amount recovered by financiers, implying that market forces lead borrowers to debt contracts which provide incentives for high pledgeability. The market prevents excessive leverage in times of lower liquidity but may force high leverage (which removes the incentives for increased pledgeability) when liquidity is high and likely to remain high.

In terms of observables, if we use loan contracts with many covenants as a proxy for high pledgeability, in bad to normal times we should see many covenants and relatively low levels of leverage when fresh capital structures are chosen (such as when the firm comes out of bankruptcy). In contrast, during booms we will see higher leverage and few or no loan covenants ("covenant lite"). Boom periods with covenant lite loans and high leverage could also be interpreted as an increase in the fraction of market finance (bonds or covenant lite loans) as opposed to intermediated finance (relationship loans). Other channels through which low pledgeability could be observed include lower than minimum quality of accounting, weak boards, and production techniques which are more idiosyncratic and thus entrench management as in Shleifer and Vishny (1989).

It may be useful here to see the differences between our model and the seminal work by Shleifer and Vishny (1992) (henceforth SV). They focus only on liquidity varying over time. SV therefore emphasize control rights exclusively through asset sales while we introduce control rights over cash flow through the pledgeability channel, which itself suffers from moral hazard. Our model therefore has different implications than Shleifer and Vishny (1992). As in SV, assets migrate in our model to agents who have lower ability to manage. However, the underlying rationale is different. In SV, assets get inefficiently allocated because highly ability managers have less liquidity than outsiders. Debt, which was created to resolve a free cash problem, has the standard debt overhang effect which limits the amount of liquidity obtainable by industry insiders. Therefore, if financial contracts were state-contingent (or if debt could be renegotiated), the asset would never be sold to outsiders. In our model, the asset goes to low types precisely because they do not suffer from the moral hazard over pledgeability and not because they have more liquidity. Indeed, financiers are unwilling to renegotiate debt down because they know the asset will be sold to outsiders who can pay more by making the asset more pledgeable even when burdened with high debt. We will point out another important difference shortly.

Our paper shares similar insights with a sequence of papers by Geanakoplos (for instance, Geanakoplos 2010) on leverage cycles—which are analogous to our financing cycles. Like us, Geanakoplos also endogenized the borrowing constraint, though by a different approach. In particular, he sets up a general equilibrium model in which agents have heterogeneous beliefs. Therefore, optimists—those who assign a high probability on good states—naturally take on leverage and borrow from pessimists. Since all borrowing is collateralized, the borrowing constraint is endogenously determined by the beliefs of heterogeneous agents. The specific mechanisms are different though. In our setup, pledgeability is essentially a choice by asset holders (incumbent), whereas in his model, pledgeability is always fixed at one. The beliefs of pessimists determine their willingness to lend, for a given amount of collateral. This, together with the beliefs of optimists which determine their willingness to borrow, pins down the loan-to-value ratio in equilibrium. After a bad shock, or just increased anticipation of one, optimists lose wealth as well as their ability to borrow on leverage. Consequently, the asset migrates to more pessimistic hands and is valued less. Excessive leverage taken in booms, if followed by bad news, leads to excessive deleveraging in bad times, even before/without an actual crash in fundamentals. This constitutes the leverage cycle. The asset price is very high in the initial or overleveraged normal economy, and after deleveraging, the price is even lower than it would have been at those tough margin levels had there never been the overleveraging in the first place.

A crucial difference between the two papers is that, in his model, the asset price is set by a small group of agents. Thus, a loss to their wealth has a huge impact (Shleifer and Vishny, 1997). In our model, they are set by all insiders. A loss to the wealth of some industry insiders only, has an insignificant effect on asset prices. Crashes only occur after system-wide liquidity shortages following periods of high liquidity. Therefore, asset prices crash less often in our model.

Our paper also bears some resemblance to papers where a small probability of a regime change is irrationally (Gennaioli, Shleifer, and Vishny (2010)) or rationally neglected (Dang, Gorton, and Holmstrom (2009)). Our point is that the overhang of debt on pledgeability cannot be reversed immediately in bad times, unlike expectations of outcomes or information acquisition. Therefore, not only is there a collapse in access to finance, but also a restoration of access takes time.

