Pledgeability, Industry Liquidity, and Financing Cycles

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Abstract

Why are downturns following episodes of high valuations of firms, which were forecast to likely persist, so severe and prolonged? In this paper, we provide a non-traditional approach to debt overhang (which extends to more general financial contracts). It links current access to finance to high prior valuations of an industry and to previous (rational) optimism about its value. In doing so, we differentiate between the control rights over asset sales, which are sufficient to enforce external claims only in a boom, and a firm's choice of *pledgeability* (control rights over cash flows) which enables the enforcement of external claims in a downturn. The endogenous choice of pledgeability causes debt built up in a boom to have long-drawn adverse effects in a downturn, which may not be resolved by renegotiation.

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How do previous market conditions and past expectations about the future influence a firm's access to capital today? Why do downturns following episodes of high valuations of firms, which were forecast to likely persist, prove to be detrimental to growth and result in more severe 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 borrowing and investment during the bust. The obvious argument against the debt overhang explanation is that 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. An explanation for the optimality of debt overhang is to say that the firm cannot be trusted to take only value enhancing investments, even in a downturn. So debt overhang is needed to constrain the firm'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 do we want to constrain firms more in bad times? Why is the moral hazard problem so much more serious in a downturn following a boom than in an upturn or in a downturn which does not follow a boom? Why isn't debt overhang the tool of choice to constrain corporate mal-investment all the time (and casual empiricism suggests it is not)?

In this paper, we provide an explanation of the causes and consequences of financial contract overhang (including debt overhang) and provide a link to high prior values and to previous (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 that facilitate the enforcement of external claims at other times, including downturns. It is the change in the nature of the control rights that causes the debt build up 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 incumbents (those who are running firms) and 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 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 not made and, second, control over cash flows generated by the asset. The first right only requires the frictionless enforcement of property rights in the economy, which we assume. It has especial value when there are a large number of capable potential buyers willing to pay a full price for the asset. Greater wealth amongst industry insiders (which we term industry liquidity) increases the availability of this *asset-sale-based* financing.

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; while 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) it makes it easier for existing creditors to collect more when the incumbent stays in control. Low pledgeability also serves to entrench the incumbent, by reducing the ability of outsiders to outbid the incumbent. Thus cash flow pledgeability is subject to moral hazard, which as we shall see, limits the fund raising 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.

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 (leaving 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. This has an important implication: In such an environment of easy sales, incumbents have little reason to maintain cash flow pledgeability.

The high resale value of assets increases the amount of financing that a firm can credibly repay, increasing the potential leverage of the firm. If the firm uses this financing capacity by issuing standard debt, both high debt built up during the asset price boom which was likely to continue and the neglect of cash flow pledgeability can be counterproductive in a downturn. Industry insiders, also hit by the downturn, no longer have personal wealth to buy assets, nor does the low cash flow pledgeability allow them to borrow against future cash flows to pay for purchases. Asset prices plummet. Faced with large debt claims, incumbents see more value to reducing future pledgeability (so as to further reduce the payout to outside claim holders) than maintaining it.

When the firm can borrow and refinance several times (such as over several business cycles), an interesting dynamic effect is possible, illustrating the interplay between industry liquidity and internal incentives to enhance pledgeability. Very high liquidity will imply that assets are fully priced, and the incumbent has no incentive to enhance pledgeability. Very low liquidity will mean that the incumbent prefers to sell to an industry outsider, who buys for resale, which reduces the need to increase pledgeability. It is only at intermediate levels of liquidity that the incumbent has the incentive to increase pledgeability, and the ability to increase borrowing capacity. An interesting relationship also emerges between debt and efficiency. High promised payments are usually thought of as forcing assets into more efficient hands. But because moral hazard over pledgeability may be more acute for more efficient producers, they may be able to borrow less when pledgeability matters. So the need to make high promised payments may force the firm out of their hands into the hands of the less efficient. Productive efficiency may suffer ex post, but this may be necessary to raise more money up front. More generally, high debt may not lead to more efficient ownership.

With debt high, creditors will either agree to renegotiate debt down significantly, or seize assets and sell to financiers (*industry outsiders)*. While industry outsiders have little ability to run the asset themselves, this may be a virtue – they have a strong incentive to improve pledgeability while the asset is under their control, because they want to sell the asset back to industry insiders at a high price. Outsiders play an important role, therefore, not because they are flush with funds but because they are not subject to moral hazard over pledgeability.

Interestingly, anticipating such sales to outsiders as the industry turns down, current debt holders have little incentive to renegotiate down debt levels, even if it causes incumbent moral hazard over pledgeability; Short term improvements in pledgeability contribute little immediately to repayments, given the weak state of the economy, but improvements in long-term pledgeability after an asset sale will enhance the recovery of long term payments significantly. Consequently, in the downturn 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 cash flows. Recoveries following periods of asset price inflation 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 financing is more difficult. It is the latter which may make the debt hangover more prolonged.

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 (forthcoming)). 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]

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.

In Shleifer and Vishny (1992), 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. Eisfeldt and Rampini (2008) develops a theory of more efficient capital reallocation in good times based on private information about managerial ability and cyclical effects of

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

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 capital. This leads to a more efficient reallocation of capital in good (high compensation) times and less in bad. Both Shleifer and Vishny (1992) and Eisfeldt and Rampini (2008) study the effects of current conditions (such as industry net worth or compensation) for the efficiency of current reallocation of capital. Our analysis of pledgeability choice shows how previous, current, and anticipated conditions determine current financial capacity and the efficiency of capital reallocation.

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 two-period model (which establishes our main ideas in a simple setting). In Section II, we analyze the implications of pledgeability choice when financial contracts are fully state-contingent. The maximum amount that can be pledged to outside investors is characterized. In Section III, we examine the implications of standard debt contracts rather than fully state-contingent payments. In Section IV we provide two important extensions, one where there is an additional period added to the model (which allows the possibility of buying the firm for resale) and the other where the incumbent can become disabled rather than fully incapacitated. In Section V, we contrast our model to one where pledgeability is fixed and cannot be changed. In Section VI, we discuss the implications of the model and conclude.

I. The Framework

The Industry and States of Nature

Consider an industry with 3 dates (0, 1, 2) and 2 periods (period 1 and 2) between these dates (we will subsequently add an additional date before date 0). A period should be thought of as a phase of the financial cycle (see Borio (2012) for example), and extends over several years. Date t marks the end of period t. The state of the industry is realized at the beginning of every period. In state G the industry experiences prosperity and industry-wide distress occurs in state B. We sometimes refer to state G as the good state and B as the bad state. The industry begins in one of the two states at date 0 – this state s_0 could be thought of as the state experienced in the previous (initially un-modeled) period. In period 1, the industry could be in either state (see Figure 1). At date 0, the probability of being in state G in period 2 is q^{s_0G}. 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). Note that a full description of the state in periods 1 and 2 includes the states that were realized in previous periods, but where a reference to past realized states is unnecessary we will skip it for convenience.

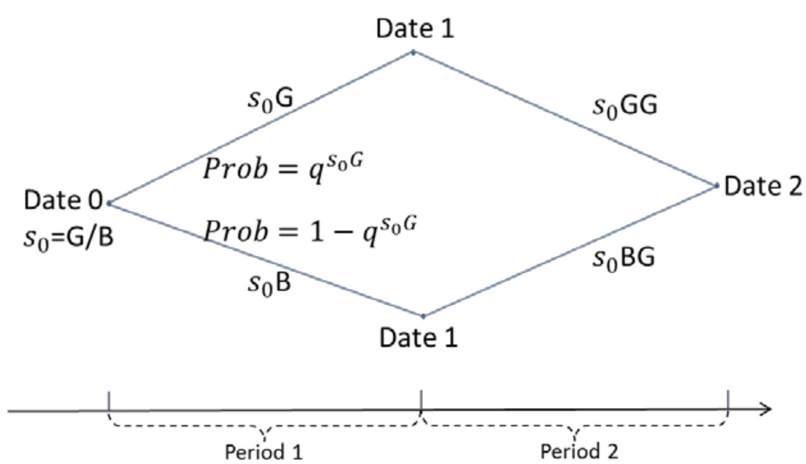

Figure 1: States of Nature in the Basic Model beginning from G or B

Agents and the Asset

There are two types of agents in the economy: Some have high ability to manage an asset, which we will call the firm. Think of them as *industry insiders*. We call them *high* types interchangeably. When the state is G, only a high (H) ability manager in place at the beginning of a period *t* can produce cash flows C_t with the asset over the period; there is some mutual specialization established over the period between the manager and the firm (or more broadly, between the CEO and the un-modeled organization that is needed to operate the firm) that creates a value to incumbency. In the B state, however, even a high ability manager cannot produce cash flows. The second type of agent, a *financier*, has no ability to produce cash flows regardless of the state. Equivalently, these are insiders who have lost their ability (see below). We use the term *low* types interchangeably for financiers. All agents are risk neutral. We ignore time discounting, which is just a matter of rescaling the units of cash flows. Financiers have funds which they will lend or invest if they expect to break even.

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 an unstable 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. A new high ability manager can take over at the end of the current period and instantly shape the firm towards her idiosyncratic management style, so she can indeed produce cash flows with the firm's assets next period in good states.

Financial Contracts

Any manager can raise money against the asset by writing one period financial contracts. We will 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.

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 a portion that we call *pledgeable* of generated cash flows 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 will describe the two control rights in detail.

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 such as the information possessed by financiers and hence the nature of financiers (arm's length or relationship), the nature of financing (for example, concentrated or dispersed), the quality of the accounting systems that are 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.).

We assume a firm's incumbent management can take voluntary actions to enhance *general pledgeability* within the limits imposed by the economy's institutions. The incumbent's actions will take time to show up (only next period), and will then persist for some time (over the entire next period). Therefore, in period t, the incumbent manager can set the general pledgeability of the firm's assets for period *t+1* at γ_{t+1}, where general pledgeability is the fraction of next period's cash flows another industry insider can commit to pay an outside financier if an insider takes over the firm's control at the end of this period (replacing the incumbent). We assume the share the incumbent can pledge next period, *incumbent* *pledgeability*, is fixed at γ^i. It can differ from general pledgeability because the incumbent may have relationships with financiers or there may be types of public information about the incumbent which allow her to commit a different amount. A previous version of this paper studied the choice of γ^i, but for simplicity we assume that it is given. When we refer to *pledgeability* with no other modifier, we are referring to *general pledgeability*.

We assume $\gamma_t \in [\underline{\gamma}, \overline{\gamma}]$ where $0 \le \underline{\gamma} < \overline{\gamma} \le 1$, and there is a small fixed cost ε of setting $\gamma_t > \underline{\gamma}$. This is the cost of taking actions like setting up a bond trustee, establishing a lending relationship by providing information to a lender or writing in detailed covenants that will ensure higher cash flow pledgeability. The range of γ_t is determined by the institutional environment in which the industry operates. If a financier is the incumbent, he cannot generate cash flows, but he can set next period's pledgeability– he does not have industry-specific managerial capabilities but has governance capabilities.

Control Rights over Assets: Auction and Resale

If the financier has not been paid in full from the pledgeable cash flow, then unless the remaining amount is repaid by the incumbent, the financier gets the right to auction the firm to the highest bidder at date t. One can think of such an auction as some form of bankruptcy. 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.

Initial Conditions, Wealth and Underpricing

At date 0, the incumbent has initial wealth $\omega_0^{i,s_0} \ge 0$. We assume that high ability industry insiders (non-incumbents) start out with wealth $\omega_0^{H,s_0} \ge 0$. If the industry state is good in period 1, both the wealth of industry insiders and that of the incumbent go up over the period by ρC_1 to $\omega_1^{H,s_0 G}$. We will refer to the wealth of an industry insider as *industry liquidity*. Intuitively, a string of good (G) states for the industry will mean that insiders – working as consultants, sub-contractors or employees – will increase their net worth, even if they do not own the firm. The incumbent's wealth further increases by the amount of non-pledgeable cash flows she generates within the firm. In any auction, bidders can pay cash from their wealth and any money they can raise from financiers against future cash flows. To simplify expressions, we assume that no agent's wealth increases during period 2, which is just a matter of rescaling units of the final cash flow C_3, since there is no uncertainty about the state of the economy then.

With higher pledgeability, industry insiders will be forced by competition to increase their bid if it is less than the value of future cash flows, because higher pledgeability allows them to raise more financing from financiers. If the (competitive) bids are less than the value of future cash flows, we will say that there is *underpricing* of the asset (some might say instead that it is selling at a fire sale price). More precisely, let us define a variable which will prove to be important in our model: *Potential underpricing.* This is the difference between the present value of cash flows accruing to an industry insider and the amount that he can bid if the incumbent sets pledgeability to be low. In particular, the potential underpricing can be reduced by increased pledgeability, which increases the amount that the acquirer can raise to finance the acquisition.

Financiers can also bid for the firm. Their wealth will turn out not to matter since they do not generate cash flow themselves, implying that they will pay only the expectation of the amount at which they can sell the asset in the future. We will see that they will be able to borrow against all of these resale proceeds.

Timing

In the basic model with state-contingent financial contracts, the timing of events within period 1 is described in Figure 2. If standard debt contracts are used, the required payments do not depend on the state of the economy and $D_1^G = D_1^B$.

The incumbent sets (general) pledgeability γ_2, knowing the amount of payment that is due at date 1, but without knowing whether she would keep her ability into period 2. We begin by assuming that the state is known by the incumbent when this choice is made, but we will show similar results when only its probabilities are known. Next, her ability in period 2 realizes. Production takes place and the pledgeable fraction goes to financiers automatically. At date 2, she either pays the remaining payment $\widehat{D}_1^{s_1}$ or enters the auction.

