Excess Liquidity against Predation

Dai Zusai*

February 28, 2014

---

*Department of Economics, Temple University, 1301 Cecil B. Moore Ave., RA 873 (004-04), Philadelphia, PA 19122, U.S.A. Tel:+1-215-204-1762. E-mail: zusai@temple.edu. I greatly appreciate the encouragement and advice of Noriyuki Yanagawa, Toshihiro Matsumura, and Bill Sandholm. I would like to thank Munetomo Ando, Susumu Cato, Raymond J. Deneckere, Dimitrios Diamantaras, Ikuo Ishibashi, Daisuke Oyama, Moritz Ritter, Marek Weretka and the seminar participants at Hitotsubashi, Kyoto, Tokyo, Wisconsin-Madison, Japan Fair Trade Committee, Japan Economic Association, and Hakone Microeconomic Conference for helpful comments and discussions. I also thank Nathan Yoder for careful reading and editing suggestions. Of course all errors are mine.
Abstract

To study motive for excess liquidity holding, we investigate cash flows of an entrant in product market competition by explicitly considering a cash-in-advance constraint on payment of production costs. A shallow-pocket entrant may secure financing to pay these costs based on anticipated profits. However, this creates a threat of predation by a deep-pocket competitor. To block predation, the entrant must raise precautionary liquidity, by taking out a loan both larger and further in advance than is actually necessary for production. Entrants with little start-up capital become less aggressive, because the need to raise precautionary liquidity introduces an additional marginal cost of production.

Keywords: excess liquidity, predation, cash-in-advance constraint, financial contract

JEL classification: G32; L12; D86
1 Introduction

Firms tend to keep more liquidity than actually needed, though such excess liquidity hoarding is costly in the presence of an interest rate spread between loans and deposits and worsens agency problems because it induces a so-called soft budget constraint. Holmström and Tirole (1998) find a reason for a firm to demand excess liquidity: to prepare for liquidity shocks in incomplete financial markets. On the other hand, empirical research by Hoberg, Phillips, and Prabhala (2013) suggests that competitive pressure increases firms’ cash holding. Fresard (2010) empirically finds that larger cash holding indeed helps a firm to gain larger market share. Motivated by these recent empirical findings, we theoretically uncover the mechanism behind the link between excess liquidity hoarding and product market competition.

We explicitly formalize a cash-in-advance constraint on the entrant’s production costs in duopoly quantity competition. This generates a threat of predation by a deep-pocket competitor. To prevent predation, the shallow-pocket entrant demands a greater than necessary amount of liquidity further in advance than actually needed to pay the production costs in the equilibrium outcome. In these two senses, the threat of predation causes excess liquidity hoarding. Furthermore, liquidity demand increases when the entrant is willing to be more aggressive against the competitor. If it is costly to raise liquidity upon entry, an additional marginal cost of production is imposed on the entrant, making him less aggressive. This result is supported by the empirical findings of Lerner (1995) on the relationship between financial weakness of firms and price wars.

Telser (1966) argues that a deep-pocket incumbent might try preying on the shallow-pocket entrant through excessively aggressive competition, without developing a rigorous model. However, he concludes that as long as the entrant’s business is profitable in the absence of predation, a rational investor should agree to lend enough liquidity to the entrant so that the incumbent would be wholly discouraged from predation.¹

Modern contract theory questions whether the entrant can finance such liquidity under financial imperfection. Bolton and Scharfstein (1990) (henceforth BS) is the seminal paper
on the modern financial theory of predation, followed by Poitevin (1989), Snyder (1996), Fernández-Ruiz (2004), Marquez (2010) and Khanna and Schroder (2010). In the BS model, firms compete over two periods and the entrant must pay some fixed entry costs in the beginning of each period. They define predation as exclusion of the entrant from the second-period market. Due to financial imperfection, the entrant cannot finance the whole entry cost and needs some internal capital. The incumbent preys on the entrant in the first period to prevent him from earning enough money to meet his need for internal capital to continue business. In the BS model, the entrant demands liquidity only as much as needed for entry and thus the liquidity demand itself is exogenously determined in the model regardless of competitive pressure. In contrast, it is endogenously determined in our model and consequently the results in our model are more consistent with the empirical findings that connect product market competition and cash holding.