V. Conclusion

We have focused on two kinds of moral hazard in this paper – moral hazard over appropriation of cash flows and moral hazard over pledgeability choice. In good times the threat of ownership change is the means of enforcing debt contracts, and plentiful liquidity makes the threat credible. The seeds of distress are sown at such times, because incumbents have no incentive to maintain cash flow pledgeability – this alternative source of commitment seems unnecessary when times largely promise to be good. Also, institutions supporting pledgeability, such as forensic accountants, regulations, and regulators, may atrophy from disuse at such times. Moral hazard increases as bad times hit because incumbents have the incentive to enhance their own value by reducing the value of outside financial claimants.[13] Hence financial capacity falls when good times are expected to continue but then end up in bad times, until outsiders take control. Cash flow pledgeability now becomes key to debt capacity, and industry outsiders have the incentive to increase it even in the face of high debt – it is precisely their ineffectiveness in managing the asset that makes them immune from moral hazard over pledgeability. As cash flow pledgeability increases and industry cash flows recover somewhat, industry insiders can once again bid large amounts and return to controlling firms. As liquidity among industry insiders increases further, the threat of asset sales once again becomes the source of debt enforcement. The incentive to maintain cash flow pledgeability wanes once again, and the cycle resumes.

Importantly, the change in effective creditor control rights, from cash-flow-based to asset-sale-based, occurs smoothly when economic conditions continue to improve. Incumbents simply neglect to maintain pledgeability since it is not needed to raise financing. However, when boom turns to bust, past neglect of pledgeability and the distortion to incentives caused by debt overhang ensure the transition from asset-sale-based to cash-flow-based enforcement is not smooth. Economic activity can be disrupted until outside capacity to control (and thus finance) is restored. Real investment, which we do not model, could fall significantly under these circumstances, even when it is positive net present value.

Another way of thinking about these financing cycles is that the pre-peak stage of the industry, where debt capacity relies on the creditors ability to threaten asset sales, may be associated with arm's length debt. The post-crash stage, where debt capacity relies on cash flow pledgeability (and probably close monitoring), may be more associated with bank or intermediated credit. So our model suggests a pattern of change in the source of credit over time. It also suggests why assets that require management (such as mortgages or bank loans, or the securitized claims on such assets) may have different collateral haircuts associated with them over the cycle, unlike passively held assets such as equities. The haircuts fall in proportion to both the liquidity of industry insiders (on the upturn) and the restoration of pledgeability (in the downturn), with a possible steep increase as the state of the economy switches from upturn to downturn.

[13] While we do not model investment, the point we make would become stronger still if we did. A greater share of the pie is more attractive when increasing the pie through new investment is difficult, so moral hazard over pledgeability increases still further in a downturn, over and above the effects of leverage.

Finally, the fluctuation in debt capacity may be larger if the range of possible pledgeability values is larger. To the extent that financial infrastructure such as accounting standards or collateral registries as well as contractual right enforcement are strong through the cycle, they may prevent large fluctuations in asset pledgeability. By allowing only moderate room to alter pledgeability, a strong institutional environment could lead to more stable credit. However, to the extent that the institutional environment is weak or responds to the cycle (forensic accountants retrain as loan brokers during the boom), asset pledgeability is more endogenous, and credit may vary more over the cycle. Credit booms and busts will be more pronounced in such cases, as are asset price booms and busts.

Our model does not allow for entrenchment, but could be extended to explore its effects. Essentially, if the incumbent loses some but not all capacity to produce when she loses ability, moral hazard over pledgeability increases, and she can borrow even less than earlier, if incentives to maintain pledgeability have to be maintained. Greater incumbent efficiency (when incumbents have partially lost ability and are less efficient then outsiders) impairs access to financing, because it reduces her incentive to sell and therefore make firm rents appropriable by others.