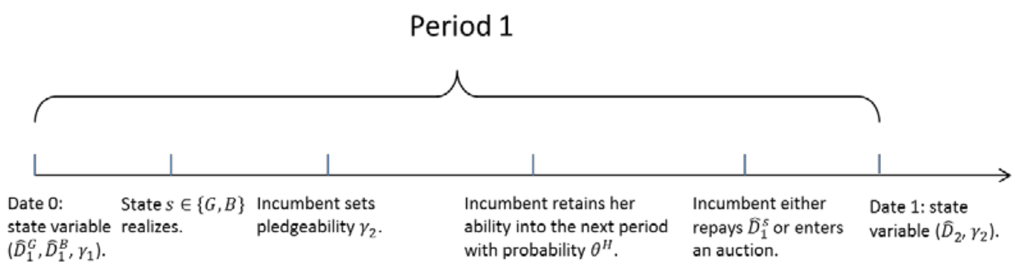

Figure 2: Timing and Decisions in Period 1

Our initial discussion focuses on determinants of pledgeability choice in a very simple setting with fully state-contingent financial contracts, where all outcomes are efficient. Many of our positive implications are clear in this simple setting. We will use these results in extensions to examine the possible inefficiency of real outcomes.

II. Solving the Basic Model

We focus on decisions in period 1, solving the model backwards from period 2. We will characterize the choice of pledgeability and the maximum state-contingent payments to lenders, where there are two forms of moral hazard which interact to determine the maximum state-contingent payments to lenders. First, incumbents can withhold cash flows from financiers net of 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, altering the amount of underpricing and potentially entrenching herself.

2.1 Date 2

Since the economy ends at date 2 and there is no uncertainty over the state of the economy then, a high type industry insider who bids for control 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 borrow up to $\gamma^i C_2$ if she remains a high type and bids to retain control into period 2.

2.2. Date 1

Let the promised payment to the financier at date 1 in state s_1 be $D_1^{s_1}$, $s_1 \in \{G, B\}$. If the incumbent in period 1 is a high type H (an industry insider) and the state is G, she will generate pledgeable cash of $\gamma_1 C_1$ which goes directly to the financier (up to the value of her promised claim), where γ_1 is a parameter that is preset before date 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 the state is good. Otherwise, $\widehat{D}_1^{s_1} = D_1^{s_1}$.

In any date 1 auction for the firm, financiers will not bid since the firm is worthless in their hands in the last period and the firm has no scrap value. Industry insiders will bid out of their wealth and period 2's output that can be pledged at date 1. Their wealth increases by ρC_1 in state G, and remains unchanged in state B, i.e., $\omega_1^{H,G} = \omega_0^{s_0} + \rho C_1$ and $\omega_1^{H,B} = \omega_0^{s_0}$. Together with the amount $\gamma_2 C_2$ they can borrow, the total amount that they can pay is $\omega_1^{H,s_1} + \gamma_2 C_2$. Hence, $\omega_1^{H,s_1} + \gamma_2 C_2$ is the most that high types can bid at date 1. Of course, they will not bid more than the total value of cash flow, C_2. So the maximum auction bid at date 1 is $B_1^{H,s_1}(\gamma_2) = Min[\omega_1^{H,s_1} + \gamma_2 C_2, C_2]$. $C_2 - B_1^{H,s_1}(\underline{\gamma})$ is the amount of potential underpricing at date 1. By choosing different levels of pledgeability, the incumbent is able to alter industry insiders' bids between $B_1^{H,s_1}(\underline{\gamma}^g)$ and $B_1^{H,s_1}(\overline{\gamma}^g)$, and can thus potentially entrench herself.

The incumbent will have to pay the financier $Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)]$ (pay in full or outbid others in an auction) if she wants to retain control into period 2. We will allow the incumbent to carry cash forward without incurring any cost. It turns out that with state-contingent contracts, there is no reason to carry cash forward: Instead she will reduce the amount to be repaid. Therefore, the cash she has at date 1 is the initial wealth level, ω_0^{i,s_0}, plus the non-pledgeable portion of cash flows generated during period 1. So 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 $\omega_1^{i,B} = \omega_0^{i,s_0}$ if the state is B. In addition, she can also issue securities to raise a constant fraction of period 2's output $\gamma^i C_2$. Therefore, if she keeps her ability in period 2, the incumbent can pay as much as $B_1^{i,s_1} = \min\left\{\omega_1^{i,s_1} + \overline{\gamma} C_2, C_2\right\}$ to the financier. The incumbent will retain control if the amount she can pay is greater than $Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}]$. Since the continuation value of the asset is identical to the incumbent and the industry insiders (C_2 in both cases), the incumbent is always willing to hold on to the asset if she is able to. 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 and the firm is worthless in her hands.

Regardless of who wins, the financier recoups $Min[\gamma_1 C_1, D_1^{s_1}] + Min[\widehat{D}_1^{s_1}, B_1^{H,s_1}]$ if the incumbent in period 1 is a high type and the state is G, and $Min[D_1^{s}, B_1^{H,s}]$ otherwise. 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 $B_1^{H,s}$ by industry insiders, which depends in turn on the wealth of industry insiders and the future pledgeability of the asset γ_2. Thus high future pledgeability is a way for the incumbent to commit to facing a high bid, and thus paying the financier a high sum, no matter who has control in period 2.

The incumbent's choice of pledgeability, and thus the maximal credible payment, $\widehat{D}_1^{s_1,Max}$, are determined differently, depending on whether the incumbent can outbid industry insiders. We classify the analysis into four cases. i) Pledgeability does not matter for repayment. ii) The incumbent can never outbid industry insiders. iii) The incumbent can always outbid industry insiders. iv) The incumbent can outbid industry insiders when pledgeability is low, but not when pledgeability is high.

We explicitly solve for the maximal credible payment $\widehat{D}_1^{s_1,Max}$ in all these cases.

(i) Pledgeability does not matter for repayment

When $B_1^{H,s}(\underline{\gamma}) = C_2$, industry liquidity is sufficiently high such that high-type insider bidders can afford the full price of the asset, even if the incumbent has chosen low general pledgeability for period 2, so $\widehat{D}_1^{s,Max} = C_2$. This case will occur in periods of industry-wide booms with high industry liquidity. In this case, there is no potential underpricing and pledgeability does not matter for repayment. As a 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 not needed or desired by anyone in this case.

(ii) Incumbent cannot outbid industry insiders in an auction

When $C_2 > B_1^{H,s}(\underline{\gamma}) > B_1^{i,s}(\gamma^i)$, the incumbent can never retain control if she enters into an auction, unless the remaining debt to be repaid is lower than her own ability to raise money if she continues as an incumbent. Therefore, $\widehat{D}_1^{s,Max} = B_1^{H,s}(\overline{\gamma}) - \varepsilon$, she would set next period's pledgeability at the highest level (and recoup the cost ε of setting pledgeability high by setting the debt level ε below the auction price).

(iii) Incumbent always retains control conditional on retaining ability

Consider $B_1^{i,s}(\gamma^i) \geq Min[\widehat{D}_1^s, B_1^{H,s}(\overline{\gamma})]$, so that the incumbent retains control even if general pledgeability is at its maximum. She will choose $\gamma_2 = \overline{\gamma}$ iff

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

The left hand side is the incumbent's rents if she chooses $\gamma_2 = \overline{\gamma}$, while the right hand side is the incumbent's rents 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 becomes a low type, and has to auction the firm at date 1. Note that a higher γ_2 (weakly) increases the amount the financier gets and (weakly) decreases the first term, while it (weakly) increases the amount the incumbent gets in the auction and (weakly) increases the second term. The incumbent has the incentive to set $\gamma_2 = \overline{\gamma}$ if by doing so she gets more, net of the cost ε, than by setting $\gamma_2 = \underline{\gamma}$, and obtaining the expected amount on the right hand side.

The maximum level of promised payment $\widehat{D}_1^s$ that still gives her an incentive to choose $\gamma_2 = \overline{\gamma}$ is easily checked to be $D_1^{s \text{ PayIC}} = \theta^H B_1^{H,s}(\underline{\gamma}) + (1-\theta^H) B_1^{H,s}(\overline{\gamma}) - \varepsilon$. If the promised payment $\widehat{D}_1^s > D_1^{s \text{ PayIC}}$, the incumbent sets $\gamma_2 = \underline{\gamma}$.

Intuitively, higher is the probability of a sale $(1-\theta^H)$, higher the value from a high bid in the auction, and greater the benefit of high general pledgeability – so higher the payment that can be committed to. Conversely, higher is stability θ^H, lower the likelihood of a forced sale, greater the attractiveness of choosing low pledgeability and reducing the enforceable payment, so lower the payment that can be sustained. Greater stability in an industry reduces the likelihood that different management capabilities will be needed, and reduces management's incentive to maintain high pledgeability for any debt level.[3]

(iv) Incumbent could lose control depending on the level of pledgeability

Now consider what happens when $B_1^{H,s}(\underline{\gamma}) \le B_1^{i,s}(\gamma^i) < Min[\widehat{D}_1^s, B_1^{H,s}(\overline{\gamma})]$ so that the incumbent retains control if she chooses low general pledgeability and continues to be a high type, because she lowers to $B_1^{H,s}(\underline{\gamma})$ the payment she has to make to retain control. By contrast, if she chooses high pledgeability, she loses control no matter what type she is because the high promised payment is enforceable and higher than what she can pay. So she chooses high pledgeability if

$$(B_1^{H,s}(\overline{\gamma}) - Min[\widehat{D}_1^s, B_1^{H,s}(\overline{\gamma})]) - \varepsilon \ge \theta^H (C_2 - Min[\widehat{D}_1^s, B_1^{H,s}(\underline{\gamma})]) \qquad (2)$$

[3] There is a parallel here to Jensen (1986)'s argument that free cash flows increase in mature industries. In his view, the paucity of investment needs in mature industries results in firms generating substantial free cash flows (and hence needing governance). 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.

This requires $\widehat{D}_1^s$ to not exceed $D_1^{s\text{Control IC}} = B_1^{H,s}(\overline{\gamma}) - \theta^H(C_2 - B_1^{H,s}(\underline{\gamma})) - \varepsilon$. Intuitively, promised payments cannot be too high if the choice of high pledgeability means a certain loss of control – the incumbent needs to obtain adequate rents from sale to choose high pledgeability. It is easily checked that $D_1^{s\text{ PayIC}} \geq D_1^{s\text{Control IC}}$.

In case (iii) where the incumbent can always outbid insiders, the incentive to keep general pledgeability low is due to its effect in reducing the amount that the incumbent must pay to win the auction. In case (iv) where the incumbent can outbid industry insiders only when pledgeability is low, the incentive to set pledgeability low comes from its reduced potential for loss of control.

Lemma 2.1 summarizes the results in different cases.

Lemma 2.1

Let $s_1 = s$,

(i) If $B_1^{H,s}(\underline{\gamma}) = C_2$, there is no potential underpricing and

$\widehat{D}_1^{s,Max} = C_2$ and $\gamma_2 = \underline{\gamma}$. For any promised payment $\widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, incumbent expects:

$V_1^{i,s}(\widehat{D}_1^s) = C_2 - \widehat{D}_1^s$.

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

(ii) if $B_1^{H,s}(\underline{\gamma}) > B_1^{i,s}(\gamma^i)$, the incumbent can never outbid the insider, and

then $\widehat{D}_1^{s,Max} = B_1^{H,s}(\overline{\gamma}) - \varepsilon$. For any promised payment $\widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, the incumbent chooses

$\gamma_2 = \overline{\gamma}$, and expects $V_1^{i,s}(\widehat{D}_1^s) = B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon$ if $B_1^{i,s}(\gamma^i) < \widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, 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 $\widehat{D}_1^s \leq B_1^{i,s}(\gamma^i)$.

(iiia) if $B_1^{i,s}(\gamma^i) \geq D_1^{s\text{ PayIC}}$, then $\widehat{D}_1^{s,Max} = D_1^{s\text{ PayIC}}$. For any promised payment $\widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$,

incumbent chooses $\gamma_2 = \overline{\gamma}$ and expects $V_1^{i,s}(\widehat{D}_1^s) = \theta^H C_2 + (1-\theta^H)B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon$.

(iiib) if $D_1^{s \text{ PayIC}} > B_1^{i,s}(\gamma^i) \geq D_1^{s\text{Control IC}}$, then $\widehat{D}_1^{s,Max} = B_1^{i,s}(\gamma^i)$. For any promised payment $\widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, incumbent chooses $\gamma_2 = \overline{\gamma}$ and expects
$V_1^{i,s}(\widehat{D}_1^s) = \theta^H C_2 + (1-\theta^H) B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon.$

(iv) $D_1^{s\text{Control IC}} > B_1^{i,s}(\gamma^i) \geq B_1^{H,s}(\underline{\gamma})$, then $\widehat{D}_1^{s,Max} = D_1^{s\text{Control IC}}$. For any promised payment $\widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, the incumbent chooses $\gamma_2 = \overline{\gamma}$, and expects $V_1^{i,s}(\widehat{D}_1^s) = B_1^{H,s}(\overline{\gamma}) - \widehat{D}_1^s - \varepsilon$ if $B_1^{i,s}(\gamma^i) < \widehat{D}_1^s \leq \widehat{D}_1^{s,Max}$, 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 $\widehat{D}_1^s \leq B_1^{i,s}(\gamma^i)$.

Proof: Sketched in the text above.

Ceteris paribus, the maximum credible payment $\widehat{D}_1^{s,Max}$ does not increase monotonically with incumbent pledgeability γ^i. When γ^i is low as in case (ii), the incumbent cannot retain control when debt levels exceed what she can pay. Since she always gets more by selling, she has the incentive to set pledgeability high, and hence promised payments can be set very high. By contrast, as γ^i increases so that case (iii) applies and she has the chance to maintain control, her incentives start mattering, resulting in a lower ability to promise payments. The maximum credible promised payment now falls as γ^i rises (from case (ii) to (iii)) because of moral hazard.

Figure 3 illustrates this non-monotonicity by plotting $\widehat{D}_1^{s_1,\max}$ as a function of γ^i. $\widehat{D}_1^{s_1,\max}$ is the highest when γ^i <0.34. After a dramatic drop, $\widehat{D}_1^{s_1,\max}$ starts to increase when γ^i increases from 0.34 to 0.4.

