A Theory of Loan Commitments Based on the Borrower's Investment Incentives

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Abstract

We model an entrepreneur's choice between a loan commitment and a spot loan. The former type of loan precedes, and the latter type follows his investment timing decision. We find that the entrepreneur prefers the former when his bargaining power is small and his equity stake in the investment is large, and the latter otherwise. The spot loan yields the first-best timing when the entrepreneur behaves by maximizing security benefits, and the second-best timing when he misbehaves by diverting security benefits to extract private rents. The loan commitment inefficiently delays the investment compared to the first- and second-best benchmarks, in the region that the entrepreneur prefers it. As a result, there is demand for loan commitments in lending markets that are less than perfectly competitive, whereas in the perfectly competitive ones, spot loans always dominate loan commitments.

JEL Classification: G31; G21

Keywords: Loan commitments; Real options; Agency

1 Introduction

In broad terms, banks offer two main types of loans. The first type is a loan commitment, which allows the borrower to fix the terms of loan in advance and leaves the timing of investment to his discretion. The second type is a spot loan, which sets the terms when the borrower contacts the bank for immediate investment. Given the significance of loan commitments in bank lending, we are interested in understanding why borrowers prefer fixing the loan terms in advance when they do not need the loans for immediate use.

The literature provides three main motivations for borrowers' demand for loan commitments. First of all, risk averse borrowers demand loan commitments in order to hedge against interest rate volatility. Second of all, when there is information asymmetry, borrowers purchase loan commitments to signal their quality. Third, when effort is unobservable or unverifiable, borrowers use them to alleviate inefficiencies, which are ultimately borne by them in competitive lending markets. In this paper, we provide another motivation for the existence of loan commitments which is not based on risk aversion, adverse selection, or moral hazard, as we work in a setting that has universal risk neutrality, perfect information and observable (but unverifiable) effort.

We model the financing choice and investment timing decision of a borrower who holds a real option to invest in his project.[1] The borrower chooses between a loan commitment and a spot loan, the terms of which are negotiated with a bank, and decides when to invest given his choice. We find that there is a fundamental motivation for the borrower's demand for loan commitments, which stems from his control over the investment timing decision. His investment-timing policy affects the terms of loan commitment offered to him by the bank, such that this type of loan becomes more attractive for him than the spot loan under certain conditions. This is because the borrower times the investment such that he maximizes the net present value (NPV) of his equity, and not the project's value, hence the borrower and the bank adjust the terms of loan commitment anticipating the borrower's ex-post reaction.[2] Note that, the investment-timing policy of the borrower does not affect the terms of spot loan, since the borrower decides when to invest ex ante, and not ex post as in the case of the

[1] See e.g Dixit and Pindyck (1994) for the real options methodology.

[2] See e.g. Mauer and Sarkar (2005) for a discussion of borrower-lender conflicts over the investment timing decision.

loan commitment.

We show that the borrower's choice between the loan commitment and the spot loan depends on his bargaining power *vis-à-vis* the bank and the proportion of investment he finances with his internal funds. More specifically, if his bargaining power is small and/or if his equity stake in the project is large, he prefers the loan commitment.[3] The reason is, in this case, he invests later than the first-best investment timing, which results in an inefficient delay in investment.[4] This inefficient delay reduces the bank's NPV. Therefore, the bank raises the share of the borrower, so that the borrower speeds up the investment. In other words, the bank mitigates the inefficient delay by offering the borrower a larger share, which in turn makes the loan commitment more attractive than the spot loan. On the other hand, if the borrower has a high level of bargaining power and/or low internal equity, he prefers the spot loan. This is due to the fact that under the loan commitment he would invest earlier than the first-best investment timing, and inefficiently hurry the investment. The bank's response is to reduce the borrower's share so that the borrower does not invest prematurely. This suggest the bank mitigates the inefficient hurry by offering the borrower a smaller share, which in turn renders the loan commitment less attractive than the spot loan.

The terms and investment thresholds of the loan commitment and the spot loan are affected by private benefits extraction by the borrower. If the borrower is not incentivized, he diverts cash-flows from security benefits of the project and extract private benefits from those cash-flows for his consumption. Private benefits include perquisite consumption, shirking, empire building and enjoying quiet life.[5] Dyck and Zingales (2004) find that private benefits of control enjoyed by managers have an average value of 14% of a firm's equity, and their value can go up to as high as 65%. Furthermore, many theoretical papers argue that private benefits extraction is inefficient in that it has a deadweight cost. These papers explain that the private benefit of $1 reduction in security benefits to the borrower is less than $1 (see e.g. Pagano and Rell (1998) and Burkart, Gromb, and Panunzi (1998)). We find that when the borrower's stake in the security benefits is higher than a certain critical value, he has no incentives to extract private benefits, and his choice between the two types of loans is as

[3]We will give a precise description of what we mean by small (or large) bargaining power and equity stake in Section 3.

[4]See e.g. Grenadier and Wang (2005) for an explanation of hurried and delayed investment.

[5]See Shleifer and Vishny (1997) for explanations of typical private benefits.

discussed above. When his stake in the security benefits is lower than that critical value, he extracts private benefits. In this case, the basis of his preference remains the same, such that if his bargaining power is small (large) and/or if his equity stake in the project is large (small), he prefers the loan commitment (spot loan). What is different is that, the bank can incentivize the borrower instead of letting him misbehave.[6] In such a case, the loan commitment and the spot loan become identical in that they offer the same terms and yield the same investment timing.

In terms of investment efficiency, we find that the spot loan is efficient, since if the borrower prefers this type of loan he applies for it at the first-best investment threshold when he behaves, and at the second-best investment threshold when he misbehaves. The second-best investment threshold is inefficiently delays the investment when first-best is attainable; but is optimal when first-best is not attainable. The loan commitment, on the other hand, is inefficient, since when the borrower prefers a loan commitment he inefficiently delays the investment compared to the first-best timing when he behaves and to the second-best timing when he misbehaves. Therefore, we conclude that competition in lending market improves investment efficiency, as borrowers prefer efficient spot loans when their bargaining positions against banks are strong. Furthermore, the fact that we observe a significant amount of loan commitments in reality implies that the lending markets are not highly competitive and/or the other motivations for the existence of loan commitments also have merit.

The literature on loan commitments started developing in the late 1970s. This development was a response to the increasing significance of loan commitments in bank lending. Overall, one can identify four main strands. The first one views loan commitments as hedging instruments that insure risk-averse borrowers from the interest rate risk in the spot lending market. The papers in this strand include Campbell (1978), who determines firms' demand for and banks' supply of insurance; and Thakor, Greenbaum, and Hong (1981) and Thakor (1982), who use option pricing models to value fixed- and variable-rate loan commitments. The latter two papers assume that the loan is always taken-down in full and only at maturity. Chateau (1990) relaxes the second assumption by modeling loan commitments as compound American put options, while Chava and Jarrow (2008) relaxes both by following a reduced

[6]Throughout the paper by behavior we mean that the borrower maximizes security benefits, and by misbehavior we mean that he reduces them by diverting cash-flow for private benefits extraction.

form credit risk approach.