The model can, with some tweaking, be applied to areas where assets are not actively managed. For instance, an analogous argument to the one above can be made for real estate cycles. In the boom, the reliance on home repossession and resale as the basis for lending (and refinance) implies the lender reduces emphasis on undertaking due diligence on buyers, their income prospects, and their repayment capacity. New potential buyers are liquid because of home equity. In a downturn, repayment capacity becomes important, and the past lack of due diligence comes to haunt lenders. At such times, high debt overhang leads owners to neglect maintenance as there is little chance they will have any equity left in a sale. It may even make sense for a lender to repossess and leave the house vacant (or use the time to fix up the house) so as to get a better price when the recovery starts. The recovery starts as lenders restructure their lending procedures to focus on buyer income and repayment prospects until, as house prices boom, the threat of repossession becomes once again the basis of repayment.

Finally, this paper has focused on the choice of pledgeability, assuming that both incumbent and industry insider pledgeability increase equally. Incumbent pledgeability could be thought of as exclusive relationship lending, which may have varying importance over the cycle. Moreover, we can delve deeper into the sources of pledgeability and its dynamics. Institutions that were designed to raise pledgeability also change over the financing cycle. When there is an prolonged aggregate boom (with a good probability of continuing), there will be little demand for increased pledgeability and the institutions and professions which supply this decrease and those with such specific skills will depart these professions. If we were to introduce more heterogeneity of borrowers, this would make it more difficult to increase pledgeability when other firms do not value such an increase. We plan to explore more of these implications in future work.

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Appendix

Proof of Lemma 2.1:

(i) If $B_1^{H,s}(\underline{\gamma}) = C_2$, then industry insider's bids are robust to the pledgeability choice: $B_1^{H,s}(\overline{\gamma}) = B_1^{H,s}(\underline{\gamma}) = C_2$. For any level of $\widehat{D}_1^s$, the incumbent's payoff from choosing high pledgeability is $\max\left\{C_2 - \widehat{D}_1^s, 0\right\} - \varepsilon$ while the payoff from choosing low pledgeability is $\max\left\{C_2 - \widehat{D}_1^s, 0\right\}$. Hence, $\gamma_2 = \underline{\gamma}$. Note here the amount C_2 could from either asset resale ($B_1^{H,s}(\gamma_2)$) or production in period 2. For any level of $\widehat{D}_1^s > C_2$, the incumbent always defaults and the maximal amount collected by financiers is C_2. Hence, $\widehat{D}_1^{s,Max} = C_2$ and $V_1^{i,s}(\widehat{D}_1^s) = C_2 - \widehat{D}_1^s$.

(ii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) < B_1^{H,s}(\underline{\gamma})$, we consider two subcases: $B_1^{i,s}(\overline{\gamma}) = C_2$ and $B_1^{i,s}(\overline{\gamma}) < C_2$.

a. If $B_1^{i,s}(\overline{\gamma}) = C_2$, then $B_1^{H,s}(\overline{\gamma}) = C_2$ since $B_1^{i,s}(\underline{\gamma}) < B_1^{H,s}(\underline{\gamma})$. For any level of $\widehat{D}_1^s$, the incumbent's payoff from choosing high pledgeability is $\max\left\{C_2 - \widehat{D}_1^s, 0\right\} - \varepsilon$ while the payoff from choosing low pledgeability is $\left(B_1^{H,s}(\underline{\gamma}) - \min\left\{B_1^{H,s}(\underline{\gamma}), \widehat{D}_1^s\right\}\right)$ if $\widehat{D}_1^s > B_1^{i,s}(\overline{\gamma})$ and $\theta^H\left(C_2 - \widehat{D}_1^s\right) + \left(1-\theta^H\right)\left(B_1^{H,s}(\underline{\gamma}) - \widehat{D}_1^s\right)$ if $\widehat{D}_1^s \le B_1^{i,s}(\overline{\gamma})$. Hence, $\gamma_2 = \overline{\gamma}$ if and only if $\widehat{D}_1^s \le C_2 - \varepsilon \equiv \widehat{D}_1^{s,Max}$. For any promised payment $\widehat{D}_1^s \le \widehat{D}_1^{s,Max}$, the incumbent expects $\max\left\{C_2 - \widehat{D}_1^s, 0\right\} - \varepsilon$.