Outline of the model. In this paper, we revisit Telser’s argument and formalize the possibility that the incumbent preys on the entrant by diminishing the future profitability of the entrant’s business, rather than by preventing him from earning enough capital to start or continue the business. Instead of having two periods, we look into the details of timing of decisions and financing in one-shot duopoly competition.

We imagine a situation where, after the entrant declares his entry to the market with a certain business plan, the incumbent can destroy the plan’s profitability. This is formalized as Stackelberg competition where the incumbent commits himself to his strategy later than the entrant, though all of our propositions remain the same in the version of Cournot competition despite of more technical complexity; see the working paper version (Zusai, 2012). While we call both firms’ strategies “outputs,” the strategies can be anything.

Our model is explicitly embedded with a cash-in-advance constraint: the entrant has to pay production costs before earning revenue. If he does not pay, he cannot proceed with production and must exit from the market. In reality, a firm may pay production
costs from advance draws of sales or ask suppliers of production materials for open account transactions and pay the costs after the firm receives revenues. We allow such transactions with accounts payable, namely, trade credits, treating them as short-term loans. However, we should notice that the firm needs to ensure repayment and thus enough sales to cover the postponed payment of production costs. In this sense, a short-term loan is conditional on profitability of the entrant’s business. On the other hand, we define the “deep-pocket” incumbent as a firm who can finance his own production costs unconditionally or by himself.

By committing to excess supply, the incumbent could lower the profitability of the entrant’s business and prevent him from raising a large enough short-term loan to pay out the production costs. Hence, the entrant cannot rely on a short-term loan. Instead, he has to raise precautionary liquidity before the incumbent decides whether commit to excess supply, so that he can proceed with production even if the incumbent commits to predatory excess supply and he cannot borrow a large enough short-term loan. Observing such precautionary liquidity holding, the incumbent gives up predation in the equilibrium outcome.

We show that the incumbent’s excess supply is a strategic complement of the entrant’s supply: the more the entrant is willing to produce, the more the incumbent preys on the entrant, because he expects lower profit in duopoly and hence the net benefit of predation becomes larger. Thus, the entrant’s demand for precautionary liquidity increases with the quantity of his supply. When a long-term loan for precautionary liquidity is more costly than a short-term loan, this imposes an additional marginal cost on the entrant. Therefore, the entrant becomes less aggressive.

The entrant needs to raise liquidity earlier than needed and keeps it until the incumbent gives up predation. In addition, the liquidity has to cover the production cost in case of predation. So the liquidity is excess liquidity hoarding in the senses of both timing and quantity. The hoarding of a large quantity of liquidity may be more obvious if the market for factor inputs is thin and the entrant’s production cost is affected by the incumbent’s supply.
So far we have not assumed any financial imperfection or asymmetric information in the economy, unlike the BS model and its variants. In particular, the demand and cost structure is assumed to be certain and common knowledge in the economy. If the entrant earns enough to pay his costs, he surely repays his short-term loan.

If there is any financial imperfection, it would amplify the distortion in the product market outcome. Financial imperfection may stem from asymmetric information about the entrant’s productivity like in BS or his effort like in Fernández-Ruiz (2004). As a variation of the basic model, we present one new theoretical possibility that is more intrinsic to the threat of predation: that even without such uncertainty on the entrant’s side, unverifiability of predation would prevent the entrant from raising enough precautionary liquidity at entry, in addition to short-term loans at the time of production.

Using predation as an excuse for operating loss, the entrant may be able to avoid repayment of loans because of limited liability. Unverifiability of predation is assumed in BS. In their model, the lender cannot distinguish operational loss due to predation from loss due to low productivity. We do not assume uncertainty or unverifiability in productivity; once enough liquidity is raised, it is certain that there is no predation and the entrant earns enough profit to repay the loans. Instead, we assume that it is unverifiable in court whether or not there is predation and the entrant actually suffers predatory loss.

We let the entrant voluntarily report the quantity of the incumbent’s supply. Thanks to common knowledge of the demand and cost structure, the lender can figure out what quantities could be plausible as rational predation. If the reported supply of the incumbent and the implied predatory loss are greater than rationalizable levels, the lender can withdraw the long-term loan before production. Yet to prevent predation on the equilibrium path, the lender has to allow the report of off-equilibrium supply up to rationalizable quantity. Otherwise, the incumbent would indeed execute rationalizable predation to get the lender to withdraw the loan and disable the entrant from proceeding with the production.