The second strand is interested in explaining the structure of loan commitments and in particular the existence of multiple fees. Melnik and Plaut (1986a) view loan commitments as packages of loan terms that contain a maximum commitment amount, markup rate, commitment fee, and collateral amount. In their model, the borrowers choose from a set of such packages the one that best suits their interests. Thakor and Udell (1987) find that when banks are risk neutral and firms are risk averse, the concurrent use of commitment and usage fees provide optimal risk sharing. Shockley and Thakor (1997) present a model of loan commitment fee structure and test it empirically. The multiple fee structure in their model serves to alleviate ex ante and ex post contracting problems stemming from private information.

The third strand seeks to explain the demand for loan commitments under risk neutrality. The common point of the papers in this strand is that risk aversion of stockholders cannot alone explain the existence of loan commitments. This is because stockholders can diversify their portfolios, and hence do not demand hedging on the firm level. Kanatas (1987) justifies the demand for loan commitments in a risk neutral world by arguing that these contracts lower the cost of debt of good firms by signaling their quality in a commercial paper market with asymmetric information. Maksimovic (1990) shows that another purpose of the loan commitments is that they improve a firm's strategic position in competition as they constitute a threat to increase product output. Berkovitch and Greenbaum (1991) provide yet another reason for loan commitments' existence when markets are risk-neutral. They show that when the investment is two staged and the amount required for the second stage is unknown, loan commitments can resolve the underinvestment problem caused by debt overhang. In the same spirit, Snyder (1998) shows that loan commitments dominate standard debt contracts, since the commitment fee charged up front allows a lower interest that incentivizes the firm to continue with the investment.

The fourth strand focuses on the comparison of loan commitments and spot loans. Some of the papers in this strand assume risk neutrality, whereas others risk aversion, but in both cases they try to explain the firms' choice between these two types of contracts. Melnik and Plaut (1986b) argue that loan commitments have become the dominant form credit instrument, and develop a model in which these contracts indeed always dominate spot loans. Their result relies on risk aversion, since the spot rate increases in the size of loan taken out. Their model is, however, restrictive in that although the loan size affects the spot rate it does not alter the probability of default. Boot, Thakor, and Udell (1987) argue that loan commitments can dominate spot loans when it incentivizes firms to put the best effort, which is unobservable by banks. This is because the interest rate uncertainty results in suboptimal efforts by firms, and loan commitments can set an interest rate low enough to induce first-best effort level. The banks charge a high commitment fee to compensate the low interest rate, but since this is a sunk cost, it does not affect the firm's ex post effort choice. In Avery and Berger (1991), banks decide whether to commit loans to firms or to wait and offer them spot loans. The idea is that the information available to banks when firms apply for loan commitments is less, and some information is revealed before a spot loan is agreed. The authors show that in this case the loan commitment contract can in fact create inefficiencies rather than alleviating them, as borrowers may shift to a riskier project after the contract is signed or riskier borrowers who would be denied financing in the spot market can get financed. Finally, the model of Duan and Yoon (1993) endogenize the investment decision when firms select between loan commitments and spot loans. They find that in the absence of informational asymmetries spot financing is efficient, and loan commitments lead to over-investment. Moreover, in this case, there is no demand for loan commitments, since the cost of over-investment is borne by the firms in a competitive lending market. They also find that in the presence of informational asymmetries, firms can signal their type by purchasing loan commitments, and hence can lower their cost of capital.

The remainder of this paper is organized as follows. In Section 2, we describe the setting of our model, explain how the terms of the loan commitment and spot loan are determined, and derive the first- and second-best investment timing. In Section 3, we solve for the terms of each type of loan and the subsequent investment timing. Then, in Section 4 we present the entrepreneur's choice between the two types of loans and discuss the implications of his choice for investment efficiency. Section 5 concludes.

2 Model

2.1 Setting

An entrepreneur has access to a project that requires an irreversible investment of I. His wealth is only A, however, such that $A \leq I$. Therefore, he decides to apply for a bank loan to finance the residual investment of $I - A$.[7] In return for the bank's capital, the entrepreneur pledges it a share of the project's security benefits. If the bank does not agree to make the loan, the investment cannot take place. The entrepreneur and the bank are both risk-neutral, and the banks operate in an imperfectly competitive market.

The project value V_t varies over time following a geometric Brownian motion:

$$dV_t = \alpha V_t dt + \sigma V_t dz \tag{1}$$

where α is the drift parameter, σ is the variance parameter, and dz is the increment of a Wiener process. The risk-free interest rate is r. If the bank agrees to make the loan, the investment takes place when V_t hits the entrepreneur's optimal investment threshold V^*. After the investment, the project starts and the entrepreneur either behaves in the best interests of the creditor and maximizes security benefits, or misbehaves and diverts cash-flows from security benefits. In the case of misbehavior, the present value of diverted cash-flows amounts to ϕ percent of the project value at the time of investment:

$$V_{\mathrm{d}} = \phi V^* \tag{2}$$

The entrepreneur has incentives to misbehave only if he can extract a sufficient amount of private benefits from the cash-flows he diverts. Private benefits extraction is costly, such that the private benefits are worth less to the entrepreneur than the cash-flows he diverts. In other words, the value of private benefits V_{pb} is only a fraction of the value of diverted cash-flows at the time of investment:

$$V_{\mathrm{pb}} = \theta V_{\mathrm{d}} = \theta \phi V^* \tag{3}$$

[7] Although we use the terms entrepreneur and bank in the rest of the paper, our setting is not confined to this kind of relationship, and can be used for borrower-lender and manager-investor type of relationships as well.

where θ is the entrepreneur's efficiency (or $1-\theta$ is the deadweight cost) of private benefits extraction and $0 \leq \theta < 1$.[8] The first-order relationship between V_{pb} and θ suggests that the value of private benefits is proportional to the entrepreneur's efficiency of private benefits extraction. While security benefits of the project are shared between the entrepreneur and the bank, private benefits accrue to the entrepreneur only. Consequently, the entrepreneur appropriates the entire value of private benefits, but bears only part of their cost, which is the reduction in security benefits. As a result, the entrepreneur has incentives to misbehave, when the value of private benefits exceeds their cost.

Inefficient private benefits extraction suggest that the project value at the time of investment V^* can be decomposed into three components:

$$\begin{aligned} V^* &= (1-\phi)V^* + \theta\phi V^* + (1-\theta)\phi V^* \\ &= V_{\text{sb}} + V_{\text{pb}} + V_{\text{lost}} \end{aligned} \tag{4}$$

where V_{sb} and V_{lost} are the values of security benefits and deadweight loss respectively. When the entrepreneur behaves $V_{\text{sb}} = V^*$ and $V_{\text{pb}} = V_{\text{lost}} = 0$; when he misbehaves, on the other hand, $V_{\text{sb}} < V^*$, $V_{\text{pb}} > 0$, and $V_{\text{lost}} > 0$.