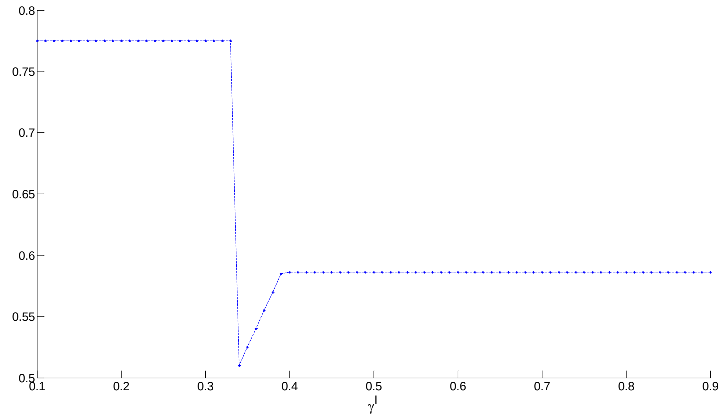

Figure 3: $\widehat{D}_1^{s_1,\max}$ **as a function of** γ^i

Note: this figure plots $\widehat{D}_1^{s_1,\max}$ against γ^i . Other parameters are given as follows:

$\overline{\gamma}^g = 0.45, \underline{\gamma}^g = 0.27, q^G = 0.7, q^{GG} = 0.8, q^{BG} = 0.1, \omega_0^H = 0.1, \omega_0^i = 0.1, \rho = 0.3, C_1 = C_2 = 1, C_3 = 1.5, \ \theta^H = 0.7, \varepsilon = 0$

What about the effects of *industry liquidity*, or equivalently, the wealth of industry insiders, ω_1^{H,s_1} ? An increase in industry liquidity will push up the amount industry insiders can pay, $B_1^{H,s}(\gamma_2)$, for any level of pledgeability. This will increase the maximum pledgeable payment whenever there is potential underpricing (and not decrease it when there are no such underpricing).

Corollary 2.1: $\widehat{D}_1^{s_1,Max}$ is weakly increasing in ω_1^{H,s_1} , and strictly increasing if and only if there is potential underpricing.

Proof: See appendix.

In sum, the incumbent in period 1 sets low pledgeability when she expects the date 1 market to be very liquid. Assets are fully priced and there is no potential underpricing. Moral hazard over pledgeability is irrelevant. In all other cases, the maximum state-contingent payment always provides incentives for the choice of high general pledgeability. When there is potential underpricing, potential acquirers pay less than full value if pledgeability is low, therefore the choice of pledgeability matters for financing capacity, and payouts are set so as to preserve the incumbent's incentives. With state-contingent contracts, pledgeability is set high whenever it can increase the payment to financiers: no one gains from promising to pay more than the amount which provides incentives for this increased payment.

We end this section by discussing the incumbent's incentive to store cash. The incumbent has no incentive to store any cash at date 1 when contracts are fully state-contingent. To see this, note that given the state, promised payments and bids, $\left(s_1, \widehat{D}_1^{s_1}, B_1^{H,s_1}(\gamma_2)\right)$, storing cash reduces the incumbent's bid $B_1^{i,s}(\gamma^i)$ and increases her date 2 consumption unit for unit, if she is still able to maintain control. However, storing cash makes the incumbent weakly more likely to lose control. Therefore, storing cash always makes the incumbent weakly worse off.

Proposition 2.1: During period 1, low general pledgeability $\gamma_2 = \underline{\gamma}$ is chosen only when there is no potential underpricing. At date 1, the incumbent does not have the incentive to carry cash forward to period 2.

Proof: See Lemma 2.1.

With fully contingent financial contracts, pledgeability is set high whenever it is needed to increase payments to financiers (net of its cost, ε). Because the choice is made ex-post knowing the state, then as the cost $\varepsilon \to 0$, the maximum credible payment involves high pledgeability in all times except state when there is no potential underpricing (times when it has no effect on anyone's bid for control).

2.3 Date 0

We will subsequently add a period -1 and for that purpose we now also keep track of the payments date 0 that can be paid by the industry insiders.

$$B_0^{H,s_0}(\gamma_1) = \underset{\substack{\widehat{D}_1^G \le \widehat{D}_1^{G,Max} \\ \widehat{D}_1^B \le \widehat{D}_1^{B,Max}}}{Max} \quad Min\Big[\omega_0^{H,s_0} + q^{s_0G}\left(\gamma_1 C_1 + \widehat{D}_1^G\right) + (1-q^{s_0G})\widehat{D}_1^B,$$

$$q^{s_0G}\left(C_1 + \widehat{D}_1^G + V_1^{i,G}(\widehat{D}_1^G)\right) + (1-q^{s_0G})\left(\widehat{D}_1^B + V_1^{i,B}(\widehat{D}_1^B)\right)\Big].$$

Financiers who have no managerial abilities may also bid at date 0, just to resell one-period later. Because they require a residual value of only ε to set $\gamma_2 = \overline{\gamma}$ (and they do not suffer from moral hazard otherwise since they have no value from retaining the firm at date 2), their bids are:

$$B_0^{L,s_0} = q^{s_0G} B_1^{H,G}(\overline{\gamma}) + (1-q^{s_0G}) B_1^{H,B}(\overline{\gamma}) - \varepsilon .$$

2.4 Financing Cycles with State-contingent Contracts

In this section, we apply the above analysis and study the variations in pledgeability, credit capacity, as well as management turnover across the business cycle. To do this, we explicitly take account of the initial state of industry liquidity at date 0, and consider beginning in both $s_0 = G$ and $s_0 = B$. The initial state $s_0 \in \{G, B\}$ summarizes the entire history before date 0. State G and B respectively represent the industry just coming out of a boom or a recession. We compare the outcomes in four states, denoted by $s_0 s_1$.

The measure of economic efficiency we use will through the rest of this paper is the ability to keep the asset in the hands of the most productive owner, assuming the initial investment need is met. In the baseline model, only equally competent managers end up managing the asset, so all allocations turn out to be efficient. We do not model investment, instead assuming that the asset exists and is owned by an incumbent. If we put a floor on the value of asset which must be bid at date 0 (the value of real inputs to be assembled into the firm), real investment would be possible at that date only if enough funding were available. Sufficiently weak incentives to make cash flows pledgeable or to transfer the firm to more efficient producers would reduce bids at date 0 below this floor, and this would result in underinvestment.

Pledgeability Choice

When is pledgeability set low? Results from Proposition 1 tell us that low pledgeability is chosen if and only there is sufficient industry liquidity such that there is no potential underpricing. Simple comparison tells us that industry-wide cash is unambiguously the highest in state GG, which is meant to capture large and long-term booms. Therefore, pledgeability is most likely to be low in state GG.

For the remaining analysis, we make the following parametric restrictions such that there is no potential underpricing if and only if the economy is in state GG.

$$\omega_0^{H,G} + \rho C_1 + \underline{\gamma} C_2 > C_2$$
$$\omega_0^{H,G} + \underline{\gamma} C_2 < C_2$$
$$\omega_0^{H,B} + \rho C_1 + \underline{\gamma} C_2 < C_2.$$

This immediately implies Proposition 2.2.

Proposition 2.2: When state-contingent contracts are used, pledgeability is low after large and long-term booms.

Proof: See Lemma 2.1.

Management Turnover and Credit Capacity

When is management turnover likely to happen with fully contingent contracts? If the incumbent only sells the asset when she loses her ability, the turnover rate is θ^H, which is the normal rate of industry instability. Note that the wealth of the incumbent is more volatile than that of industry insiders. The incumbent's wealth increases more than that of industry insiders when $s_1 = G$, because not all of the cash flow generated by the firm is pledgeable and turnover will be at the normal rate. In bad times (when $s_1 = B$), $B_1^{i,s_1}\left(\gamma^i\right)$ is more likely to fall below $B_1^{H,s_1}\left(\underline{\gamma}\right)$ or $\widehat{D}_1^{s_1,ControlIC}$, in which case management turnover is more frequent than the normal rate, θ^H.

Table 1 below compares $B_1^{i,s_1}\left(\gamma^i\right)$ with $B_1^{H,s_1}\left(\underline{\gamma}\right)$ and $\widehat{D}_1^{s_1,ControlIC}$ in different states. State GG is omitted since there is no potential underpricing. We assume there always exists underpricing in other states. In addition, we assume that all agents (the incumbent and industry insiders) start with the same wealth ω_{-1} at the beginning of period 0. The incumbent pays upfront B_{-1} to acquire the asset, and receives $\left(1-\gamma_0\right)C_0$ if $s_0 = G$, but nothing if $s_0 = B$. Therefore, $\omega_0^{i,G} = \omega_{-1} - B_{-1} + \left(1-\gamma_0\right)C_0$, $\omega_0^{i,B} = \omega_{-1} - B_{-1}$ and $\omega_0^{H,G} = \omega_0^{H,B} = \omega_{-1}$.

Table 1: Wealth Comparison in Different States

State	GB	BG	BB
$B_1^{i,s_1}\left(\gamma^i\right) - B_1^{H,s_1}\left(\underline{\gamma}\right)$	$\left(1-\gamma_0\right)C_0 + \left(\gamma^i - \underline{\gamma}\right)C_2 - B_{-1}$	$\left(1-\gamma_1\right)C_1 + \left(\gamma^i - \underline{\gamma}\right)C_2 - B_{-1}$	$\left(\gamma^i - \underline{\gamma}\right)C_2 - B_{-1}$
$B_1^{i,s_1}\left(\gamma^i\right) - D_1^{s_1,ControlIC}$	$\left(1-\gamma_0\right)C_0 + \left(\gamma^i - \overline{\gamma}\right)C_2$ $+\theta^H\left[\left(1-\underline{\gamma}\right)C_2 - \omega_{-1}\right] - B_{-1}$	$\left(1-\gamma_1\right)C_1 + \left(\gamma^i - \overline{\gamma}\right)C_2$ $+\theta^H\left[\left(1-\underline{\gamma}\right)C_2 - \omega_{-1} - \rho C_1\right] - B_{-1}$	$\left(\gamma^i - \overline{\gamma}\right)C_2 +$ $\theta^H\left[\left(1-\underline{\gamma}\right)C_2 - \omega_{-1}\right] - B_{-1}$

From Table 1, it is clear that both $B_1^{i,s_1}\left(\gamma^i\right) < D_1^{s_1,ControlIC}$ and $B_1^{i,BB}\left(\gamma^i\right) < B_1^{H,BB}\left(\underline{\gamma}\right)$ is most likely to hold in state BB. In fact, $B_1^{i,BB}\left(\gamma^i\right) < B_1^{H,BB}\left(\underline{\gamma}\right)$ if and only if $\left(\gamma^i - \underline{\gamma}\right)C_2 < B_{-1}$. In section 4.1, we extend the model by adding a previous period and show that this condition is not restrictive.

Proposition 2.3: When state-contingent contracts are used, management turnover (which is due to payment default and being outbid) is more frequent when the industry is in a distress. If the incumbent's initial payment B_{-1} satisfies: $\min\left\{\left(1-\gamma_0\right)C_0+\left(\gamma^i-\underline{\gamma}\right)C_2,\left(1-\gamma_1\right)C_1+\left(\gamma^i-\underline{\gamma}\right)C_2\right\}>B_{-1}>\left(\gamma^i-\underline{\gamma}\right)C_2$, financial capacity is high (relative to future value) in large and long-term booms, and also in deep and long-term recessions.

Proof: Sketched in the text above.

With state-contingent contracts, when the ex-post state has so much industry liquidity that there is no potential underpricing, no high type manager cares who will manage the asset, removing the moral hazard over pledgeability, so ex-post financial capacity is high (and equal to the full value of the asset). Incumbents have as much liquidity as industry insiders, and turnover is at a normal level. If there is intermediate liquidity (in states BG or GB), then there is potential underpricing and increased pledgeability can allow the incumbent to be lose control. This limits financial capacity to a payment below full value of the cash flows, to provide an incentive to increase pledgeability. In these states, the expected cash flow is lower than in state GG and a lower fraction of it can be borrowed. In state BB, the incumbent can never hold on to control in an auction, even with low pledgeability. As a result, a payment very close to the full value of cash flows can be promised and then incumbent will choose to set high pledgeability (it is not quite the full value, in order to allow the small cost, ε, to accrue to the incumbent). In these very bad times, the full value of the firm is low, but a very large fraction of it can be promised to financiers as a part of fully state-contingent financial contracts.

2.5 ***Ex-ante*** **Pledgeability Choice with State-Contingent Contracts**

If the incumbent chooses pledgeability before the end of period state is known, based on the ex-ante probability distribution of the states, the results are the same as the case of ex-post choice except that the increase in the amount which can be pledged must exceed the cost ε in expectation across states instead of in the ex-post state where pledgeability is increased. Figure 4, below, shows the timing but it assumes standard debt contracts (replacing those with state contingent contracts would describe the timing here). The proof is straightforward: if there is an incentive to set pledgeability high in both states with ex-post choice, then the same state-contingent payments will provide incentives given the ex-ante choice. If there is an incentive in only one state with ex-post choice, then reducing the state-contingent payment slightly in that state (to allow the incumbent to recover the cost ε in expectation, because there is no incentive ex-post to increase it in the other state) will provide incentives for ex-ante choice, and as $\varepsilon \rightarrow 0$ the state contingent payment will approach that which prevails in the ex-post analysis.