Hence the lender foresees the possibility of default due to a report of the rationalizable
predation. To avoid it, the lender would ask the entrant for collateral that can be used to punish him for the (falsified) request for default on the loan. Thus, the entrant needs enough initial assets to secure a long-term loan. This works as a borrowing constraint on the available amount of a long-term loan at entry. Even if no interest is incurred on the long-term loan, a less capitalized entrant behaves less aggressively to reduce the needed precautionary liquidity within this borrowing constraint. The borrowing constraint is established as a necessary condition for every non-predation equilibrium, and can be generalized to any form of financial contract according to the revelation principle proved by Zusai (2013). In any valid financial contract (including a debt contract), the entrant’s total repayment should be kept constant, independent of the realized profit. This is consistent with the empirical finding of Kjenstad and Su (2012) on the relation between competitive pressure and debt contracts.

More on related literature. Among the preceding literature on predation due to financial imperfection, Poitevin (1989) presents predatory excess supply and excess liquidity as a solution of an adverse selection problem. In his model, the entrant chooses either debt or equity to finance liquidity. Excess liquidity is raised by debt, which increases risk of bankruptcy and stimulates the incumbent’s predation. This is what a high-productivity entrant wants. He raises the debt level so high that a low-productivity entrant cannot bear intensified predation; so large debt is a signal of high productivity. In contrast, the incumbent whose productivity is known publicly does not need such a signal and finances his fixed cost by equity. This enables him to exercise predation free from risk of his own bankruptcy. In short, Poitevin sees debt financing as a signal of the entrant’s productivity and excess liquidity holding arises as the flip side of excess debt, not as a barrier to predation. Fresard (2010) empirically distinguishes the effects of cash holding on competition from the effects of debt holding, and confirms that the former has a significant and great impact on market shares separately from the latter.
Our model is a game of complete but imperfect information, as there is no uncertainty in the cost and demand structure, while the preceding models of financial predation à la BS involve signaling about the entrant’s hidden productivity or demand and thus they consider games of incomplete information. Recently, some authors have constructed (nonfinancial) theories of predation under perfect and complete information: see Argenton (2010) and Fumagali and Motta (2013). Roth (1996) presents predation as a rationalizable strategy (in the sense of Bernheim and Pearce) in War of Attrition. Bevia, Corchon, and Yasuda (2011) consider repeated Cournot competition with an ad-hoc constraint that requires a firm to achieve non-negative profit in each period. In the theoretical portion of their paper, Kjenstad and Su (2012) consider two-period Hotelling competition with the entrant having to pay some given amount of money to continue production. These models analyze how the threat of predation realizes in and/or affects repeated production market competition. Our model can be seen as another attempt to formalize a theory of predation in complete information games, paying more attention to financial decisions.

Allegations of predatory pricing are often made from owners of small businesses. Small businesses, such as local retailers, restaurants, and food manufacturers, do not involve large physical uncertainty or large investment. We prove that the threat of predation distorts market outcomes even without physical uncertainty or fixed costs, as in such small businesses.

Plan of the paper. The paper proceeds as follows. We set up the model in the next section. Section 3 presents the benchmark where the entrant, as well as the incumbent, does not face a cash-in-advance constraint. In Section 4 we see the case where the rival’s output is verifiable and present formally the threat of predation and the entrant’s demand for precautionary liquidity. In Section 5 we show that unverifiability amplifies distortion in the product market. In Section 6 we discuss structural assumptions in the model and in the propositions. Finally, Section 7 concludes. Lengthy proofs are given in the Appendix.
2 The Economy

We consider quantity competition between an entrant (firm E) and an incumbent (firm I). After deciding on quantities to be supplied, the entrant has to pay production costs before completing production and achieving sales, because he is new to this business and thus has no reputation to defer payment unconditionally. That is, the entrant faces a cash-in-advance constraint on proceeding with production. In principle, he can borrow funds to pay these costs by putting his start-up asset as collateral when he enters the market. After both firms decide on quantities, the entrant can borrow an additional loan on the basis of anticipated profit. Below, we formalize the model.

The economy starts in period 0 and ends in period 4. In period 0, the entrant appears in the market with start-up liquidity \( w_0 \geq 0 \). The entrant borrows an initial loan from a lender. Denote by \( B \) the entrant’s total liquidity holding at the end of period 0 (his precautionary liquidity), i.e., the start-up capital \( w_0 \) plus the initial loan \( B - w_0 \geq 0 \). At the same time, the entrant decides on quantity to be supplied \( q_E \in Q_E \subseteq \mathbb{R}^+ \).