We define the ratio of V_{pb} to V_{sb} as a measure for the *severity* of agency problem inherent in the project:[9]

$$x = \frac{\theta\phi}{(1-\phi)} \tag{5}$$

Misbehavior is more likely when V_{pb} is high, and more costly for the investor when V_{sb} is low. Therefore, agency problem is more severe for the investor when x is higher. When the entrepreneur cannot extract any private benefits from the diverted cash-flows ($\theta = 0$) and/or when no cash-flows can be diverted ($\phi = 0$), x is equal to zero. In this case, the entrepreneur behaves and maximizes security benefits, hence the investor's interests are served and there is no agency problem. On the other hand, when the entrepreneur can divert cash-flows ($\phi > 0$), and extract private benefits from those cash-flows ($\theta > 0$), x is positive. Now, there

[8] The parameter θ can be interpreted as the entrepreneur's skill of converting diverted cash-flows into private benefits. The entrepreneur would be perfectly skilled, if he could convert each diverted-dollar into one dollar worth of private benefits. The constraint $\theta < 1$ ensures that he is less than perfectly skilled and $(1-\theta)$ percent of a diverted-dollar is lost during conversion.

[9] DeMarzo and Fishman (2007) has a similar measure for the severity of agency problem. Their measure is the fraction of each dollar the agent consumes privately, which corresponds to θ in our model.

is a potential agency conflict such that the investor may suffer from a reduction in security benefits due to entrepreneurial misbehavior.

2.2 Loan Terms

As we have mentioned in the previous section, we assume that the bank does not operate in a perfectly competitive market. Therefore, it extracts some portion of the surplus created by the project. The portion it extracts is determined through bargaining between the entrepreneur and itself. We denote the entrepreneur's bargaining power as η and the bank's as $1-\eta$, where $0 \leq \eta \leq 1$ (note that, there is perfect competition in the lending market when $\eta = 1$, in which case the entrepreneur gets the entire surplus). The outcome of their bargaining settles the loan terms, such that the entrepreneur gets $\gamma\%$ of the project value at the time of investment (i.e. V^*), and the bank rest of it.

The bargaining game they play in order to determine γ is subject to the following constraints:

1. Limited liability constraint (LLC): The entrepreneur and the bank receive a nonnegative share of the security benefits:
$$0 \leq \gamma \leq 1 \tag{6}$$

2. Investors' rationality constraint (IRC): The parties invest in the project if and only if they at least breakeven by doing so:
$$\begin{aligned} \gamma V^* - A &\geq 0 \\ (1-\gamma)V^* - (I - A) &\geq 0 \end{aligned} \tag{7}$$

3. Incentive compatibility constraint (ICC): The payoff of the entrepreneur when he behaves exceed that of when he misbehaves, so that he has no incentives to misbehave:
$$\gamma V^* - A \geq \gamma(1-\phi)V^* + \theta\phi V^* - A$$
which simplifies into:
$$\gamma \geq \theta \tag{8}$$

2.3 Investment Timing

The entrepreneur has a real-option to invest in his project. Therefore, he has to decide when to exercise his option. In particular, he needs to choose an investment threshold, and invest in the project when its value reaches this threshold. The optimal investment threshold is the one that maximizes his NPV. We will show in the next section that the optimal investment thresholds for the loan commitment and the spot loan are different. In order to compare the efficiency of them, we need to first establish the efficient thresholds, which will serve as benchmarks.

The first-best investment threshold is the one that maximizes the NPV of the project when the entrepreneur behaves:

$$\max_V (V - I)\left(\frac{V_0}{V}\right)^\beta$$

The solution of this maximization yields:

$$V^*_{\mathrm{fb}} = kI \tag{9}$$

where

$$\begin{aligned} k &= \frac{\beta}{\beta - 1} \\ \beta &= \frac{1}{\sigma^2}\left(-\left(\alpha - \sigma^2/2\right) + \sqrt{\left(\alpha - \sigma^2/2\right)^2 + 2r\sigma^2}\right) \end{aligned}$$

V^*_{fb} suggests that the investment should take place when the project value reaches k times the investment cost I where $k > 1$ as $\beta > 1$.[10]. Any deviation from this threshold is inefficient, since it yields a smaller NPV. Therefore, any investment threshold larger than V^*_{fb} implies inefficiently delayed investment, and any smaller than that implies inefficiently hurried investment.

The first-best investment timing can only be attained when the entrepreneur behaves, since misbehavior entails a deadweight cost due to the inefficiency of private benefits extraction. If the bank cannot offer a loan when the entrepreneur behaves, it may still be able to

[10]Note that β is a function of three parameters: α (drift parameter), σ (variance parameter), and r (risk-free rate) These parameters are exogenous to our analysis.

offer one when he misbehaves. In such a case, the second-best investment threshold is the one that maximizes the remaining NPV of the project:

$$\max_{V}(\delta V - I)\left(\frac{V_0}{V}\right)^{\beta}$$

The solution of this maximization yields:

$$V_{\text{sb}}^{*} = \frac{kI}{\delta} > V_{\text{fb}}^{*} \tag{10}$$

Note that, the second-best investment threshold is higher than the first-best threshold, suggesting an inefficient delay. It is the most efficient threshold, however, if the bank can only make a loan when the entrepreneur misbehaves.

3 Solution

The solution of our model presents the terms of loan commitment and spot loan, and the optimal investment thresholds for each type of loan. The investment occurs under one of the two types of equilibrium. In the first type, the entrepreneur behaves and maximizes security benefits. This requires entrepreneur to have a sufficiently high stake in the security benefits so that he has no incentives to misbehave. In other words, ICC has to be satisfied (i.e. $\theta \leq \gamma \leq 1$). In the second type, the entrepreneur misbehaves by diverting cash-flows from security benefits to extract private benefits. This occurs when his stake in the security benefits is low, such that the sum of his reduced security benefits and private benefits when he misbehaves exceeds his security benefits when he behaves. That is, ICC is violated (i.e. $0 \leq \gamma < \theta$).

3.1 Equilibrium when the Entrepreneur Behaves

The entrepreneur has two financing options. First, he can apply to the bank for a loan commitment at time $t = 0$ for investment at time $t = C > 0$. If he does that the parties bargain over the terms. They understand that once they fix the terms of loan commitment, the entrepreneur's ex-post investment policy will be to maximize his equity and not the project value. As a result, they take into account the entrepreneur's timing reaction to the terms they set. Second, the entrepreneur can apply to the same bank for a spot loan at time $t = S > 0$ for immediate investment. This time bargaining is based on the contemporary value of the project, and is not affected by the entrepreneur's investment policy. In other words, in the case of loan commitments the entrepreneur's timing decision is ex post to contracting, whereas, in the case of spot loan it is ex ante.