b. If $B_1^{i,s}(\overline{\gamma}) < C_2$, then the incumbent is outbid for any pledgeability choice. For any level of $\widehat{D}_1^s$, the incumbent's payoff from choosing high pledgeability is

$$\begin{cases} \left(B_1^{H,s}(\overline{\gamma}) - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\}\right) - \varepsilon & \text{if } \widehat{D}_1^s > B_1^{i,s}(\overline{\gamma}) \\ \theta^H\left(C_2 - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\}\right) + \left(1-\theta^H\right)\left(B_1^{H,s}(\overline{\gamma}) - \min\left\{B_1^{H,s}(\overline{\gamma}), \widehat{D}_1^s\right\}\right) - \varepsilon & \text{if } \widehat{D}_1^s \le B_1^{i,s}(\overline{\gamma}). \end{cases}$$

The incumbent's payoff from choosing low pledgeability is

$$\begin{cases} \left(B_1^{H,s}(\underline{\gamma}) - \min\left\{B_1^{H,s}(\underline{\gamma}), \widehat{D}_1^s\right\}\right) & \text{if } \widehat{D}_1^s > B_1^{i,s}(\underline{\gamma}) \\ \theta^H\left(C_2 - \min\left\{B_1^{H,s}(\underline{\gamma}), \widehat{D}_1^s\right\}\right) + \left(1-\theta^H\right)\left(B_1^{H,s}(\underline{\gamma}) - \min\left\{B_1^{H,s}(\underline{\gamma}), \widehat{D}_1^s\right\}\right) & \text{if } \widehat{D}_1^s \le B_1^{i,s}(\underline{\gamma}). \end{cases}$$

Hence, $\gamma_2 = \overline{\gamma}$ if and only if $\widehat{D}_1^s \le B_1^{H,s}(\overline{\gamma}) - \varepsilon \equiv \widehat{D}_1^{s,Max}$.

(iii) If $C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{i,s}(\underline{\gamma}) \ge B_1^{H,s}(\underline{\gamma})$, then the incumbent can outbid industry insiders for any pledgeability choice. For any level of $\widehat{D}_1^s$, the incumbent's payoff from choosing high pledgeability is $\theta^H\left(C_2-\min\left\{B_1^{H,s}(\overline{\gamma}),\widehat{D}_1^s\right\}\right)+\left(1-\theta^H\right)\left(B_1^{H,s}(\overline{\gamma})-\min\left\{B_1^{H,s}(\overline{\gamma}),\widehat{D}_1^s\right\}\right)-\varepsilon$

The incumbent's payoff from choosing low pledgeability is

$\theta^H\left(C_2-\min\left\{B_1^{H,s}(\underline{\gamma}),\widehat{D}_1^s\right\}\right)+\left(1-\theta^H\right)\left(B_1^{H,s}(\underline{\gamma})-\min\left\{B_1^{H,s}(\underline{\gamma}),\widehat{D}_1^s\right\}\right)$. Hence, $\gamma_2=\overline{\gamma}$ if and only if $\widehat{D}_1^s\le\theta^H B_1^{H,s}(\underline{\gamma})+(1-\theta^H)B_1^{H,s}(\overline{\gamma})-\varepsilon\equiv D_1^{s\ \text{PayIC}}$.

Proof of Proposition 2.1:

Since $\left(1-\underline{\gamma}\right)C_2>\omega_0^{H,G}\ge\left(1-\underline{\gamma}\right)C_2-\rho C_1>\omega_0^{H,B}$, there is no potential rents to acquirers if and only if in state GG. Thus, according to Lemma 2.1, low pledgeability is chosen only in state GG.

Proof of Lemma 2.2

Case (i) to (iii) are identical to the proof of Lemma 2.1. Case (iv) is new.