In period 1, observing \( q_E \), the incumbent decides on his supply \( q_I \in Q_I \subseteq \mathbb{R}^+ \). Let \( Q := Q_E \times Q_I \) and \( q := (q_E, q_I) \in Q \). To ensure the existence of optimal strategies and pure-strategy equilibrium, we assume that \( Q \) is a finite set.

In period 2, the entrant must pay out the production cost \( C^E(q) \) (the cash-in-advance constraint), while the “deep-pocket” incumbent can postpone paying \( C^I(q) \) until achieving his sales. If the entrant does not have enough money, he is forced to exit the market. As the precautionary liquidity \( B \) may not cover the production cost \( C^E(q) \), the entrant can ask for an additional loan.

In period 3, both firms produce and sell their products. If the entrant stays in the market, each firm \( i \) achieves revenue \( R^i(q) \). If the entrant exits, only the incumbent achieves revenue \( R^I(0, q_I) \). We denote by \( \pi^i(q) \) firm \( i \)'s operating profit: \( \pi^i(q) := R^i(q) - C^i(q) \). We assume that each \( \pi^i : \mathbb{R}^2_+ \rightarrow \mathbb{R} \) is continuously differentiable, \( \pi^I_j < 0, \pi^E_i < 0, \pi^I_{ij} < 0, \pi^E_{jj} \leq 0, \pi^E(0, q_I) = 0 \) and \( \pi^I(q_E, 0) = 0 \) for each \( i = E, I, j \neq i \), and \( q \in \mathbb{R}^2_+ \). (Here
\[ \pi_j^i := \partial \pi^i / \partial q_j, \pi_{ij}^i := \partial^2 \pi^i / \partial q_i \partial q_j. \]

Since \( \pi_{ii}^i < 0 \), we could uniquely determine the incumbent’s optimal supply \( q_i \) to maximize \( \pi^i(q_i, q_j) \) given \( q_j \) if the domain of \( q \) was \( \mathbb{R}^2_+ \). Assume that it is uniquely determined in \( Q \) as well. Let it be \( q_i^{BR}(q_j) \) and the entrant’s profit following \( q_E \) and \( q_i^{BR}(q_E) \) be \( \tilde{\pi}^E(q_E) \):

\[ q_i^{BR}(q_j) := \arg \max_{q_i \in Q_i} \pi^i(q_i, q_j), \quad \tilde{\pi}^E(q_E) := \pi^E(q_E, q_i^{BR}(q_E)). \]

After the product is sold and the entrant achieves revenue \( R^E \), the loans are repaid. We assume that the additional loan is repaid in period 3 before the repayment of the initial loan in period 4. In the base model that we study until Section 5, every element in the economy is assumed to be verifiable. As long as the entrant has enough liquidity to repay the loans after period 3, repayment is able to be enforced. Since there is no uncertainty between periods 2 and 3 in the model, the additional loan is available in period 2 if the entrant will earn enough profit given \( q \) to repay the additional loan. To make a clear comparison, the interest rate on the additional loan is assumed to be 0, while that on the initial long-term loan is \( r \geq 0 \). \( r \) can be interpreted as the interest rate spread between lending and deposit, because the entrant holds \( B \) over multiple periods.

### 3 Benchmark: No Cash-in-advance Constraint

As a benchmark, we consider an entrant with no cash-in-advance constraint. That is, the entrant commits to production and can postpone paying the production cost until he achieves sales in period 3. Our game reduces to standard Stackelberg competition: the benchmark output \( q^\dagger \) is determined by

\[ q_E^\dagger := \arg \max_{q_E \in Q_E} \tilde{\pi}^E(q_E), \quad q_I^\dagger := q_I^{BR}(q_E^\dagger). \tag{1} \]

Without the CIA constraint, there is no threat of predation and no need to raise pre-
Figure 1: The events in the verifiable case.
cautionary liquidity at the time of entry. We exclude the trivial case where neither firm can earn positive profit.

Assumption 1. $\pi_i(q^\dagger) > 0$ for each $i$.

In addition, so that we can characterize equilibrium by first-order conditions, we assume that the restriction on the output space from $\mathbb{R}^2$ to $Q$ does not alter the benchmark equilibrium output levels.