Proposition 1 *When the entrepreneur behaves, the terms and the investment threshold of loan commitment are:*

$$(\gamma_C^*, V_C^*) = \left(\frac{A + \eta(k-1)A}{I + (k-1)A}, \frac{kA}{\gamma_C^*} \right) \textit{ for } \theta < \gamma_C^* \leq 1 \tag{11}$$

Those of spot loan are:

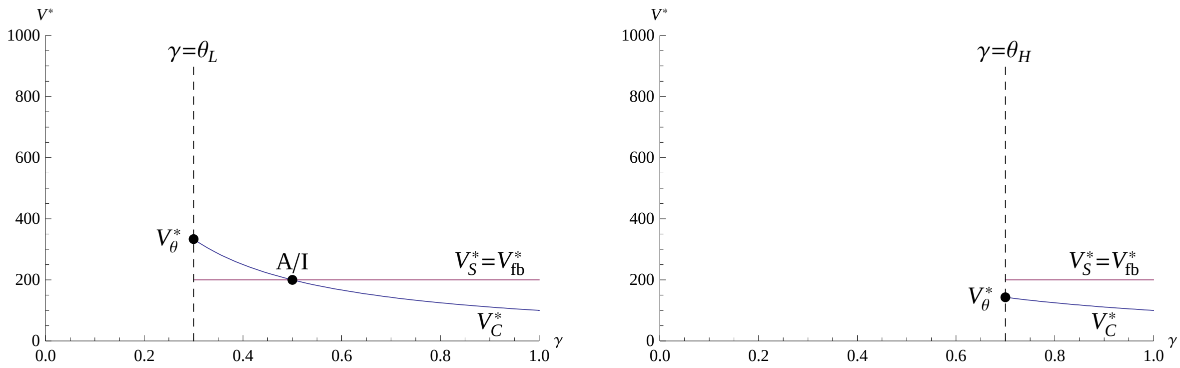
$$(\gamma_S^*, V_S^*) = \left(\frac{A + \eta(k-1)I}{I + (k-1)I}, kI \right) \textit{ for } \theta < \gamma_S^* \leq 1 \tag{12}$$

If the sharing rule turns out to be smaller than θ, the bank incentivizes the entrepreneur to behave. In this case, the terms and the investment threshold for both type of loans are:

$$(\gamma_\theta^*, V_\theta^*) = \left(\theta, \frac{kA}{\theta} \right) \textit{ for } \gamma_C^* \leq \theta, \gamma_S^* \leq \theta \tag{13}$$

Proof. See Appendix ∎

The intuition of Proposition 1 is as follows. The bargaining game of parties yields a sharing rule, which is γ_C^* if the entrepreneur applies for a loan commitment, or γ_S^* if he applies for a spot loan. What determines whether the entrepreneur behaves or misbehaves is the relationship between this sharing rule and his efficiency of private benefits extraction. ICC, as defined in (8), tells that if the entrepreneur's share exceeds θ, he behaves. In this case, if the entrepreneur applied for a loan commitment he gets $\gamma_C^* \times 100\%$ of V_C^*; and if he applied for a spot loan he gets $\gamma_S^* \times 100\%$ of V_S^*. On the other hand, if as a result of their bargaining, the entrepreneur's share turns out to be less than θ, ICC is violated, and the entrepreneur misbehaves. Now, the equilibrium in which the entrepreneur behaves can only exist if the bank increases the entrepreneur's share to θ. This suggests that the bank incentivizes the entrepreneur to behave by offering a new sharing rule (i.e. γ_θ^*), which is higher than the one dictated by the parties' bargaining power distribution (i.e. γ_C^* or γ_S^*), in



(a) $\theta_L < A/I$ **(b)** $\theta_H > A/I$

Figure 1. Investment thresholds as a function of the entrepreneur's share in the security benefits, given that he behaves. The downward sloping curve is $V_C^* = kA/\gamma$, the horizontal line segment is $V_S^* = kI$, and the point $(\theta, kA/\theta)$ is $V_\theta^* = kA/\theta$. The set of parameter values used for plotting graphs is: $\{A, I, \beta, \theta_L, \theta_H\} = \{50, 100, 0.5, 0.3, 0.7\}$.

order to prevent inefficient private benefits extraction.

Figure 1 plots the investment thresholds for both type of loans and for the case when the bank incentivizes the entrepreneur, for a low and high value of θ. It suggests that when θ is low, the type of equilibrium that we are analyzing in this section exists for a wide range of γ values, while when it is high, it only exists for a narrow range, such that if as a result of bargaining γ_C^* or γ_S^* turns out to be lower than θ, the bank has to cap the sharing rule to θ in order to prevent misbehavior. For the loan commitment, investment is accelerated as γ increases, whereas for the spot loan investment timing is independent from γ.

The implications of Proposition 1 are as follows:

1. Investment efficiency: The spot loan is efficient in that it yields first-best timing when the entrepreneur behaves. That is, the investment threshold V_S^* is equal to V_{fb}^* for $\theta < \gamma \leq 1$. The loan commitment is inefficient, except for the special case when γ equals A/I. It inefficiently delays the investment when γ is smaller than A/I, since $V_C^* > V_{fb}^*$ for $\theta < \gamma < A/I$; and it inefficiently hurries it when γ is larger than A/I, since $V_C^* < V_{fb}^*$ for $\gamma > A/I$ (see Figure 1a). Finally, investment is inefficiently timed if the bank incentivizes the entrepreneur, except for the special case when θ equals A/I. It is inefficiently delayed when θ is smaller than A/I, since $V_\theta^* > V_{fb}^*$ for $\theta < A/I$ (see Figure 1a); and is inefficiently hurried when θ is larger than A/I, since $V_\theta^* < V_{fb}^*$ for $\theta > A/I$ (see Figure 1b).

2. Entrepreneur's equity: The proportion of the investment financed by the entrepreneur's equity is a key determinant of terms of the loan commitment and the spot loan. In particular, both γ_C^* and γ_S^* are increasing in A, keeping other parameters constant. That is, the more equity the entrepreneur puts in the project, the higher his stake is in its security benefits. Moreover, the investment threshold of loan commitment V_C^* is increasing in A, whereas V_S^* is not affected by it. This suggests that when the proportion of the investment financed by the loan commitment is low (i.e. when $(I - A)/I$ is small), the entrepreneur prefers to invest later. This situation does not arise with the spot loan. For all feasible values of A, the entrepreneur applies for a spot loan when the project value hits kI for the first time.

The entrepreneur's equity determines, *ceteris paribus*, whether the entrepreneur behaves, or the bank incentivizes him. There is a critical level of equity for each type of loan below which the bank has to offer him a share of θ, so that ICC is satisfied. This critical level for the loan commitment is:

$$A_C^* = \frac{\theta I}{1 + (\eta - \theta)(k - 1)} \tag{14}$$

and the one for the spot loan is:

$$A_S^* = \theta I - (\eta - \theta)(k - 1)I \tag{15}$$

A_C^* follows from (11) and A_S^* from (12). Moreover, there is a minimum level of wealth below which an equilibrium when the entrepreneur behaves cannot exist. This is because if A is below that minimum level, the bank cannot break even if the sharing rule is θ, and if it lowers it in order to break even, the entrepreneur no longer behaves, since ICC is violated. This minimum level follows from IRC as defined in (7):

$$\underline{\mathrm{A}} = \frac{\theta I}{1 + (1 - \theta)(k - 1)} \tag{16}$$

3.2 Equilibrium when the Entrepreneur Misbehaves

We have shown that if the entrepreneur's equity in the project A is smaller than A_C^* (A_S^*) when he applies for a loan commitment (spot loan), the bank has to incentivize the entrepreneur to behave. It gets, however, more and more costly for the bank to offer θ as the entrepreneur's equity in the project gets smaller, since although it finances a larger proportion of the investment as A decreases, it gets a fixed proportion of the security benefits, which is $1 - \theta$. When A reaches $\underline{\mathrm{A}}$, the bank just breaks even, and if A falls further below, it does not participate. When $A < \underline{A}$, the equilibrium we described in Section (3.1) is replaced by another equilibrium in which the bank violates ICC by offering a sharing rule smaller than θ and letting the entrepreneur to consume private benefits. This is optimal for the bank as long as it gets a nonnegative when the entrepreneur misbehaves, since the bank's payoff in the case of credit rationing is zero.