With fully contingent financial contracts, pledgeability is set high (when the cost $\varepsilon \rightarrow 0$) whenever it increases expected payments to financiers. When choice is ex-post this holds state by state and this involves all times except state GG, where the incumbent is relatively liquid and will not be outbid (and where there is no potential underpricing in any case). When choice is ex-ante and the cost $\varepsilon \rightarrow 0$, then, pledgeability is set high except when the probability of state GG approaches 1. Therefore, with state-contingent contracts the *pledgeability choices* are essentially identical to one where pledgeability is always set high and turnover is then caused by realizations sufficiently bad states (state BB) because that is when incumbents are at the biggest liquidity disadvantage compared to industry insiders. However, there is weakly more turnover than when pledgeability is fixed, because providing the incentive to set high pledgeability limits what can be financed, forcing increased turnover in bad times when incumbents have less liquidity than industry insiders. State-contingent contracts lead to countercyclical turnover and capital reallocation (which in our benchmark model, where industry insiders are equally skilled as incumbents, has no implications for efficiency). There are liquidity-based "defaults" on state-contingent contacts, where the payment is made by selling the asset. We know from Eisfeldt-Rampini (2006) that there is more capital reallocation in good times, which occurs in their model (Eisfeldt-Rampini [2008]) where all reallocation is voluntary but limited due to private information interacting with managerial incentives in the labor market. In the next section we study debt contracts (which can force involuntary relocation in bad states when the payment cannot be made by the incumbent) and show this influences the choice of pledgeability and examine the implications for managerial turnover.

III. Debt Contracts

In this section, we turn to debt contracts. Simple debt contracts specify a constant promised payment on a given date in all states, that is, $D_t^s = D_t$ for all s. We do not add explicit frictions to make debt the optimal contract, such as costs of verifying the state at the relevant time.

We consider two timing scenarios for the choice of pledgeability by an incumbent. In section 3.1, incumbent chooses pledgeability choices before learning the state in period 1 (*ex-ante* choice), knowing only the probability of each state. This situation represents more durable pledgeability choices such as the specificity of the production technique, internal or the internal organization of a firm. In addition, it represents longer-term debt. In section 3.2, incumbent sets pledgeability choices after the state in period 1 has already realized (*ex-post* choice). This reflects some combination of choices which can be changed rather quickly (such as a more reputable accountant) and relatively short-term debt. It fits our interpretation of a period as the length of a business cycle less well than ex-ante choice.

In the analysis of ex-post choice, we assume there are impediments to renegotiation of debt contracts after the state is known but before pledgeability choices are made. Without this, debt in some cases becomes identical to state-contingent payments. When pledgeability choice is made ex-ante (knowing the probabilities of each state), renegotiation does not occur even if allowed.

3.1. *Ex-ante* Pledgeability Choice

The incumbent chooses pledgeability before the end of period state is known, based on the probability distribution of the states. The choice of pledgeability turns out to interact with traditional debt overhang in several interesting ways. Figure 4 describes the timing of events in period 1.

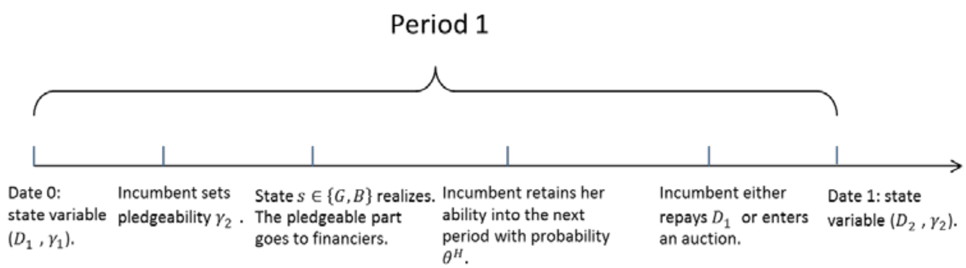

Figure 4: Timing and Decisions with Debt Contracts and *ex-ante* Pledgeability Choice

With fully state-contingent financial contracts, we showed the maximum payment that the incumbent could commit to pay (taking account of incentives) is $\widehat{D}_1^{s_1,Max}$. When only debt contracts are allowed and pledgeability is decided *ex-ante*, there is a single incentive constraint. In particular, the maximal payment consistent with the incumbent choosing high pledgeability lies between $\widehat{D}_1^{s_0B,Max}$ and $\widehat{D}_1^{s_0G,Max} + \gamma_1 C_1$.

Lemma 3.1: There exists $D_1^{s_0,IC} \in \left[\widehat{D}_1^{s_0B,Max}, \widehat{D}_1^{s_0G,Max} + \gamma_1 C_1\right]$ such that $\gamma_2 = \overline{\gamma}$ if only if $D_1 < D_1^{s_0,IC}$.

Proof: see appendix.

We further illustrate two special cases, which provide some general intuition. If there is no potential underpricing in state s_0G, we will see that $D_1^{s_0,IC} = \widehat{D}_1^{s_0B,Max}$, the maximum incentive compatible *state-contingent* payment in state s_0B. If in state s_0B, the incumbent has no chance to retain control even with low pledgeability, then $D_1^{s_0,IC} = \widehat{D}_1^{s_0G,Max} + \gamma_1 C_1$, the maximum state-contingent payment in state s_oG (including the pledgeable amount $\gamma_1 C_1$). The reason is that when in one of the two ex-post states there is either no effect on underpricing (such as in s_oG) or alternatively if in s_oB, there is no effect on control or payments made, then the incentive to choose low pledgeability in the other ex-post state is what matters because extra payoff from choosing low pledgeability in this state is at most ε. If no underpricing in s_oG, pledgeability does not matter except for its cost and in losing control for sure in s_oB

implies that incumbents always prefer high pledgeability unless they recover less than the ε cost of increased pledgeability.

Let $\Delta^{s_0 s_1}\left(D_1\right)$ be the difference between the borrower's payoff from choosing high general pledgeability and the payoff from low pledgeability. When high pledgeability is to be implemented, $D_1^{s_0,IC}$ satisfies $q^{s_0 G}[\Delta_1^{s_0 G}(D_1^{s_0,IC}-\gamma_1 C_1)]+(1-q^{s_0 G})[\Delta_1^{s_0 B}(D_1^{s_0,IC})]=0$. For all D_1, $\Delta^{s_0 G}\left(D_1\right)\equiv-\varepsilon$ if there is no underpricing in state $s_0 G$. If in state B the incumbent has no chance to retain control then $\Delta^{s_0 B}\left(D_1\right)\equiv-\varepsilon$ for all $D_1>\widehat{D}_1^{s_0 B,Max}$ in $s_0 B$ and is strictly positive for all lower values of D_1). In all remaining cases, $\left|\Delta^{s_0 s_1}\left(D_1\right)\right|\gg\varepsilon$ and $D_1^{s_0,IC}$ lies strictly between $\widehat{D}_1^{s_0 B,Max}$ and $\widehat{D}_1^{s_0 G,Max}+\gamma_1 C_1$.

However, $D_1^{s_0,IC}$ may not be the face value that enables the incumbent to pledge the most. A promised payment above $D_1^{s_0,IC}$ will lead to low general pledgeability and a lower payment given state B ($B_1^{H,B}\left(\underline{\gamma}\right)$ which is necessarily a payment less than D_1^{IC}) and a payment in state G of $B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1$. This payment above D_1^{IC} will provide a larger expected payment if

$$q^{s_0 G}\left[B_1^{H,G}(\underline{\gamma})+\gamma_1 C_1-D_1^{s_0,IC}\right]+(1-q^{s_0 G})\left[B_1^{H,B}(\underline{\gamma})-\min\left\{B_1^{H,B}(\overline{\gamma}),D_1^{s_0,IC}\right\}\right]>0. \quad (3)$$

If so, the largest pledgeable debt payment implies $\gamma_2=\underline{\gamma}$.

Pledgeability across business cycles with state-contingent contracts

When is low pledgeability chosen? We maintain the assumption that there is no potential underpricing if and only if the state of the economy is GG. Therefore, $D_1^{G,IC}=\widehat{D}_1^{GB,Max}$. An examination of inequality (1) tells us that $D_1^{G,IC}$ enables the incumbent to pledge more if and only if q^{GG} is low.

When q^{GG} is large, $B_1^{H,GG}\left(\gamma\right)+\gamma_1 C_1 = C_2+\gamma_1 C_1$ can pledge more than $\widehat{D}_1^{GB,Max}$ alone. We interpret large q^{GG} as a good (high industry liquidity) state that is likely to continue.

Proposition 3.1: When debt contracts are used and pledgeability choice is made *ex-ante*, low pledgeability is chosen in state G to maximize expected payments to financiers if the good state is sufficiently likely to continue.

What about when the economy begins in the B state? If $\omega_0^{i,B} < \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$, the incumbent has no chance to retain control in state BB. Consequently, low pledgeability is never chosen for any level of q^{BG}. The reason is that, high pledgeability is always preferred in state BB, except for the ε cost. Therefore, as $\varepsilon \to 0$, $D_1^{G,IC} \to \widehat{D}_1^{BG,Max} + \gamma_1 C_1 > B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$ and the incumbent can never pledge more by violating the incentive constraint.

If $\omega_0^{i,B} \geq \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$, the incumbent may still retain control in state BB for some choice of pledgeability. In other words, her choice is determined by a binding constraint on her incentive to choose pledgeability (due either to the effect on payments given retaining control or the effect on keeping control in an auction). In that case, high pledgeability choice is preferred for both large and small q^{BG}. It is only at the intermediate level of q^{BG} that the incumbent might pledge more by violating the IC constraint. This occurs due to the volatility of the desired state-contingent payment being high and the payment being constant due to debt contracts. For large q^{BG}, $D_1^{B,IC}$ approaches to $\widehat{D}^{GB,Max} + \gamma_1 C_1$ which exceeds $B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1$ for sure. For small q^{BG}, inequality (1) is unlikely to hold and $B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1$ pledges less than $D_1^{B,IC}$ in expectation.

Proposition 3.2: When debt contracts are used and pledgeability choice is made *ex-ante*, if $\omega_0^{i,B} < \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$, low pledgeability is never chosen in state B. Otherwise, low pledgeability might be chosen when q^{BG} is neither too high nor too low.

3.2. *Ex-post* Pledgeability Choice

The previous section assumed that the realized economic and liquidity conditions that prevail when current debt will be refinanced are unknown when the choice of pledgeability is made. Now pledgeability choice is made after the state is known. We can imagine that the incumbent learns superior information about the state after acquiring the firm and is able to modify pledgeability. *Ex-post* choice simply means that such learning is perfect. This corresponds to the analysis of the previous section with the probabilities q^{sG} always equal to zero or one.

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. At date 1, there are only two candidates for the value leading to the maximum pledgeable expected payment. The face value of the debt is either $\widehat{D}_1^{s_0G,\max} + \gamma_1 C_1$ or $\widehat{D}_1^{s_0B,\max}$. If there is no potential underpricing in state B, then $D_1^{s_0,Max} = \widehat{D}_1^{s_0G,\max} + \gamma_1 C_1$ as high face value does not distort incumbent's pledgeability choice. When there are potential rents to acquirers, the incumbent is able to raise $q^{s_0G}[\widehat{D}_1^{s_0G,Max} + \gamma_1 C_1] + (1-q^{s_0G})B_1^{H,s_0B}(\underline{\gamma})$ by setting $D_1 = \widehat{D}_1^{s_0G,\max} + \gamma_1 C_1$ and $\widehat{D}_1^{s_0B,Max}$ by setting $D_1 = \widehat{D}_1^{s_0B,Max}$. Debt is risky in the former case as the incumbent defaults if state B realizes. In the latter case, debt is riskless. The incumbent sets $D_1 = \widehat{D}_1^{s_0G,\max} + \gamma_1 C_1$ if and only if $q^{s_0G}[\widehat{D}_1^{s_0G,Max} + \gamma_1 C_1] + (1-q^{s_0G})B_1^{H,s_0B}(\underline{\gamma}) > \widehat{D}_1^{s_0B,Max}$, which is likely to hold when q^{s_0G} is large.

Note that any face value between $\widehat{D}_1^{s_0B,Max}$ and $\widehat{D}_1^{s_0G,Max} + \gamma_1 C_1$ cannot lead to the maximum payment to lenders in this case, because the incumbent chooses pledgeability after knowing the state. A debt contract with face value $D_1 \in (\widehat{D}_1^{s_0 B,Max}, \widehat{D}_1^{s_0 G,Max} + \gamma_1 C_1)$ always delivers less than

$D_1^{s_0,Max} = \widehat{D}_1^{s_0 G,\max} + \gamma_1 C_1$ as it distorts pledgeability choice in the bad state but pays less in the good state.

Lemma 3.2 summarizes the results at date 1. Detailed results about payoff functions are listed in the appendix.

Lemma 3.2:

(1) If there is no potential underpricing even in state s_0 B, $D_1^{s_0,Max} = \widehat{D}_1^{s_0 G,\max} + \gamma_1 C_1$. Pledgeability choices are not distorted (relative to state-contingent contracting) in either state.

(2) If there is potential underpricing in state s_0 B and $q^{s_0 G}[\widehat{D}_1^{s_0 G,Max} + \gamma_1 C_1] + (1-q^{s_0 G}) B_1^{H,s_0 B}(\underline{\gamma}) > \widehat{D}_1^{s_0 B,Max}$, $D_1^{Max} = \widehat{D}_1^{s_0 G,\max} + \gamma_1 C_1$, then pledgeability choice is distorted in state B: $\gamma_2 = \underline{\gamma}$. Debt is risky in state B.

(3) If there is potential underpricing in state B and $q^{s_0 G}[\widehat{D}_1^{s_0 G,Max} + \gamma_1 C_1] + (1-q^{s_0 G}) B_1^{H,s_0 B}(\underline{\gamma}) < \widehat{D}_1^{s_0 B,Max}$, $D_1^{Max} = \widehat{D}_1^{B,Max}$. Pledgeability choice is not distorted in either state. Debt is riskless and leverage is set low.

Proof: Sketched in the text above.