If $B_0^{\max,s}>B_0^{\min,s}$, $B_0^{i,s_0}\left(\overline{\gamma}\right)\ge B_0^{\max,s}$, and $B_0^{i,s_0}\left(\underline{\gamma}\right)<B_0^{\min,s}$, the incumbent can hold onto control with high pledgeability, but not low. Thus, she chooses $\gamma_1=\overline{\gamma}$ if and only if

$\theta^H\left(\tilde{C}_1^{i,s_0}\left(\widehat{D}_1^G,\widehat{D}_1^B\right)-\min\left\{\widehat{D}_0^{s_0},B_0^{\max,s_0}\right\}\right)+\left(1-\theta^H\right)\left(B_0^{\max,s_0}-\min\left\{\widehat{D}_0^{s_0},B_0^{\max,s_0}\right\}\right)\ge\left(B_0^{\min,s_0}-\min\left\{\widehat{D}_0^{s_0},B_0^{\min,s_0}\right\}\right).$

This holds if and only if $\widehat{D}_0^{s_0}\le\widehat{D}_0^{s,Max}=D_0^{s,\text{ControlIC}}=\theta^H\tilde{C}_1^{i,s_0}\left(\widehat{D}_1^G,\widehat{D}_1^B\right)+\left(1-\theta^H\right)B_0^{\max,s_0}$.

Proof of Proposition 2.2:

Apply Assumption 2.1 and Lemma 2.1, the results naturally follow.

Proof of Lemma 3.1:

(i) If $B_1^{H,s}\left(\underline{\gamma}\right)=C_2$, $V_1^{i,s}\left(\gamma_2=\overline{\gamma}\right)=\max\left\{C_2-\widehat{D}_1^s-\varepsilon,-\varepsilon\right\}$ and $V_1^{i,s}\left(\gamma_2=\underline{\gamma}\right)=\max\left\{C_2-\widehat{D}_1^s,0\right\}$. Thus, $\Delta^s\equiv-\varepsilon$.

(ii) If $C_2>B_1^{H,s}\left(\underline{\gamma}\right)$ and $B_1^{i,s}\left(\underline{\gamma}\right)<B_1^{H,s}\left(\underline{\gamma}\right)$,

$$V_1^{i,s}\left(\gamma_2=\overline{\gamma}\right)=\begin{cases}-\varepsilon & \text{if } \widehat{D}_1^s>B_1^{H,s}\left(\overline{\gamma}\right)\\ B_1^{H,s}\left(\overline{\gamma}\right)-\widehat{D}_1^s-\varepsilon & \text{if } B_1^{i,s}\left(\overline{\gamma}\right)<\widehat{D}_1^s\le B_1^{H,s}\left(\overline{\gamma}\right),\\ \theta^H C_2+\left(1-\theta^H\right)B_1^{H,s}\left(\overline{\gamma}\right)-\widehat{D}_1^s-\varepsilon & \text{if } \widehat{D}_1^s\le B_1^{i,s}\left(\overline{\gamma}\right)\end{cases}$$

$$V_1^{i,s}\left(\gamma_2=\underline{\gamma}\right)=\begin{cases}0 & \text{if } \widehat{D}_1^s>B_1^{H,s}\left(\underline{\gamma}\right)\\ B_1^{H,s}\left(\underline{\gamma}\right)-\widehat{D}_1^s & \text{if } B_1^{i,s}\left(\underline{\gamma}\right)<\widehat{D}_1^s\le B_1^{H,s}\left(\underline{\gamma}\right).\\ \theta^H C_2+\left(1-\theta^H\right)B_1^{H,s}\left(\underline{\gamma}\right)-\widehat{D}_1^s & \text{if } \widehat{D}_1^s\le B_1^{i,s}\left(\underline{\gamma}\right)\end{cases}$$