In this type of equilibrium, the entrepreneur again can either apply to the bank for a loan commitment at time $t = 0$ for investment at time $t = c > 0$, or for a spot loan at time $t = s > 0$ for immediate investment. The main differences as compared to the first type of equilibrium are that now the parties take into account the entrepreneur's private benefits when they bargain, and the entrepreneur's investment-timing policy is such that he invests at the threshold that maximizes the sum of his security and private benefits.

Proposition 2 *When the entrepreneur misbehaves, the terms and the investment threshold of loan commitment are:*

$$(\gamma_c^*, V_c^*) = \left((1+x)\gamma_C^* - x, \frac{kA}{(1-\phi)(\gamma_c^* + x)}\right) \text{ for } 0 < \gamma_c^* < \theta \tag{17}$$

Those of spot loan are:

$$(\gamma_s^*, V_s^*) = \left((1+x)\gamma_S^* - x, \frac{V_S^*}{\delta}\right) \text{ for } 0 < \gamma_s^* < \theta \tag{18}$$

where

$$\delta = (1-\phi)(1+x)$$

If the sharing rule turns out to be negative, the bank increases the entrepreneur's share to zero due to limited liability. In this case the terms and the investment threshold for both type of loans are:

$$(\gamma_z^*, V_z^*) = \left(0, \frac{V_\theta^*}{\phi}\right) \text{ for } \gamma_C \leq 0, \gamma_S \leq 0 \tag{19}$$

Proof. See Appendix ■

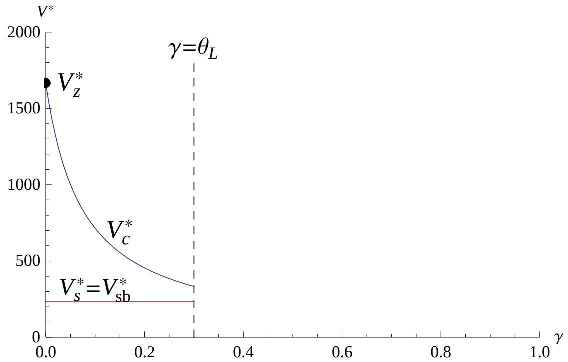
The intuition of Proposition 2 is as follows. The bargaining game of parties, in anticipation of the entrepreneur's misbehavior, yields a sharing rule, which is γ_c^* if the entrepreneur applies for a loan commitment, or γ_s^* if he applies for a spot loan. In order for this sharing rule to be consistent with the parties' anticipation it has to be smaller than θ, so that the entrepreneur indeed misbehaves. Furthermore, it has to be larger than zero to satisfy LLC, as defined in (6). In this case, if the entrepreneur applied for a loan commitment he gets $\gamma_c^* \times 100\%$ of $(1-\phi)V_c^*$ and 100% of $\theta\phi V_c^*$, since he diverts $\phi \times 100\%$ of the project value to extract private benefits with $\theta\%$ efficiency. Similarly, if he applied for a spot loan he gets $\gamma_s^* \times 100\%$ of $(1-\phi)V_s^*$ and 100% of $\theta\phi V_s^*$. On the other hand, if as a result of their bargaining, the entrepreneur's share turns out to be less than zero, LLC is violated, and the bank not only gets 100% of the security benefits, but also part of the entrepreneur's private benefits. Private benefits, however, by definition can only be consumed by the entrepreneur.[11] Now, the equilibrium in which the entrepreneur misbehaves can only exist if the bank increases the entrepreneur's share to zero. This suggests that the bank offers a new sharing rule (i.e. γ_z^*), which is higher than the one dictated by the parties' bargaining power distribution (i.e. γ_c^* or γ_s^*), since it cannot appropriate the entrepreneur's private benefits.

Figure 2 plots the investment thresholds for both type of loans and for the case when the bank increases the entrepreneur's share to zero, for a low and high value of θ. Figure 2 complements Figure 1. These two figures together suggest that when the entrepreneur's efficiency of private benefits extraction is low, for a wide range of γ values an equilibrium in which he behaves exists. On the other hand, if he can efficiently extract private benefits, at a small deadweight cost, the bank has to incentivize him by offering a share of θ, which is high. Therefore, for all sharing rules below θ, the entrepreneur misbehaves. Finally, if γ_c^* or γ_s^* turns out to be lower than zero, the bank has to increase the entrepreneur's share to zero. That is, limited liability places a floor under the feasible range of γ values the parties bargain over. When the entrepreneur misbehaves, for the loan commitment, investment is accelerated as γ increases, whereas for the spot loan investment timing is independent from γ, as was the case when he behaved.

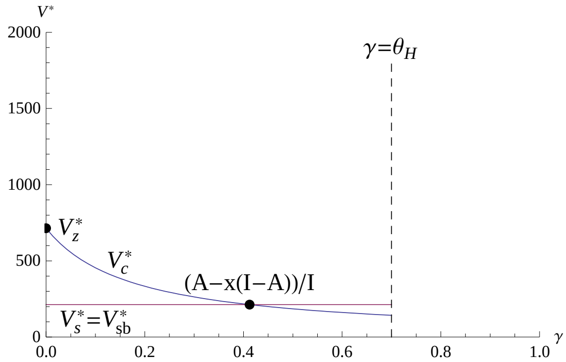
The implications of Proposition 2 are as follows:

1. Investment efficiency: When the entrepreneur misbehaves, the spot loan is again the efficient type of loan as it yields the second-best timing. That is, the investment threshold V_s^* is equal to V_{sb}^* for $0 < \gamma < \theta$. The loan commitment is again inefficient, except for the special

[11]For instance, the bank does not benefit when the entrepreneur shirks, or when he purchases extravagant office furniture. . . etc.



(a) $\theta_L < (A - x(I - A))/I$



(b) $\theta_H > (A - x(I - A))/I$

Figure 2. Investment thresholds as a function of the entrepreneur's share in the security benefits, given that he misbehaves. The downward sloping curve is $V_c^* = kA/(1-\phi)(\gamma + x)$, the horizontal line segment is $V_s^* = kI/\delta$, and the point $(0, kA/(\theta\phi))$ is $V_z^* = kA/(\theta\phi)$. The set of parameter values used for plotting graphs is: $\{A, I, \beta, \theta_L, \theta_H, \phi\} = \{50, 100, 0.5, 0.3, 0.7, 0.2\}$.

case when γ equals $(A - x(I - A))/I$. It inefficiently delays the investment when γ is smaller than $(A - x(I - A))/I$, since $V_c^* > V_{sb}^*$ for $0 < \gamma < (A - x(I - A))/I$; and it inefficiently hurries it when γ is larger than $(A - x(I - A))/I$, since $V_c^* < V_{sb}^*$ for $(A - x(I - A))/I < \gamma < \theta$ (see Figure 2a). Finally, investment is inefficiently timed if the bank increases the entrepreneur's share to zero, except for the special case when $\theta\phi$ equals $\delta A/I$. It is inefficiently delayed when $\theta\phi$ is smaller than $\delta A/I$, since $V_z^* > V_{sb}^*$ for $\theta\phi < \delta A/I$ (see Figure 2a); and is inefficiently hurried when $\theta\phi$ is larger than $\delta A/I$, since $V_z^* < V_{sb}^*$ for $\theta\phi > \delta A/I$ (see Figure 2b).