Pledgeability across economic cycles

We maintain the assumptions that there is no potential underpricing in state GG. We also assume sufficient auto-correlation of states over time. We assume that

$q^{GG}[\mathrm{C}_2 + \gamma_1 C_1] + (1-q^{GG}) B_1^{H,GB}(\underline{\gamma}) > \widehat{D}_1^{GB,Max}$ whereas

$q^{BG}[\widehat{D}_1^{BG,Max} + \gamma_1 C_1] + (1-q^{BG}) B_1^{H,BB}(\underline{\gamma}) > \widehat{D}_1^{BB,Max}$. This requires q^{GG} to be large and q^{BG} to be small. Both the good state and the bad state are likely to continue. As a result, low pledgeability is chosen in state GG, due to no potential underpricing, and in state GB, due to the fact that the debt payment is in excess of that which provides the incumbent an incentive for choosing high pledgeability. High pledgeability is chosen in both state BG and BB.

Proposition 3.3: If the economic states are sufficiently positively autocorrelated and debt contracts are used with pledgeability is set *ex-post*, then pledgeability will be low in the good state and high in the bad state.

Proof: Sketched in the text above.

We end this section with a discussion on incumbent's incentive to store cash. The incumbent has no additional incentive to store cash at date 1 since there is no uncertainty in the state at date 2. At date 0, when debt is riskless, the incumbent has no incentive to store cash. Storing unit of inputs at date 0 increases D_1 by one unit. If D_1+1 is still riskless, the incumbent's payoff stays unchanged. If however D_1+1 becomes risky, the incumbent's incentive constraint is violated. She cannot commit to set high pledgeability and thus can raise less liquidity. As a result, she is worse off.

However, the incumbent may store some cash at date 0 when debt is risky. By storing 1 unit at date 0, the incumbent borrows less and increases D_1 by $\frac{1}{q^{s_0G}}$ because lenders know that the increased debt is only repayable in state G. The expected value of the borrowers payoff state G is thus unchanged. In state B, the additional 1 unit stored will increase incumbent's bid $B_1^{i,B}(\gamma^i)=\min\left\{\omega_1^{i,B}+\gamma^i C_2, C_2\right\}$ and may help him outbid the insiders. As a result, there might be a upward jump in the expected value of state B and if that happens, the incumbent would like to store some cash. This has some similarity to Hart (1995).

IV. Extensions

In this section, we introduce several extensions to the basic model. In section 4.1, we add one more period to the model, and show that at date 0, the asset can be inefficiently sold to a financier who has no production capabilities. Such an inefficient allocation is more likely when the moral hazard on pledgeability limits the payment that the incumbent can credibly repay. In section 4.2, we relax the assumption that the incumbent cannot produce conditional on losing her ability. Instead, we assume that she can produce a fraction αC_t when the state is good. Interestingly, the maximal credible payment $\widehat{D}_1^{s_1,Max}$ can decrease with α, since the incumbent may want to retain control even if she loses ability.

4.1. The Dynamic Model with fully state-contingent contracts

The allocations so far are always efficient. This is because the high type managers always manage the asset and we have assumed that the economy starts with a high-type manager in place. In this section, we add one more period and show that in that period the asset could be sold to a financier, despite the fact that he has no production capabilities. Such allocation is inefficient (it does not maximize total surplus) and this outcome is more likely to occur when the moral hazard on pledgeability choice is severe, limiting the payment a high type manager can commit to pay. Interestingly, payment capacity is not similarly limited for the financier– because he generates no cash, he has no incentive to lower pledgeability or to hold on to the asset longer than he needs to, therefore his focus is on increasing pledgeability to make the asset more saleable. This difference will explain why assets sometimes migrate to less-able financiers for a while when potential moral hazard (the incentive to reduce pledgeability) is high, even when industry insiders have some liquidity (which may be more liquidity than held by a financier).

The setup is identical to that in Section I except that we introduce an additional period 0 and date -1. The economy has 4 dates– -1, 0, 1, 2– and 3 periods (period 0, 1 and 2). There is uncertainty over state realization in both period 0 and period 1. At date -1, the probability of a good state realized in period 1 is q^G. At date 0, the probability of a good state realized in period 2 is $q^{s_0 G}$. Figure 5 describes the state of nature in the dynamic model.

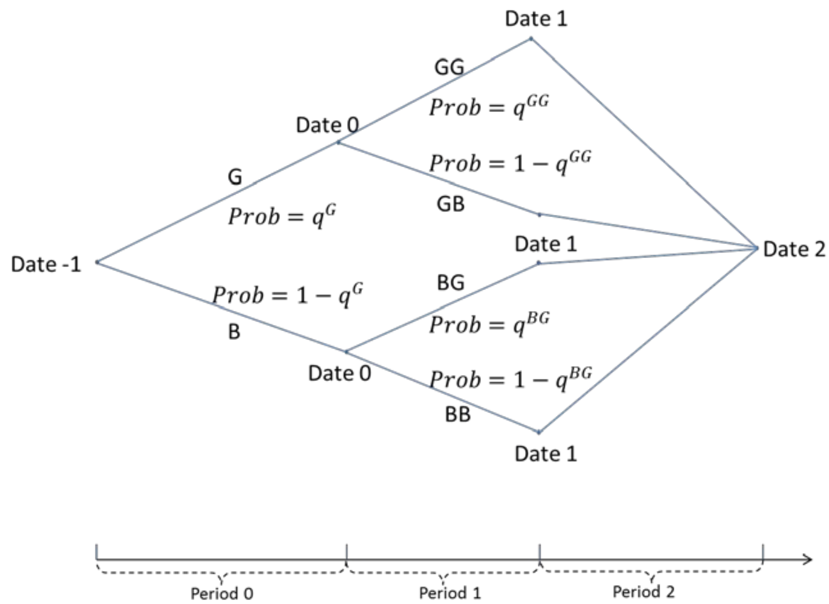

Figure 5: States of nature in the dynamic model

The analysis at date 1 remains unchanged. Here, we focus on date 0, when financiers also may bid successfully. Lemma 4 below is the date 0 analog of Lemma 2.1. We omit the payoff functions for simplicity.

Let $B_0^{L,s}$ and $B_0^{H,s}(\gamma)$ respectively be the bid by financiers and industry insiders. Let $B_0^{\min,s} = \max\{B_0^{L,s}, B_0^{H,s}(\underline{\gamma})\}$ be the minimum bid the incumbent will face.

<u>Lemma 4.1</u>

Let $s_0 = s$.

(ia) If $B_0^{\min,s} \geq q^{sG}C_1 + C_2$, $\widehat{D}_0^{s,Max} = q^{sG}C_1 + C_2$,and $\gamma_1 = \underline{\gamma}$.

(ib) else if $q^{sG}C_1 + C_2 > B_0^{\min,s} \geq B_0^{H,s}(\overline{\gamma})$, $\widehat{D}_0^{s,Max} = B_0^{\min,s}$ and $\gamma_1 = \underline{\gamma}$.

(ii) else if $B_0^{\min,s} > B_0^{i,s}(\gamma^i)$ then $\widehat{D}_0^{s,Max} = B_0^{H,s}(\overline{\gamma}) - \varepsilon$ and $\gamma_1 = \overline{\gamma}$.

else if $B_0^{H,s}(\overline{\gamma}) > B_0^{\min,s}$ and if (iiia) $B_0^{i,s}(\overline{\gamma}) \geq D_0^{s \text{ Pay IC}}$, then $\widehat{D}_0^{s,Max} = D_0^{s \text{ Pay IC}}$ and $\gamma_1 = \overline{\gamma}$.

(iiib) $D_0^{s \text{ Pay IC}} > B_0^{i,s}(\gamma^i) \geq D_0^{s \text{ Control IC}}$, then $\widehat{D}_0^{s,Max} = B_0^{i,s}(\gamma^i)$ and $\gamma_1 = \overline{\gamma}$.

(iv) $D_0^{s \text{ Control IC}} > B_0^{i,s}(\overline{\gamma}) \geq B_0^{\min,s}$ then $\widehat{D}_0^{s,Max} = D_0^{s \text{ Control IC}}$ and $\gamma_1 = \overline{\gamma}$.

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

The cases in Lemma 4.1 are similar to those in Lemma 2.1. In case 1, there is no potential underpricing so that low pledgeability is chosen. Case 2 is unique to the dynamic model. It incorporates two different scenarios. In the first scenario, $B_0^{L,s} \geq B_0^{H,s}(\overline{\gamma}) = B_0^{H,s}(\underline{\gamma})$ so that industry insiders are constrained by the amount of liquidity they can raise and they are outbid by the financiers at date 1. These are periods during which high type managers, once in control, will suffer from severe moral hazard problems and thus can only commit to relatively small payments. Therefore, the bids from industry insiders are low at date 0. Low pledgeability is chosen by the incumbent because the she plans to sell the firm to a financier. Note that renegotiation does not resolve this issue. In the second scenario, $(1-\rho)q^{sG}C_1 + C_2 > B_0^{H,s}(\overline{\gamma}) = B_0^{H,s}(\underline{\gamma}) > B_0^{L,s}$. Here, raising pledgeability γ_1 does not help an industry insider raise more liquidity, although there is potential underpricing in the date 1 auction. These rents cannot be pledged by the incumbent at date 0. In this scenario, again, low pledgeability is chosen.

In contrast to period 1, the incumbent in period 0 selects low pledgeability in two polar cases. In booms, acquirers have enough cash so that there is no underpricing and thus no potential rents to them. This is identical to the result at date 1. Somewhat surprisingly, the period 1 incumbent also sets low pledgeability in a deep bust when a financier is able to outbid industry insiders even if high pledgeability was selected. In that case, a fire sale occurs and the asset is acquired inefficiently by an outsider. Although total output is not maximized, this outcome allows a larger amount to be pledged in the auction.

We end this section by providing some micro-foundations to our earlier assumption in Proposition 3.2. Suppose that the incumbent starts with the same initial wealth ω_0^H as industry insiders. They acquire the firm by winning an initial auction at date -1 and needed to invest their initial wealth in the firm which ended up returning zero in state B at date 0. Therefore, $\omega_0^{i,B} < \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$ will hold. Therefore, when debt contracts are used and the pledgeability choice is made *ex-ante*, high pledgeability is always set.

4.2. Inefficient Incumbency with State-contingent Contracts

Let us now turn to a different possibility than dynamic choice and inefficient acquirers, returning to the analysis beginning on date 0. What if the incumbent loses ability with probability $(1-\theta^H)$ as before, but can in this case still produce αC_t in the firm when the state is good, where $\alpha \in (0,1)$, instead of $\alpha = 0$ as previously assumed? The disabled incumbent's productivity now lies between that of the able industry insider, who can produce C_t when the state is good, and the financier, who can produce nothing. A new source of moral hazard emerges: the incumbent may want to retain the firm even when she loses some ability. This may necessitate still lower maximum payments so as to restore incentives.

An incumbent who is able in period 1 will remain high ability (H) in period 2 with probability θ^H and be able to bid up to $B_1^{iH,s}(\gamma^i) = (1-\gamma_1)i_{[s=G]}C_1 + \gamma^i C_2$ if the period 1 state is *s*, where *i* is the indicator variable. The incumbent is disabled (L) with probability $(1-\theta^H)$ and can bid up to $B_1^{iL,s}(\gamma^i) = (1-\gamma_1)i_{[s=G]}C_1 + \gamma^i \alpha C_2$. To simplify notation, let us assume that, as before, the disabled incumbent can produce nothing if she leaves the firm.

Note that if $\alpha C_2 \le B_1^{H,s}(\underline{\gamma})$ or $B_1^{iL,s}(\gamma^i) < B_1^{H,s}(\underline{\gamma})$, the maximum debt capacity derived in Lemma 1 remains unchanged. Intuitively, the first inequality indicates that the disabled incumbent can get more by selling than by holding on, even after setting pledgeability low, so she will always sell when she loses ability. The second inequality indicates that the disabled incumbent cannot match the lowest possible outside offer, so once again she will have to sell even at the lowest level of debt capacity. Given that she sells when she loses ability, the analysis is then identical to that leading to Lemma 1.

Matters are different when $\alpha C_2 > B_1^{H,s}(\underline{\gamma})$ and $B_1^{iL,s}(\gamma^i) > B_1^{H,s}(\underline{\gamma})$. First consider $\alpha C_2 > B_1^{H,s}(\overline{\gamma})$. Now it is impossible to provide incentives for the incumbent to choose high pledgeability. By retaining control, not only does she generate more cash flow than the highest possible outside bid, she can (weakly) reduce payout for any level of debt by choosing low pledgeability. She also retains control under all circumstances after choosing low pledgeability (because $B_1^{iL,s}(\gamma^i) \geq B_1^{H,s}(\underline{\gamma})$). So low pledgeability is what she will always choose, and she will always retain control. This outcome is always inefficient since $\alpha C_2 < C_2$. Moreover, the maximum debt she can borrow will be $B_1^{H,s}(\underline{\gamma})$.

That leaves $B_1^{H,s}(\overline{\gamma}) > \alpha C_2 \geq B_1^{H,s}(\underline{\gamma})$. To determine the incentive when only payments are influenced by pledgeability, $D_1^{s\ \text{PayIC}}$, we need to first consider the case where $B_1^{iH,s}(\overline{\gamma}) \geq B_1^{H,s}(\overline{\gamma})$, that is the incumbent can outbid industry insiders at date 1 if she retains her ability, even after choosing high pledgeability. For her to have the incentive to do so (and along the lines of our analysis for Lemma 1), it must be that

$$\begin{aligned}&\theta^H(C_2 - D_1^{s\ \text{PayIC}}) + (1-\theta^H)(B_1^{H,s}(\overline{\gamma}) - D_1^{s\ \text{PayIC}}) - \varepsilon \\ &\qquad \geq \theta^H(C_2 - B_1^{H,s}(\underline{\gamma})) + (1-\theta^H)(\alpha C_2 - B_1^{H,s}(\underline{\gamma}))\end{aligned}$$

The left hand side is what the incumbent can get by choosing high pledgeability and selling when she loses ability, and the right hand side is what she gets by choosing low pledgeability and retaining control even after losing ability. It is easily seen that

$$D_1^{s\ \text{PayIC}} = (1-\theta^H)B_1^{H,s}(\overline{\gamma}) + \theta^H B_1^{H,s}(\underline{\gamma}) - (1-\theta^H)[\alpha C_2 - B_1^{H,s}(\underline{\gamma})] - \varepsilon$$

Similarly, when $B_1^{H,s}(\overline{\gamma}) > B_1^{iH,s}(\gamma^i) \geq B_1^{H,s}(\underline{\gamma})$, it can be shown that

$$D_1^{s\text{Control IC}} = B_1^{H,s}(\overline{\gamma}) - \theta^H[C_2 - B_1^{H,s}(\underline{\gamma})] - (1-\theta^H)[\alpha C_2 - B_1^{H,s}(\underline{\gamma}^g)] - \varepsilon$$

Comparing with our earlier values for lemma 2.1, we can see that these values, indicating the maximum incentive compatible debt capacity under different circumstances, are lower by $(1-\theta^H)[\alpha C_2 - B_1^{H,s}(\underline{\gamma})]$, which is the expected rent the incumbent earns if she chooses low pledgeability and turns out to be of disabled.