Thus,

$$\Delta^{s_0 s_1}\left(\widehat{D}_1\right)\begin{cases} = \min\left\{-\varepsilon, B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1 - \varepsilon\right\} & \text{if } \widehat{D}_1 \geq B_1^{H,s}(\overline{\gamma}) - \varepsilon \\ > 0 & \text{if } \widehat{D}_1 < B_1^{H,s}(\overline{\gamma}) - \varepsilon. \end{cases}$$

(iii) If $C_2 > B_1^{H,s}\left(\underline{\gamma}\right)$ and $B_1^{i,s}\left(\underline{\gamma}\right) \geq B_1^{H,s}\left(\underline{\gamma}\right)$,

$$V_1^{i,s}\left(\gamma_2 = \overline{\gamma}\right) = \begin{cases} \theta^H\left(C_2 - B_1^{H,s}\left(\overline{\gamma}\right)\right)\text{-}\varepsilon & \text{if } \widehat{D}_1^s > B_1^{H,s}\left(\overline{\gamma}\right) \\ \theta^H C_2 + \left(1-\theta^H\right) B_1^{H,s}\left(\overline{\gamma}\right) - \widehat{D}_1^s - \varepsilon & \text{if } \widehat{D}_1^s \leq B_1^{H,s}\left(\overline{\gamma}\right) \end{cases},$$

$$V_1^{i,s}\left(\gamma_2 = \underline{\gamma}\right) = \begin{cases} \theta^H\left(C_2 - B_1^{H,s}\left(\underline{\gamma}\right)\right) & \text{if } \widehat{D}_1^s > B_1^{H,s}\left(\underline{\gamma}\right) \\ \theta^H C_2 + \left(1-\theta^H\right) B_1^{H,s}\left(\underline{\gamma}\right) - \widehat{D}_1^s & \text{if } \widehat{D}_1^s \leq B_1^{H,s}\left(\underline{\gamma}\right) \end{cases}.$$

Thus, $\Delta^{s_0 s_1}\left(\widehat{D}_1\right)\begin{cases} \leq 0 & \text{if } \widehat{D}_1 \geq D_1^{PayIC} \\ > 0 & \text{if } \widehat{D}_1 < D_1^{PayIC}. \end{cases}$

Proof of Lemma 3.2:

(i) If there is no potential underpricing in state G, $\Delta^{s_0 G}\left(\widehat{D}_1^{s_0 G}\right) \equiv -\varepsilon$ for all $\widehat{D}_1^{s_0 G}$. If there is potential underpricing in state B, then $D_1^{s_0,IC} \to \widehat{D}_1^{s_0 B,\max}$ since $\Delta^{s_0 B}\left(\widehat{D}_1^{s_0 B,\max}\right) = 0$.

(ii) If the incumbent has no hope of retaining control in state B, $\Delta^{s_0 B}\left(\widehat{D}_1^{s_0 B}\right) \equiv -\varepsilon$ for $\widehat{D}_1^{s_0 B} \geq \widehat{D}_1^{s_0 B,\max} + \varepsilon$. Since $\Delta^{s_0 G}\left(\widehat{D}_1^{s_0 G,\max}\right) = 0$, $D_1^{s_0,IC} \to \gamma_1 C_1 + \widehat{D}_1^{s_0 G,\max}$.

Proof of Lemma 3.3:

(i) Given the parameter range, there exists no potential rents to acquirers in state $s_0 G$. In state $s_0 B$, the incumbent can retain control irrespective of the pledgeability choices. Apply Case (i) of Lemma 3.2, the result $D_1^{s_0,IC} = D_1^{s_0 B,PayIC}$ follows.

(ii) Given the parameter range, in state $s_0 G$, the incumbent can retain control irrespective of the pledgeability choices. In state $s_0 B$, she has no hope of retaining control. Apply Case (ii) of Lemma 3.2, the result $D_1^{s_0,IC} \to \gamma_1 C_1 + \widehat{D}_1^{s_0 G,PayIC}$ follows.

Proof of Lemma 3.4:

Similar to the proof of Lemma 3.2.

Proof of Lemma 3.4:

Similar to the proof of Lemma 3.3.