2. Entrepreneur's equity: In analogy to the equilibrium in Section 3.1, both γ_c^* and γ_s^* are increasing in A, keeping other parameters constant. Also, the investment threshold of loan commitment V_c^* is increasing in A, whereas V_s^* is not affected by it.

There is a critical level of equity for each type of loan below which the sharing rule is negative, and hence the bank has to increase it to zero. This critical level for the loan commitment is:

$$A_c^* = \frac{(x/1+x)I}{1 + (\eta - (x/1+x))(k-1)} \tag{20}$$

and the one for the spot loan is:

$$A_s^* = (x/1+x)I - (\eta - (x/1+x))(k-1)I \tag{21}$$

A_c^* follows from (17) and A_s^* from (18). Moreover, there is a minimum level of wealth below which an equilibrium when the entrepreneur misbehaves cannot exist. This is because if

A is below that minimum level, the bank cannot break even if he gets the entire security benefits. This minimum level follows from IRC as defined in (7), but we need to modify the bank's breakeven conditions to account for the reduction in security benefits due to the entrepreneur's misbehavior:

$$(1-\gamma)(1-\phi)V^{*}-(I-A)\geq 0 \tag{22}$$

Then:

$$\underline{\mathrm{A}}_{\phi}=\frac{(x/1+x)I}{1+(1-(x/1+x))(k-1)} \tag{23}$$

This means that if the entrepreneur's equity is below $\underline{\mathrm{A}}_{\phi}$, the bank refuses to make a loan, and the entrepreneur cannot invest in the project.

4 The Entrepreneur's Choice and Investment Efficiency

So far in the paper, we have been silent on the entrepreneur's preference between the loan commitment and spot loan. The purpose of this section is to explain why the entrepreneur may prefer to fix the terms of borrowing in advance through a loan commitment contract, rather than negotiating them in the spot market. Under risk neutrality, the borrower's choice of loan type depends on the net present value of his expected payoff, which we denote by π.

Proposition 3 *For the equilibrium when the entrepreneur behaves, he prefers the spot loan when his bargaining power exceeds $\eta^{*}=A/I$, and the loan commitment otherwise.*

Proof.

$$\begin{aligned}
\pi_C &\lesseqgtr \pi_S \\
(\gamma_C^{*}V_C^{*}-A)\left(\frac{V_0}{V_C^{*}}\right)^{\beta} &\lesseqgtr (\gamma_S^{*}V_S^{*}-A)\left(\frac{V_0}{V_S^{*}}\right)^{\beta} \\
(k-1)A\left(\frac{(1+\eta(k-1))V_0}{kI+k(k-1)A}\right)^{\beta} &\lesseqgtr \eta(k-1)I\left(\frac{V_0}{kI}\right)^{\beta} \qquad (24)\\
\frac{A}{I}\left(\frac{\eta+(\beta-1)}{A+(\beta-1)I}\right)^{\beta} &\lesseqgtr \frac{\eta}{I^{\beta}} \\
\frac{A/I}{(A/I+(\beta-1))^{\beta}} &\lesseqgtr \frac{\eta}{(\eta+(\beta-1))^{\beta}} \qquad (25)
\end{aligned}$$

The left hand side is equal to the right hand side when $\eta = A/I$. For, $\eta > A/I$ the right hand side is larger; and for $\eta < A/I$ it is smaller. ■

The intuition of Proposition 3 is as follows. In the case of loan commitment, the entrepreneur's net payoff at the time of investment is tied to his equity A (see the first term on the left hand side of (24)); whereas in the case of spot contract it is tied to his bargaining power η (see the first term on the right hand side of (24)). An increase in η tips the balance in favor of the spot loan in terms of the payoffs. But, that's not the whole story. An increase in η also accelerates the investment in the case of loan commitment yielding a higher NPV (see the second term on the left hand side of (24)). Therefore, η alone is not driver of the entrepreneur's choice, and A matters as well. In particular, for the loan commitment a high A implies late investment as $V_C^* = kA/\gamma_C^*$ increases in A. When the parties bargain, neither of them would like the investment take place too late, however, since this reduces the NPV of their payoffs. The remedy is to speed up the investment by offering the entrepreneur a higher share. That is, γ_C^* is increasing in A as well as V_C^*. In other words, the increase in γ_C^* as a response to an increase in A, curbs the rate of increase in V_C^* due to the increase in A. This creates a favorable situation for the entrepreneur, since if he has high A, he receives a larger share of the project value earlier. Therefore, for high enough A and low enough η, the entrepreneur prefers the loan commitment to the spot loan, hence the critical level of bargaining power $\eta^* = A/I$.

Proposition 4 *For the equilibrium when the entrepreneur misbehaves, he prefers the spot loan when his bargaining power exceeds $\eta^* = A/I$, and the loan commitment otherwise.*

Proof.

$$\begin{aligned}
\pi_c &\lesseqgtr \pi_s \\
(\gamma_c^*(1-\phi)V_c^* + \theta\phi V_c^*)\left(\frac{V_0}{V_c^*}\right)^\beta &\lesseqgtr (\gamma_s^*(1-\phi)V_s^* + \theta\phi V_s^*)\left(\frac{V_0}{V_s^*}\right)^\beta \\
\left(((1+x)\gamma_C^* - x)(1-\phi) + \theta\phi)\frac{V_C^*}{\delta}\right)\left(\frac{\delta V_0}{V_C^*}\right)^\beta &\lesseqgtr \left(((1+x)\gamma_S^* - x)(1-\phi) + \theta\phi)\frac{V_S^*}{\delta}\right)\left(\frac{\delta V_0}{V_S^*}\right)^\beta \\
(\gamma_C^* V_C^* - A)\left(\frac{V_0}{V_C^*}\right)^\beta &\lesseqgtr (\gamma_S^* V_S^* - A)\left(\frac{V_0}{V_S^*}\right)^\beta \\
\pi_C &\lesseqgtr \pi_S
\end{aligned}$$

Therefore, the entrepreneur comparison between the loan commitment and the spot loan when he misbehaves is identical to the comparision he makes when he behaves. ■

Proposition 4 implies that the entrepreneur's criterion for choosing between the loan commitment and the spot loan is the same when he misbehaves. The intuition is the same, as A increases loan commitment becomes more favorable, since he gets a higher share of the value they bargain over earlier.