Somewhat paradoxically, the higher the retention of ability α by the incumbent, the lower the incentive to pledge, and lower the debt she can raise. The consequences of “debt” overhang, even under state-contingent contracts, are thus even more serious – because “pledgeable” debt capacity is so low for an industry insider, the incentive for creditors to seize and sell assets to an industry outsider when liquidity falls off increases. In a richer model with differentiated firms, productivity differentials will increase as liquidity falls off, based on how much debt a firm had taken on during the period of high liquidity. We complete the analysis for earlier dates in the appendix.

V. Implications Related Literature and Evidence

A related alternative model, developed by Shleifer and Vishny (1992) (SV), is that pledgeability choice is fixed with only liquidity varying over time. SV model emphasizes the control rights over assets exclusively through asset sales while we introduce more types of control rights over cash flow through the pledgeability channel, which itself suffers from moral hazard. By doing this, we provide an alternative theory of credit capacity.

Our model has different implications than Shleifer and Vishny (1992). Our model Implies that pledgeability is neglected in booms and in stable industries (see Jensen, 1986). In our economy, assets also migrate to agents who have lower ability to manage, as in SV. However, the underlying mechanism is different. In SV, asset gets 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 owned 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, asset goes to low types because they do not suffer from the moral hazard from pledgeability. As we have shown in Lemma 2.1, this moral hazard problem can greatly reduce the maximal amount that insiders can credibly repay. In our three-period model, financiers are unwilling to renegotiate debt down because they know the asset will be sold to financiers (low types), or the disabled incumbent. Although such allocation is inefficient (in the sense to total surplus) from the society's view, financiers can recover more by selling to low types.

(to be completed).

VI. Discussion and 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. When the bidder can pay full dollar up front for the asset or the asset goes to the outsider, the first moral hazard problem disappears, and so does the moral hazard over pledgeability. Low pledgeability is chosen. When the future bidder can appropriate over and above what she pays, high pledgeability can reduce rents. So the second moral hazard problem also becomes relevant, and debt capacity is limited by the need to retain incentives for pledgeability.

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 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 become more likely because incumbents have the incentive to enhance their own value by reducing the value of outside financial claimants.[4] Hence financial capacity falls when good times are expected to continue but we 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 seamlessly 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 seamless. Economic activity can be disrupted until enforcement 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

[4] 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.

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.

Finally, the fluctuation in debt capacity may be larger if the range of possible values of cash flow pledgeability that can be chosen 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 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.

This paper has focused on the choice of (general) pledgeability, assuming incumbent pledgeability to be costless or fixed. We develop implications for pledgeability enhancing devices such as accounting choice, routine production plans and bond covenants. Incumbent pledgeability could be thought of as exclusive relationship lending, which may have varying importance over the cycle. We plan to explore more of these implications in future work.

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Appendix

Proof of Corrollary 2.1:

If $\omega_1^{H,s_1} = 0$ and there is potential underpricing, then

$D_1^{s_1\ Pay\ IC} = \theta^H B_1^{H,s}(\underline{\gamma}) + (1-\theta^H) B_1^{H,s_1}(\overline{\gamma}) - \varepsilon = \theta^H(\underline{\gamma} C_2) + (1-\theta^H)\overline{\gamma} C_2 - \varepsilon \le B_1^{i,s_1}(\gamma^i)$

because $\overline{\gamma} \le \gamma^i$ and thus $\widehat{D}_1^{s,Max} = D_1^{s\ Pay\ IC} - \varepsilon$ according to case (iiia) of Lemma 2.1. Apparently, $D_1^{s_1\ Pay\ IC}$ increases in ω_1^{H,s_1} until it approaches $B_1^{i,s_1}(\gamma^i) - \varepsilon$. Eventually $D_1^{s_1\ Pay\ IC} > B_1^{i,s_1}(\overline{\gamma}^i) \ge D_1^{s\ Control\ IC}$ and according to case (iiib) of Lemma 2.1, $\widehat{D}_1^{s_1,Max} = B_1^{i,s_1}(\gamma^i) - \varepsilon$. Here, $\widehat{D}_1^{s,Max}$ is flat in ω_1^{H,s_1}. If ω_1^{H,s_1} further increases such that $D_1^{s_1\ Control\ IC} > B_1^{i,s_1}(\overline{\gamma}^i) \ge B_1^{H,s}(\underline{\gamma})$, $\widehat{D}_1^{s_1,Max} = D_1^{s_1\ Control\ IC} - \varepsilon$ according to case iv). Once again, $\widehat{D}_1^{s,Max}$ increases in ω_1^{H,s_1}. With further increase in ω_1^{H,s_1}, $B_1^{H,s_1}(\underline{\gamma}) > B_1^{i,s_1}(\gamma^i)$ and according to case (ii), $\widehat{D}_1^{s_1,Max} = B_1^{H,s_1}(\overline{\gamma}) - \varepsilon$, which also increases in ω_1^{H,s_1}. Finally, if ω_1^{H,s_1} further increases, $B_1^{H,s_1}(\underline{\gamma}) \ge C_2$ and there is no potential underpricing. According to case (i) of Lemma 2.1, $\widehat{D}_1^{s_1,Max} = C_2$ weakly increases in ω_1^{H,s_1}.

Proof of Lemma 3.1:

Let s_0 and s_1 be the realized states at date 0 and date 1. Define $\Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1})$ as the excess of a borrower's payoff from choosing high pledgeability over the payoff from choosing low pledgeability during period 1. Lemma 7.1 is useful for proving Lemma 3.1. It describes $\Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1})$ in various cases of Lemma 2.1.

Lemma 7.1: If $B_1^{H,s_0 s_1}(\underline{\gamma}^g) < B_1^{i,s_0 s_1}(\overline{\gamma}^i) < C_2$, $\Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1}) > 0$ for $\hat{D}_2^{s_1 s_2} < \hat{D}_2^{s_1 s_2,\max}$ and $\Delta_2^{s_1 s_2}(\hat{D}_2^{s_1 s_2}) < 0$ for $\hat{D}_2^{s_1 s_2} > \hat{D}_2^{s_1 s_2,\max}$. If $B_1^{H,s_0 s_1}(\underline{\gamma}^g) = C_2$, $\Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1}) \equiv -\varepsilon$.

Proof: for notational convenience, we skip s_0. When $s_1 = G$, $\Delta_1^{s_0 s_1}(D_1^{s_0 s_1}) = \Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1} + \gamma_1 C_1)$. When $s_1 = B$, we have $\Delta_1^{s_0 s_1}(D_1^{s_0 s_1}) = \Delta_1^{s_0 s_1}(\hat{D}_1^{s_0 s_1})$.

(i) If $B_1^{H,s_0 s_1}(\underline{\gamma}) = C_2$, $\widehat{D}_1^{s_1,Max} = C_2$ and $\gamma_2 = \underline{\gamma}$.

$$V_1^{i,s_1}(\widehat{D}_1^{s_1},\underline{\gamma}) = \begin{cases} 0 & \text{if } \widehat{D}_1^{s_1} > C_2 \\ C_2 - \widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1} \le C_2 \end{cases},$$

$$V_1^{i,s_1}(\widehat{D}_1^{s_1},\overline{\gamma}) = \begin{cases} -\varepsilon & \text{if } \widehat{D}_1^{s_1} > C_2 \\ C_2 - \widehat{D}_1^{s_1} \text{-} \varepsilon & \text{if } \widehat{D}_1^{s_1} \le C_2 \end{cases} \text{ and } \Delta_1^{s_1}(\hat{D}_1^{s_1}) \equiv -\varepsilon .$$

If $C_2 > B_1^{H,s_0 s_1}(\underline{\gamma})$ and

(ii) if $B_1^{H,s_1}(\underline{\gamma}) \ge B_1^{i,s_1}(\gamma^i)$

$\widehat{D}_1^{s_1,Max} = B_1^{H,s_1}(\overline{\gamma}) - \varepsilon$. $\gamma_2 = \overline{\gamma}$ if $\widehat{D}_1^{s_1} \le \widehat{D}_1^{s_1,Max}$ and $\gamma_2 = \underline{\gamma}$ if $\widehat{D}_1^{s_1} > \widehat{D}_1^{s_1,Max}$.

$$V_1^{i,s_1}(\overline{\gamma},\widehat{D}_1^{s_1}) = \begin{cases} -\varepsilon & \text{if } \widehat{D}_1^{s_1} > B_1^{H,s_1}(\overline{\gamma}) \\ B_1^{H,s_1}(\overline{\gamma}) - \widehat{D}_1^{s_1} - \varepsilon & \text{if } B_1^{H,s_1}(\overline{\gamma}) \ge \widehat{D}_1^{s_1} > B_1^{i,s_1}(\gamma^i) \\ \theta^H C_2 + (1-\theta^H) B_1^{H,s_1}(\overline{\gamma}) - \widehat{D}_1^{s_1} - \varepsilon & \text{if } \widehat{D}_1^{s_1} \le B_1^{i,s_1}(\gamma^i) \end{cases},$$

$$V_1^{i,s_1}(\underline{\gamma},\widehat{D}_1^{s_1}) = \begin{cases} 0 & \text{if } \widehat{D}_1^{s_1} > B_1^{H,s_1}(\underline{\gamma}) \\ B_1^{H,s_1}(\underline{\gamma}) - \widehat{D}_2^{s_2} & \text{if } B_1^{H,s_1}(\underline{\gamma}) \ge \widehat{D}_1^{s_1} > B_1^{i,s_1}(\gamma^i) \\ \theta^H C_2 + (1-\theta^H) B_1^{H,s_1}(\underline{\gamma}) - \widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1} \le B_1^{i,s_1}(\gamma^i) \end{cases} \text{ and}$$

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

(iiia1) $B_1^{i,s_1}(\gamma^i) \ge B_1^{H,s_1}(\overline{\gamma})$, then $\widehat{D}_1^{s_1,Max} = D_1^{s_1,PayIC}$. $\gamma_2 = \overline{\gamma}$ if $\widehat{D}_1^{s_1} \le \widehat{D}_1^{s_1,Max}$ and $\gamma_2 = \underline{\gamma}$ if $\widehat{D}_1^{s_1} > \widehat{D}_1^{s_1,Max}$.

$$V_1^{i,s_1}(\overline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}\theta^H[C_2-B_1^{H,s_1}(\overline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } \widehat{D}_1^{s_1}\le B_1^{H,s_1}(\overline{\gamma})\end{cases},$$

$$V_1^{i,s_1}(\underline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})] & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\underline{\gamma})\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\underline{\gamma})-\widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1}\le B_1^{H,s_1}(\underline{\gamma})\end{cases} \text{ and}$$

$$\Delta_1^{s_1}(\widehat{D}_1^{s_1})=\begin{cases}-\theta^H[B_1^{H,s_1}(\overline{\gamma})-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ D_1^{s_1,PayIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\overline{\gamma})\ge\widehat{D}_1^{s_1}>B_1^{H,s_1}(\underline{\gamma})\\ (1-\theta^H)[B_1^{H,s_1}(\overline{\gamma})-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } B_1^{H,s_1}(\underline{\gamma})\ge\widehat{D}_1^{s_1}\end{cases}$$

(iiia2) $B_1^{H,s_1}(\overline{\gamma})>B_1^{i,s_1}(\gamma^i)\ge D_1^{s_1,PayIC}$, then $\widehat{D}_1^{s_1,Max}=D_1^{s_1,PayIC}$. $\gamma_2=\overline{\gamma}$ if $\widehat{D}_1^{s_1}\le\widehat{D}_1^{s_1,Max}$ and $\gamma_2=\underline{\gamma}$ if $\widehat{D}_1^{s_1}>\widehat{D}_1^{s_1,Max}$.

$$V_1^{i,s_1}(\overline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } B_1^{H,s_1}(\overline{\gamma})\ge\widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } \widehat{D}_1^{s_1}\le B_1^{i,s_1}(\gamma^i)\end{cases},$$

$$V_1^{i,s_1}(\underline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})] & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\underline{\gamma})\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\underline{\gamma})-\widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1}\le B_1^{H,s_1}(\underline{\gamma})\end{cases} \text{ and}$$

$$\Delta_1^{s_1}(\widehat{D}_1^{s_1})=\begin{cases}-\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ D_1^{s_1\,ControlIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\overline{\gamma})\ge\widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ D_1^{s_1\,PayIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\underline{\gamma})<\widehat{D}_1^{s_1}\le B_1^{i,s_1}(\gamma^i)\\ (1-\theta^H)[B_1^{H,s_1}(\overline{\gamma})-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}<B_1^{H,s_1}(\underline{\gamma})\end{cases}$$