We now turn our attention to the implications of the entrepreneur's choice for investment efficiency. We first focus on the equilibrium when he behaves. In this case there are three possible investment thresholds. If the entrepreneur prefers loan commitment the investment takes place when the project value hits V_C^* the first time. If he prefers the spot loan, the investment threshold is V_S^*. Finally, if the bank incentivizes him, he invests at the threshold V_C^*. The entrepreneur prefers the loan commitment when $\eta < \eta^*$. In this case, $V_C^* > V_{fb}^*$, hence the loan commitment results in inefficiently delayed investment. He prefers the spot loan if $\eta \geq \eta^*$, which yields first-best investment timing, since $V_S^* = V_{fb}^*$. Finally, if $\underline{\mathrm{A}} \leq A < A_C^*$ or if $\underline{\mathrm{A}} \leq A < A_S^*$, the sharing rule is smaller than θ, and the bank has to incentivize the entrepreneur. In this case, the investment takes place at the threshold V_θ^*, which is inefficient except for the case when $\theta = A/I$. V_θ^* yields an inefficient delay if θ is smaller than A/I, and an inefficient hurry when it is larger than that.

For the equilibrium when the entrepreneur misbehaves there are again three possible investment thresholds. These are V_c^*, V_s^*, and V_z^* if the entrepreneur prefers the loan commitment, the spot loan and if the bank increases his share to zero respectively. As in the first type of equilibrium, he prefers the loan commitment when $\eta < \eta^*$. In this case, $V_c^* > V_{sb}^*$, hence the loan commitment results in inefficiently delayed investment with respect to the second-best investment timing. The spot loan, on the other hand, yields second-best investment timing as $V_s^* = V_{sb}^*$. If $\underline{\mathrm{A}}_\phi \leq A < A_c^*$ or if $\underline{\mathrm{A}}_\phi \leq A < A_s^*$, the sharing rule turns out to be negative, and the bank has to increase the entrepreneur's share to zero. Analogous to the case of V_θ^*, V_z^* is inefficient except for the case when $\theta\phi = (A - x(I - A))/I$. It yields an inefficient delay if $\theta\phi$ is smaller than $(A - x(I - A))/I$, and an inefficient hurry when it is larger than that.

These results suggest that socially efficient investment timing is more likely to be attained when the borrowers have stronger bargaining positions against the lenders. This is because, in this case it is more likely for η to exceed η^*, resulting in a preference for the efficient spot loan by the borrower. The presence of inefficient private benefits extraction introduces a further distortion to investment optimality, since the investment thresholds when the lender incentivizes the borrower, or when he increases the borrower's share to zero diverges from the first- and second-best thresholds.

5 Conclusion

Why do loan commitments exist? Put another way, why do borrowers not negotiate the loans when they need it, but seek contractual agreements that fix loan terms in advance? Previous research proposed several answers to these questions. Some papers argued that loan commitments are used for optimal risk sharing when borrowers are risk averse. Others claimed that when banks did not know the quality of firms in the spot loan market, loan commitments served as a signaling device. Yet, others pointed out loan commitments induced borrowers to exert their first-best efforts in moral hazard settings.

In this paper, we focused on an important aspect of loan commitments that has been overlooked in literature so far: The borrower's flexibility to choose investment timing. We showed that even though the procedure of applying for a loan commitment and spot loan are identical (i.e. the borrower and the lender meet and bargain over the terms), these two types of contracts yielded distinct terms and investment thresholds. The key to these differences is the borrower's ex-post investment-timing policy in the case of a loan commitment. That is, the parties are aware, when they are bargaining for the terms of loan commitment, that once they fix the terms, the borrower will follow an investment-timing strategy that is solely in his interests, and not the lender's. This situation does not arise in the case of spot loan, as borrower decides when to invest before he bargains with the lender.

Our results indicate that, since the spot loan offers the borrower a share of the project's surplus, it induces him to apply for this type of loan at the first-best investment threshold when he behaves, and at the second-best one when he misbehaves. The borrower, however, prefers the loan commitment when his bargaining power is below the critical threshold $\eta^* = A/I$. In this region, loan commitment results in inefficiently delayed investment compared to the first-best benchmark when he behaves and to the second-best benchmark when he misbehaves. Therefore, we find that there is scope for loan commitments in lending markets that are less than perfectly competitive. Moreover, competition in the lending market enhances efficiency of investments, since as banks compete with each other more and more for the loans, the borrower's bargaining power *vis-à-vis* the banks increases, which in turn makes him more likely to prefer the efficient spot loan. In perfectly competitive lending markets, loan commitments are dominated by spot loans.

We also show that inefficient private benefits extraction distorts investment optimality. In the absence of it, investment timing is efficient as long as the spot loan is preferred by the borrower. When private benefits extraction is feasible (i.e. $x > 0$), however, if the sharing rule determined by bargaining falls below the borrower's efficiency of private benefits extraction (i.e. θ), the borrower misbehaves. The bank can incentivize him to behave by offering a higher sharing rule. In this case, we find that the terms and the investment thresholds of the loan commitment and spot loan become identical. The investment timing is not efficient, however. Furthermore, the bank can only incentivize the borrower as long as it can break even. Thus, when the borrower's equity is so low ($A < \underline{A}$) that the bank rejects to participate in an equilibrium in which the borrower behaves, it lets him misbehave. In this case, the borrower's choice between the loan commitment and the spot loan is still determined by the critical bargaining power level η^*. If his equity is tiny, the bank receives 100% of the security benefits, in which case once again the loan commitment and spot loan are identical; and if the borrower's equity is even lower ($A < \underline{A}_\phi$), the bank does not participate and the investment does not take place.

A Appendices

Proof of Proposition 1. In the case of loan commitment, the parties bargain at time $t = 0$ anticipating that the entrepreneur will invest at time $t = C > 0$. The entrepreneur's ex-post investment policy is such that for a stake of γ in the security benefits, where $\gamma \geq \theta$, he invests at the threshold that maximizes the net present value of his payoff:

$$\max_V (\gamma V - A) \left(\frac{V_0}{V} \right)^\beta$$

This yields the timing of investment as a function of loan commitment terms:

$$V(\gamma) = \frac{kA}{\gamma} \quad \text{for} \quad \theta \leq \gamma \leq 1 \tag{A.1}$$

The parties rationally anticipate $V(\gamma)$ when they bargain over γ, such that they play the following Nash bargaining game, which is subject to LLC, IRC, and ICC:

$$\begin{aligned}
&\max_{\gamma} \left(\gamma V(\gamma) - A\right)^{\eta} \left((1-\gamma)V(\gamma) - (I-A)\right)^{1-\eta} \left(\frac{V_0}{V(\gamma)}\right)^{\beta} + \lambda_C(\gamma - \theta) \\
&= \max_{\gamma} \left(kA - A\right)^{\eta} \left(\frac{(1-\gamma)kA}{\gamma} - (I-A)\right)^{1-\eta} \left(\frac{\gamma V_0}{kA}\right)^{\beta} + \lambda_C(\gamma - \theta)
\end{aligned} \tag{A.2}$$

where λ_C is the Langrangian coefficient for ICC in the case of loan commitment. If $\lambda_C = 0$, ICC is nonbinding, and the outcome of this game is $\gamma_C^* = (A + \eta(k-1)A)/(I + (k-1)A)$. Plugging this into (A.1) yields $V_C^* = (kI + k(k-1)A)/(1 + \eta(k-1))$. If $\lambda_C > 0$, ICC is binding, and the outcome is $\gamma_\theta^* = \theta$. Plugging this into (A.1) this time yields $V_\theta^* = kA/\theta$.