(iiib) $D_1^{s_1,PayIC}>B_1^{i,s_1}(\overline{\gamma}^i)\ge D_1^{s_1,ControlIC}$, then $\widehat{D}_1^{s,Max}=B_1^{i,s_1}(\overline{\gamma}^i)-\varepsilon$. $\gamma_2=\overline{\gamma}$ if $\widehat{D}_1^{s_1}\le\widehat{D}_1^{s_1,Max}$ and $\gamma_2=\underline{\gamma}$ if $\widehat{D}_1^{s_1}>\widehat{D}_1^{s_1,Max}$.

$$V_1^{i,s_1}(\overline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } B_1^{H,s_1}(\overline{\gamma})\geq \widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } \widehat{D}_1^{s_1}\leq B_1^{i,s_1}(\gamma^i)\end{cases},$$

$$V_1^{i,s_1}(\underline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})] & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\underline{\gamma})\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\underline{\gamma})-\widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1}\leq B_1^{H,s_1}(\underline{\gamma})\end{cases} \text{ and}$$

$$\Delta_1^{s_1}(\widehat{D}_1^{s_1})=\begin{cases}-\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ D_1^{s_1\,ControlIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\overline{\gamma})\geq \widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ D_1^{s_1\,PayIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\underline{\gamma})<\widehat{D}_1^{s_1}\leq B_1^{i,s_1}(\gamma^i)\\ (1-\theta^H)[B_1^{H,s_1}(\overline{\gamma})-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}<B_1^{H,s_1}(\underline{\gamma})\end{cases}$$

(iv) $D_1^{s_1,ControlIC}>B_1^{i,s_1}(\gamma^i)\geq B_1^{H,s_1}(\underline{\gamma})$ then $\widehat{D}_1^{s_1,Max}=D_1^{s_1\,ControlIC}$. $\gamma_2=\overline{\gamma}$ if $\widehat{D}_1^{s_1}\leq \widehat{D}_1^{s_1,Max}$ and $\gamma_2=\underline{\gamma}$ if $\widehat{D}_1^{s_1}>\widehat{D}_1^{s_1,Max}$.

$$V_1^{i,s_1}(\overline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } B_1^{H,s_1}(\overline{\gamma})\geq \widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\overline{\gamma})-\widehat{D}_1^{s_1}-\varepsilon & \text{if } \widehat{D}_1^{s_1}\leq B_1^{i,s_1}(\gamma^i)\end{cases},$$

$$V_1^{i,s_1}(\underline{\gamma},\widehat{D}_1^{s_1})=\begin{cases}\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})] & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\underline{\gamma})\\ \theta^H C_2+(1-\theta^H)B_1^{H,s_1}(\underline{\gamma})-\widehat{D}_1^{s_1} & \text{if } \widehat{D}_1^{s_1}\leq B_1^{H,s_1}(\underline{\gamma})\end{cases} \text{ and}$$

$$\Delta_1^{s_1}(\widehat{D}_1^{s_1})=\begin{cases}-\theta^H[C_2-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}>B_1^{H,s_1}(\overline{\gamma})\\ D_1^{s_1\,ControlIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\overline{\gamma})\geq \widehat{D}_1^{s_1}>B_1^{i,s_1}(\gamma^i)\\ D_1^{s_1\,PayIC}-\widehat{D}_1^{s_1} & \text{if } B_1^{H,s_1}(\underline{\gamma})<\widehat{D}_1^{s_1}\leq B_1^{i,s_1}(\gamma^i)\\ (1-\theta^H)[B_1^{H,s_1}(\overline{\gamma})-B_1^{H,s_1}(\underline{\gamma})]-\varepsilon & \text{if } \widehat{D}_1^{s_1}<B_1^{H,s_1}(\underline{\gamma})\end{cases}$$

The proof of Lemma 3.1 follows apparently then. We prove the case when there is potential underpricing in both states. When $D_1=\widehat{D}_1^{s_0B,Max}$, $\Delta_1^{s_0G}(D_1)>0$ and $\Delta_1^{s_0B}(D_1)=0$. Therefore,

$q^{s_0G}[\Delta^{s_0G}(D_1 - \gamma_1 C_1)] + (1-q^{s_0G})[\Delta_2^{s_0B}(D_1)] > 0$. When $D_1 = \widehat{D}_1^{s_0G,Max} + \gamma_1 C_1$, $\Delta_1^{s_0G}(D_1) = 0$ and $\Delta_1^{s_0B}(D_1) < 0$. Therefore, $q^{s_0G}[\Delta^{s_0G}(D_1 - \gamma_1 C_1)] + (1-q^{s_0G})[\Delta_2^{s_0B}(D_1)] < 0$. Since $q^{s_0G}[\Delta^{s_0G}(D_1 - \gamma_1 C_1)] + (1-q^{s_0G})[\Delta_2^{s_0B}(D_1)]$ decreases with D_1, there exists such $D_1^{s_0,IC}$ that $q^{s_0G}[\Delta^{s_0G}(D_1 - \gamma_1 C_1)] + (1-q^{s_0G})[\Delta_2^{s_0B}(D_1)] > 0$ holds for $D_1 < D_1^{s_0,IC}$ and the reverse holds for $D_1 > D_1^{s_0,IC}$.

Proof of Proposition 3.1:

Since we always assume that in GG, there is no potential underpricing, $D_1^{G,IC} = \widehat{D}_1^{GB,Max}$. We also assume that $\gamma_1 = \underline{\gamma}^g$ since date 0 state was G. The candidates for $D_1^{G,Max}$ are either $C_2 + \gamma_1 C_1$ or $\widehat{D}_1^{GB,Max} \in \left(B_1^{GB}\left(\underline{\gamma}\right), B_1^{GB}\left(\overline{\gamma}\right)\right)$.

- If $D_1 = C_2 + \underline{\gamma} C_1$, the incumbent can raise $q^{GG}\left(C_2 + \underline{\gamma} C_1\right) + \left(1-q^{GG}\right) B_1^{GB}\left(\underline{\gamma}\right)$.
- If $D_1 = \widehat{D}_1^{GB,Max}$, the incumbent can raise $\widehat{D}_1^{GB,Max}$.

Therefore, $D_1^{G,Max} = C_2 + \underline{\gamma} C_1$ if and only if $q^{GG}\left(C_2 + \underline{\gamma} C_1\right) + \left(1-q^{GG}\right) B_1^{GB}\left(\underline{\gamma}\right) > \widehat{D}_1^{GB,Max}$. We know that $B_1^{GB}\left(\underline{\gamma}\right) < \widehat{D}_1^{GB,Max} \le B_1^{GB}\left(\overline{\gamma}\right) - \varepsilon < C_2 + \underline{\gamma} C_1$, the inequality holds for $q^{GG} = 1$ and fails for $q^{GG} = 0$. Since the LHS is strictly increasing in q^{GG}, there exists $q^{GG,IC}$ such that the inequality holds if and only if $q^{GG} \ge q^{GG,IC}$.

Therefore,

- If $q^{GG} \ge q^{GG,IC}$, $D_1^{G,Max} = C_2 + \underline{\gamma} C_1$. $\gamma_2 = \underline{\gamma}$ for $D_1^G \in (\widehat{D}_1^{GB,Max}, D_1^{G,Max}]$ and $\gamma_2 = \overline{\gamma}$ for $D_1^G \in (0, \widehat{D}_1^{GB,Max}]$.
- If $q^{GG} < q^{GG,IC}$, $D_1^{G,Max} = \widehat{D}_1^{GB,Max}$. $\gamma_2 = \overline{\gamma}$.

Proof of Proposition 3.2:

We always assume that in both BG and BB, there is underpricing even if $\gamma_2 = \overline{\gamma}$. We also assume that $\gamma_1 = \overline{\gamma}$ since the date 0 state was B.

1) If $\omega_0^{i,B} < \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$, the incumbent loses control for sure in state BB.

$D_1^{B,IC} = \widehat{D}_1^{BG,Max} + \gamma_1 C_1$ if and only if $\widehat{D}_1^{BG,Max} + \gamma_1 C_1 \geq B_1^{H,BB}\left(\overline{\gamma}^g\right) = \omega_0^{H,B} + \overline{\gamma}^g C_2$. If $C_1 = C_2$, this translates into $\left(\rho + \overline{\gamma}\right) > \theta^H\left(\overline{\gamma} - \underline{\gamma}\right)$ which always holds. Since $B_1^{H,BG}\left(\underline{\gamma}\right) < \widehat{D}_1^{BG,Max}$, the only candidate for $D_1^{B,Max}$ is $\widehat{D}_1^{BG,Max} + \gamma_1 C_1$. Therefore, for any level of q^{BG}, $\gamma_2 = \overline{\gamma}$ is chosen and $D_1^{B,Max} = D_1^{B,IC} = \widehat{D}_1^{BG,Max} + \gamma_1 C_1$.

2) If $\omega_0^{i,B} > \omega_0^{H,B} - \left(\gamma^i - \underline{\gamma}\right)C_1$, the incumbent is either on the Pay IC (where the constraint is due to the effect on payment made given that control can be retained) or the control IC constraint (where pledgeability can cause the incumbent to lose control). We show the case that the incumbent is on the Control IC constraint in BB and on the Pay IC constraint in GB. The result when she is on other IC constraints can be proved in a similar way.

Let's first solve for $D_1^{B,IC}$.

Fact 1: $\widehat{D}_1^{BB,ControlIC} < D_1^{B,IC}$. Simple calculation shows that $\widehat{D}_1^{BB,ControlIC} < \widehat{D}_1^{BG,\mathrm{Pay}\,IC} + \gamma_1 C_1$.

Therefore, $q^G \Delta_1^{BG}\left(D_1 - \gamma_1 C_1\right) + \left(1 - q^G\right)\Delta_1^{BB}\left(D_1\right) > 0$ at $D_1 = \widehat{D}_1^{BB,ControlIC}$.

Fact 2: $D_1^{B,IC} < \widehat{D}_1^{BG,PayIC} + \gamma_1 C_1$. Simple calculation shows that $\widehat{D}_1^{BG,PayIC} + \gamma_1 C_1 > B_1^{H,BB}\left(\overline{\gamma}^g\right)$. Therefore, $q^G \Delta_1^{BG}\left(D_1 - \gamma_1 C_1\right) + \left(1 - q^G\right)\Delta_1^{BB}\left(D_1\right) < 0$ at $D_1 = \widehat{D}_1^{BG,PayIC} + \gamma_1 C_1$.

Fact 3: $B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1 > B_1^{H,BB}(\overline{\gamma}^g)$.

Fact 4: there exists $q^{BG,IC1} = \dfrac{\theta^H\left(C_2 - \omega_0 - \underline{\gamma} C_2\right)}{\left(1 - \theta^H\right)\left(\overline{\gamma} - \underline{\gamma}\right)C_2 - \theta^H\left(C_2 - \omega_0 - \underline{\gamma} C_2\right)}$ such that $q^{BG}\Delta_1^{BG}\left(B_1^{H,BG}(\underline{\gamma})\right) + \left(1 - q^{BG}\right)\Delta_1^{BB}\left(B_1^{H,BB}(\overline{\gamma})\right) < 0$ if and only if $q^{BG} < q^{BG,IC1}$. Evaluate $q^{BG}\Delta_1^{BG}\left(D_1 - \gamma_1 C_1\right) + \left(1 - q^{BG}\right)\Delta_1^{BB}\left(D_1\right)$ at $D_1 = B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$ shows that

$$q^{BG}\Delta_1^{BG}\left(B_1^{H,BG}(\underline{\gamma})\right) + \left(1 - q^{BG}\right)\Delta_1^{BB}\left(B_1^{H,BB}(\overline{\gamma})\right) = q^{BG}\left(1 - \theta^H\right)\left(\overline{\gamma} - \underline{\gamma}\right)C_2 - \left(1 - q^{BG}\right)\theta^H\left(C_2 - \omega_0 - \underline{\gamma} C_2\right).$$

- If $q^G < q^{G,IC1}$, $D_1^{B,IC} < B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1$.
- If $q^G > q^{G,IC1}$, $D_1^{B,IC} > B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1$.

Therefore, $\gamma_2 = \overline{\gamma}$ if $q^{BG} > q^{BG,IC1}$. For the remaining analysis, we discuss the when $q^{BG} < q^{BG,IC1}$.

Fact 5: $D_1^{B,IC} < B_1^{H,BB}(\overline{\gamma})$. Evaluate $q^{BG}\Delta_1^{BG}\left(D_1 - \gamma_1 C_1\right) + \left(1-q^{BG}\right)\Delta_1^{BB}\left(D_1\right)$ at $D_1^{B,IC} = B_1^{H,BB}(\overline{\gamma}^g)$ shows that

$$q^{BG}\Delta_1^{BG}\left(B_1^{H,BB}(\overline{\gamma}) - \gamma_1 C_1\right) + \left(1-q^{BG}\right)\Delta_1^{BB}\left(B_1^{H,BB}(\overline{\gamma})\right) = q^{BG}\left(1-\theta^H\right)\left(\overline{\gamma} - \underline{\gamma}\right)C_2 - \left(1-q^{BG}\right)\theta^H\left(C_2 - \omega_0 - \underline{\gamma}C_2\right).$$

The expression takes on negative values if $q^{BG} < q^{BG,IC1}$.

Fact 6: $D_1^{B,IC} < B_1^{H,BB}(\overline{\gamma}) < B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$. We can explicitly solve for $D_1^{B,IC}$. It satisfies

$q^{BG}\left(1-\theta^H\right)\left(\overline{\gamma} - \underline{\gamma}\right)C_2 + \left(1-q^{BG}\right)\theta^H\left(\widehat{D}_1^{BB,ControlIC} - D_1^{B,IC}\right) = 0.$ Solving this equation shows that,

$$D_1^{B,IC} = \widehat{D}_1^{BB,ControlIC} + \frac{q^G\left(1-\theta^H\right)}{\theta^H\left(1-q^{BG}\right)}\left(\overline{\gamma} - \underline{\gamma}\right)C_2.$$

The question remaining is, given $q^{BG} < q^{BG,IC1}$, does $B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1$ pledge more than $D_1^{B,IC}$? We know that $B_1^{H,BG}(\underline{\gamma}^g) + \gamma_1 C_1$ pledges more if and only if

$q^{BG}\left(B_1^{H,BG}(\underline{\gamma}) + \gamma_1 C_1\right) + \left(1-q^{BG}\right)B_1^{H,BB}(\underline{\gamma}) > D_1^{B,IC}$. Since $D_1^{B,IC}$ also increases with q^{BG}, it turns out that this inequality is non-monotonic w.r.t. q^{BG}. In fact, it reduces to

$$q^{BG}\left[\left(\rho + \gamma_1\right)C_1 - \frac{1-\theta^H}{\theta^H}\frac{1}{1-q^{BG}}\left(\overline{\gamma} - \underline{\gamma}\right)C_2\right] > \left(1-\theta^H\right)\left(\overline{\gamma} - \underline{\gamma}\right)C_2 - \theta^H\left(C_2 - \omega_0 - \underline{\gamma}C_2\right).$$

The inequality is definitely violated for both large and small q^{BG} s. low pledgeability might be chosen when q^{BG} is neither too high nor too low.

Proof of Lemma 4.1:

We have determined the maximum credible payment a bidder can make in each state at date 1. Now we solve who wins the auction in each state at date 0. We begin by solving all parties' bids at date 0.

Industry insiders

The bid by industry insiders is easily arrived at. Each insider has the resources to bid up to $\omega_0^{H,s_0} + q^{s_0G}\left(\gamma_1 C_1 + \widehat{D}_1^{s_0G}\right) + (1-q^{s_0G})\widehat{D}_1^{s_0B}$ where ω_0^{H,s_0} is the cash she has at date 0 and $\gamma_1 C_1 + \widehat{D}_1^{s_0G}$ (less than $\gamma^i C_1 + \widehat{D}_1^{s_0G,Max}$) and $\widehat{D}_1^{s_0B}$ (less than $\widehat{D}_1^{s_0B,Max}$) are the state contingent date-1 payments contracted at date 0. The additional surplus (before debt repayments) she hopes to get by acquiring the firm at date 1 (relative to staying an industry insider and collecting ρC_1 in good states if she retains capability) is $q^{s_0G}\left((1-\rho)C_1 + \widehat{D}_1^{s_0G} + V_1^{i,s_0G}(\widehat{D}_1^{s_0G})\right) + (1-q^{s_0G})\left(\widehat{D}_1^{s_0B} + V_1^{i,s_0B}(\widehat{D}_1^{s_0B})\right)$.

So the industry insider's maximum bid with promised payments $\left(\widehat{D}_1^{s_0G}, \widehat{D}_1^{s_0B}\right)$ and pre-set pledgeability γ_1 (by the incumbent) is

$$B_0^{H,s_0}(\gamma_1) = \underset{\substack{\widehat{D}_1^{s_0G} \le \widehat{D}_1^{s_0G,Max} \\ \widehat{D}_1^{s_0B} \le \widehat{D}_1^{s_0B,Max}}}{Max} \quad Min\Big[\omega_0^{H,s_0} + q^{s_0G}\left(\gamma_1 C_1 + \widehat{D}_1^{s_0G}\right) + (1-q^{s_0G})\widehat{D}_1^{s_0B},$$
$$q^{s_0G}\left(C_1 + \widehat{D}_1^{s_0G} + V_1^{i,s_0G}(\widehat{D}_1^{s_0G})\right) + (1-q^{s_0G})\left(\widehat{D}_1^{s_0B} + V_1^{i,s_0B}(\widehat{D}_1^{s_0B})\right)\Big]$$

Note that higher $\left(\widehat{D}_1^{s_0G}, \widehat{D}_1^{s_0B}\right)$ enable an industry insider to raise more at date 0, thus more likely to win an auction. Meanwhile, higher scheduled payments make her more likely to lose control at date 1, and lose the associated rents. The amount the industry insider raises from financiers at date 0, trades off these two effects.

Financiers

A low-type financier can also bid at date 0, with the objective of holding on to the firm over the period if he can get it cheaply, and selling at date 1. Given that the financier does not suffer from moral hazard (he has no desire to set γ_2 low because he wants to sell for certain), he can pay up to $B_0^{L,s_0} = q^{s_0G} B_1^{H,s_0G}(\overline{\gamma}) + (1-q^{s_0G}) B_1^{H,s_0B}(\overline{\gamma}) - \varepsilon$. Note that the wealth of the financier coming into date 1 does not matter. Because he does not suffer from moral hazard, he can borrow the entire amount he realizes from the verifiable future sale (though he must keep a small rent to compensate himself for the cost of enhancing pledgeability).

High-type Incumbent

Consider now the high type incumbent at date 0. Her bid can be achieved in a similar way as industry insiders. She can afford to pay up to $\omega_0^{i,s_0} + q^{s_0G}\left(\gamma^i C_1 + \widehat{D}_1^{s_0G,Max}\right) + (1-q^{s_0G})\widehat{D}_1^{s_0B,Max}$ where i_{s_0} is an indicator variable for the period 1 state:

$$B_0^{i,s} = \underset{\substack{\widehat{D}_1^{s_0G} \le \widehat{D}_1^{s_0G,Max} \\ \widehat{D}_1^{s_0B} \le \widehat{D}_1^{s_0B,Max}}}{Max} \quad Min\Big[\omega_0^{i,s_0} + q^{s_0G}\left(\gamma^i C_1 + \widehat{D}_1^{s_0G,Max}\right) + (1-q^{s_0G})\widehat{D}_1^{s_0B,Max},$$

$$q^{s_0G}\left(C_1 + \widehat{D}_1^{s_0G} + V_1^{i,s_0G}(\widehat{D}_1^{s_0G})\right) + (1-q^{sG})\left(\widehat{D}_1^{s_0B} + V_1^{i,s_0B}(\widehat{D}_1^{s_0B})\right)\Big].$$

Incumbent's Choice of γ_1

Consider the incentive problem for the period-0 incumbent in setting γ_1. Let $B_1^{\min,s} = \max\{B_1^{L,s}, B_1^{H,s}(\underline{\gamma}^g)\}$. This is the minimum bid the incumbent will face. Consistent with Lemma 2.1, we classify the analysis into four cases. i) Pledgeability does not matter for repayment. ii) The incumbent can never outbid industry insiders. iii) The incumbent can always outbid industry insiders. iv) The incumbent can outbid industry insiders when pledgeability is low, but not when pledgeability is high.

(i) Pledgeability does not matter for repayment

This case has two subcases. (a) If $B_0^{\min,s_0} \geq q^{s_0G}C_1 + C_2$ so that there is no potential underpricing. (b) $q^{s_0G}C_1 + C_2 > B_0^{\min,s} \geq B_0^{H,s}(\overline{\gamma})$ so that there is potential underpricing. Subcase (b) also includes two scenarios. In the first scenario, $B_0^{L,s} \geq B_0^{H,s}(\overline{\gamma}) = B_0^{H,s}(\underline{\gamma})$ so that industry insiders are outbid by financiers. In the second scenario, $q^{s_0G}C_1 + C_2 > B_0^{H,s_0}(\overline{\gamma}) = B_0^{H,s_0}(\underline{\gamma}) > B_0^{L,s_0}$, although there is potential underpricing in the date 1 auction. These rents cannot be pledged by the incumbent at date 0. In all categories above, the incumbent has no incentive to set pledgeability high since it does not affect the auction outcome.

(ii) The incumbent can never outbid industry insiders.

Along the lines of analysis in period 1, high pledgeability is set and $\widehat{D}_0^{s_0,Max} = B_0^{H,s}(\overline{\gamma}) - \varepsilon$.

(iii) Incumbent always retains control conditional on retaining ability

Along the lines of the analysis in period 1, when the incumbent's choice does not lead to a change in control so long as she remains capable, the maximal promised payout $D_0^{s\ \text{Pay IC}}$ solves equation $\theta^H V_{0+}^{i,s_0}(\gamma^i, D_0^{s_0\ \text{Pay IC}}) + (1-\theta^H)\left(B_0^{H,s_0}(\overline{\gamma}) - D_0^{s_0\ \text{Pay IC}}\right) - \varepsilon = \theta^H V_{0+}^{i,s_0}(\gamma^i, B_0^{\min,s_0})$, where $V_{0+}^{i,s_0}(\gamma^i, d)$ is the maximum expected rent a high type incumbent can get if she wins the auction at date 0 after setting incumbent pledgeability at its maximum γ^i and promised repayments enough to repay *d*.

Specifically, $V_{0+}^{i,s_0}(\gamma^i, d) = \underset{\substack{\widehat{D}_1^{s_0G} \leq \widehat{D}_1^{s_0G,Max} \\ \widehat{D}_1^{s_0B} \leq \widehat{D}_1^{s_0B,Max}}}{Max} \quad q^{s_0G}\left((1-\gamma^i)C_1 + V_1^{i,s_0G}(\widehat{D}_1^{s_0G})\right) + (1-q^{s_0G})V_1^{i,s_0B}(\widehat{D}_1^{s_0B})$

such that $\omega_0^{i,s_0} + q^{s_0G}\left(\gamma^i C_1 + \widehat{D}_1^{s_0G}\right) + (1-q^{s_0G})\widehat{D}_2^{s_0B} \geq d$. If the payment to retain control does not dynamically affect future control, this reduces to $D_0^{s_0 \text{ Pay IC}} = \theta^H B_0^{\min,s_0} + (1-\theta^H) B_0^{H,s_0}(\overline{\gamma}) - \varepsilon$ which is analogous to the date 1 expression $D_1^{s_1 \text{ Pay IC}}$.

(iv) Incumbent could lose control depending on the level of pledgeability

When the choice of pledgeability leads to a change in control, we have:

$$D_0^{s_0 \text{ Control IC}} = B_0^{H,s}(\overline{\gamma}) - \theta^H V_{0+}^{i,s}(\gamma^i, B_0^{Min,s_0}) - \varepsilon .$$

Lemma 7.2 is the full-fledged version of Lemma 4.1.

Lemma 7.2

Let $s_0 = s$,

(ia) If $B_0^{\min,s} \geq q^{sG} C_1 + C_2$, $\widehat{D}_0^{s,Max} = q^{sG} C_1 + C_2$,and $\gamma_1 = \underline{\gamma}$

For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent expects $V_0^{i,s}(\widehat{D}_0^s) = (q^{sG} C_1 + C_2) - \widehat{D}_0^s$.

(ib) else if $(q^{s_0 G} C_1 + C_2) > B_0^{\min,s} \geq B_0^{H,s}(\overline{\gamma})$, $\widehat{D}_0^{s,Max} = B_0^{\min,s}$ and $\gamma_1 = \underline{\gamma}$

For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent gets $V_0^{i,s}(\widehat{D}_0^s) = B_0^{\min,s} - \widehat{D}_0^s$ if $B_0^{i,s}(\gamma^i) < \widehat{D}_0^s$.

If $B_0^{i,s}(\gamma^i) \geq \widehat{D}_0^s$ then the incumbent gets $V_0^{i,s}(\widehat{D}_0^s) = \theta^H V_{0+}^{i,s}(\gamma^i, \widehat{D}_0^s) + (1-\theta^H)(B_0^{\min,s} - \widehat{D}_0^s)$.

(ii) else if $B_0^{\min,s} > B_1^{i,s}(\gamma^i)$ then $\widehat{D}_0^{s,Max} = B_0^{H,s}(\overline{\gamma}) - \varepsilon$. For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent chooses $\gamma_2 = \overline{\gamma}$ and gets $V_0^{i,s}(\widehat{D}_0^s) = B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s - \varepsilon$ if $B_0^{i,s}(\gamma^i) < \widehat{D}_0^s$, otherwise $V_0^{i,s}(\widehat{D}_0^s) = \theta^H V_{0+}^{i,s}(\gamma^i, \widehat{D}_0^s) + (1-\theta^H)(B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s) - \varepsilon$.

Else if $B_1^{H,s}(\overline{\gamma}^g) > B_1^{\min,s}$ and if

(iiia) $B_0^{i,s}(\gamma^i) \geq D_0^{s \text{ Pay IC}}$, then $\widehat{D}_0^{s,Max} = D_0^{s \text{ Pay IC}}$. For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent chooses $\gamma_2 = \overline{\gamma}$ and gets $V_0^{i,s}(\widehat{D}_0^s) = \theta^H V_{0+}^{i,s}(\gamma^i, \widehat{D}_0^s) + (1-\theta^H)(B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s) - \varepsilon$

(iiib) $D_0^{s\text{ Pay IC}} > B_0^{i,s}(\gamma^i) \geq D_0^{s\text{ Control IC}}$, then $\widehat{D}_0^{s,Max} = B_0^{i,s}(\gamma^i)$. For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent chooses $\gamma_2 = \overline{\gamma}$ and gets $V_0^{i,s}(\widehat{D}_0^s) =$
$\theta^H V_{0+}^{i,s}(\gamma^i, \widehat{D}_0^s) + (1-\theta^H)(B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s) - \varepsilon$.

(iv) $D_0^{s\text{ Control IC}} > B_0^{i,s}(\gamma^i) \geq B_0^{\min,s}$ then $\widehat{D}_0^{s,Max} = D_0^{s\text{ Control IC}}$. For any promised payment $\widehat{D}_0^s \leq \widehat{D}_0^{s,Max}$, the incumbent chooses $\gamma_2 = \overline{\gamma}$ and gets $V_0^{i,s}(\widehat{D}_0^s) =$ $B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s - \varepsilon$ if $B_0^{i,s}(\gamma^i) < \widehat{D}_0^s$. Otherwise, the incumbent chooses $\gamma_2 = \overline{\gamma}$ and gets $V_0^{i,s}(\widehat{D}_0^s) =$
$\theta^H V_{0+}^{i,s}(\gamma^i, \widehat{D}_0^s) + (1-\theta^H)(B_0^{H,s}(\overline{\gamma}) - \widehat{D}_0^s) - \varepsilon$.