In the case of spot loan, the parties bargain at time $t = S > 0$, when the entrepreneur applies for the spot loan:

$$\max_{\gamma} \left(\gamma V - A\right)^{\eta} \left((1-\gamma)V - (I-A)\right)^{1-\eta} + \lambda_S(\gamma - \theta)$$

where λ_S is the Langrangian coefficient for ICC in the case of spot loan. If $\lambda_S = 0$, ICC is nonbinding, and the outcome gives the terms of spot loan as a function of investment timing:

$$\gamma(V) = \frac{A + \eta(V - I)}{V} \quad \text{for} \quad \theta < \gamma \leq 1 \tag{A.3}$$

The entrepreneur rationally anticipates $\gamma(V)$ and decides the time to apply for the spot loan such that the investment threshold at that time maximizes the net present value of his payoff:

$$\begin{aligned}
&\max_{V} (\gamma(V)V - A) \left(\frac{V_0}{V}\right)^{\beta} \\
&= \max_{V} (\eta(V - I)) \left(\frac{V_0}{V}\right)^{\beta}
\end{aligned} \tag{A.4}$$

This yields the investment timing as $V_S^* = kI$. Plugging this into (A.3) yields $\gamma_S^* = (A +$

$\eta(k-1)I)/(I+(k-1)I)$. If $\lambda_S > 0$, ICC is binding, and the outcome is $\gamma^*_\theta = \theta$. The entrepreneur rationally anticipates γ^*_θ and decides the time to apply for the spot loan such that the investment threshold at that time maximizes the net present value of his payoff:

$$\max_V(\theta V - A)\left(\frac{V_0}{V}\right)^\beta$$

The solution yields $V^*_\theta = kA/\theta$. Therefore, when the entrepreneur is incentivized to behave there is no distinction between the loan commitment and spot loan. ■

Proof of Proposition 2. In the case of loan commitment, the parties bargain at time $t = 0$ anticipating that the entrepreneur will invest at time $t = c > 0$. The entrepreneur's ex-post investment policy is such that for a stake of γ in the security benefits, where $0 \le \gamma < \theta$, and 100% stake in the private benefits, he invests at the threshold that maximizes the net present value of his payoff:

$$\max_V\left((\gamma(1-\phi)+\theta\phi)V - A\right)\left(\frac{V_0}{V}\right)^\beta$$

which yields the timing of investment as a function of loan commitment terms when the entrepreneur misbehaves:

$$V(\gamma) = \frac{kA}{(1-\phi)(\gamma+x)} \quad \text{for} \quad 0 \le \gamma < \theta \tag{A.5}$$

The parties rationally anticipate $V(\gamma)$ when they bargain over γ, such that they play the following Nash bargaining game, which is subject to LLC and IRC, and which satisfies incentive incompatibility constraint (IIC) (which we define as the opposite of ICC):

$$\begin{aligned}
&\max_\gamma(\gamma(1-\phi)V(\gamma)+\theta\phi V(\gamma)-A)^\eta((1-\gamma)(1-\phi)V(\gamma)-(I-A))^{1-\eta}\left(\frac{V_0}{V(\gamma)}\right)^\beta \\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad +\lambda_{c1}(\theta-\gamma)+\lambda_{c2}(\gamma-0) \\
&\qquad\qquad = \max_\gamma\left((k-1)A\right)^\eta\left(\frac{(1-\gamma)kA}{\gamma+x}-(I-A)\right)^{1-\eta}\left(\frac{(1-\phi)(\gamma+x)V_0}{kA}\right)^\beta \\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad +\lambda_{c1}(\theta-\gamma)+\lambda_{c2}(\gamma-0)
\end{aligned}$$

where λ_{c1} and λ_{c2} are the Langrangian coefficients for IIC and LLC in the case of loan commitment. If $\lambda_{c1} = \lambda_{c2} = 0$, IIC and LLC are nonbinding, and the outcome of this game is $\gamma_c^* = (1+x)((A+\eta(k-1)A)/(I+(k-1)A)) - x = (1+x)\gamma_C^* - x$. Plugging this into (A.5) yields $V_c^* = (kI + k(k-1)A)/(1-\phi)(1+x)(1+\eta(k-1)) = V_C^*/\delta$. If $\lambda_{c1} = 0$ and $\lambda_{c2} > 0$, IIC is nonbinding and LLC is binding, and the outcome is $\gamma_z^* = 0$. Plugging this into (A.1) this time yields $V_z^* = kA/\theta\phi = V_\theta^*/\phi$.

In the case of spot loan, the parties bargain at time $t = s > 0$, when the entrepreneur applies for the spot loan:

$$\max_\gamma((\gamma(1-\phi) + \theta\phi)V - A)^\eta((1-\gamma)(1-\phi)V - (I-A))^{1-\eta}\left(\frac{V_0}{V}\right)^\beta \\ +\lambda_{s1}(\theta - \gamma) + \lambda_{s2}(\gamma - 0)$$

where λ_{s1} and λ_{s2} are the Langrangian coefficients for IIC and LLC in the case of spot loan. If $\lambda_{s1} = \lambda_{s2} = 0$, IIC and LLC are nonbinding, and the outcome gives the terms of spot loan as a function of investment timing when the entrepreneur misbehaves:

$$\gamma(V) = \frac{A + \eta((1-\phi)V - I)}{(1-\phi)V} - (1-\eta)x \quad \text{for} \quad 0 < \gamma < \theta \tag{A.6}$$

The entrepreneur rationally anticipates $\gamma(V)$ and decides the time to apply for the spot loan such that the investment threshold at that time maximizes the net present value of his payoff:

$$\max_V (\gamma(V)(1-\phi)V + \theta\phi V - A)\left(\frac{V_0}{V}\right)^\beta \\ = \max_V (\eta(\delta V - I))\left(\frac{V_0}{V}\right)^\beta$$

This yields the investment timing as $V_s^* = kI/(1-\phi)(1+x) = V_S^*/\delta$. Plugging this into (A.6) yields $\gamma_s^* = (1+x)(A+\eta(k-1)I)/(I+(k-1)I) - x = (1+x)\gamma_S^* - x$. If $\lambda_{c1} = 0$ and $\lambda_{c2} > 0$, IIC is nonbinding and LLC is binding, and the outcome is $\gamma_z^* = 0$. The entrepreneur rationally anticipates γ_z^* and decides the time to apply for the spot loan such that the investment threshold at that time maximizes the net present value of his payoff:

$$\max_V ((\theta\phi)V - A)\left(\frac{V_0}{V}\right)^\beta$$

The solution yields $V_z^* = kA/\theta\phi = V_\theta^*/\phi$. Therefore, when the entrepreneur relinquishes all security benefits to the bank, there is no distinction between the loan commitment and spot loan. ■

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