Assumption 2. i) $\tilde{\pi}_{EE}^E < 0$ and thus $\tilde{\pi}^E$ is strictly concave when $q_i$ could take any real number: $Q = \mathbb{R}^2$. ii) Let $q^\dagger$ be the solution of (1) when $Q = \mathbb{R}^2$. Then we have $q^\dagger \in Q$.

Then the benchmark equilibrium is characterized as

$$\tilde{\pi}_{EE}^E(q^\dagger) = 0, \quad \pi_i(q^\dagger) = 0. \quad (2)$$

4 Excess Liquidity against Predation

Here we see the case where the incumbent’s output is verifiable but the entrant faces a cash-in-advance constraint in period 2. We specify the notions of “threat of predation” and of “excess liquidity against predation” in our model.

4.1 Threat of Predation

The cash-in-advance constraint alone would not cause any difference from the benchmark case if the incumbent took the same strategy as in the benchmark: the entrant would not need precautionary liquidity. Suppose that the incumbent chooses the benchmark output $q^BR_I(q_E)$ after each $q_E$, especially $q^\dagger_I$ after $q^\dagger_E$, regardless of the entrant’s precautionary liquidity holding $B$. It is verifiable in period 3 that the entrant paid $C^E(q^\dagger)$ in period 2 and that now he earns revenue $R^E(q^\dagger)$ and thus has $B - C^E(q^\dagger) + R^E(q^\dagger)$ plus the additional loan. The additional lender agrees on the loan in period 2 if and only if the entrant will have enough liquidity to
repay it, i.e., $\pi^E(q^\dagger) + B \geq 0$. As long as entry is profitable in the benchmark equilibrium, i.e., $\pi^E(q^\dagger) > 0$, this condition holds even without precautionary liquidity $B = 0$.

However, the CIA constraint indeed makes the incumbent’s strategy depend on the entrant’s precautionary liquidity $B$ and consequently generates demand for $B$. As we argued above, verifiability guarantees full repayment of the additional loan and thus enable the entrant to borrow the additional loan in period 2 if and only if

$$\pi^E(q) + B \geq 0.$$  \hspace{1cm} (3)

If this inequality is satisfied, the additional lender is sure and can verify in court that the entrant is able to repay it. Anticipating this, the lender agrees to the loan. Otherwise the lender is sure that the additional loan is spent to cover an operating loss and that the entrant is not able to repay it. Thus, the lender refuses the loan. So the inequality (3) is the sufficient and necessary condition for the entrant to finance the production cost with the additional loan and continue production in period 2.

We can see condition (3) as the liquidity constraint that the entrant faces in the beginning of period 2. In period 1, the incumbent decides on his own output so as to maximize his net profit, anticipating that the entrant faces the liquidity constraint (3). Given the entrant’s precautionary liquidity $B$ and the entrant’s output $q_E$, the incumbent’s optimal output is the solution of

$$\max_{q_I \in Q} P(q_E, q_I; B)\pi^I(q_E, q_I) + (1 - P(q_E, q_I; B))\pi^I(0, q_I),$$  \hspace{1cm} (4)

where $P(q; B)$ is the probability that the entrant gets the additional loan (if necessary) and stays in the market given $q$ and $B$. It is 1 if the liquidity constraint (3) holds at $q$ and 0 if not. Here we can see that the incumbent may set predatory excess output because of this liquidity constraint: he can break the liquidity constraint by raising his output $q_I$, which lowers the entrant’s anticipated net profit $\pi^E$. When he succeeds in such predation,
the entrant is forced to exit from the market and the incumbent enjoys the predatory profit \( \pi^I(0, q_I) \) by monopilizing the market. The liquidity constraint brings the threat of predation to the entrant.

But, there is a bound on plausible predatory supply, as the incumbent is rational. As seen in Fig. 2, there is a threshold of the incumbent’s output \( \bar{q}_I^P(q_E) \) where the predatory profit begins to fall below the optimal profit without predation, given the entrant’s output \( q_E \):

\[
Q^P_I(q_E) := \{ q_I \in Q_I | q_I \geq q^R_I(q_E), \pi^I(0, q_I) > \pi^I(q_E, q^R_I(q_E)) \}, \quad \bar{q}^P_I(q_E) := \sup Q^P_I(q_E). \tag{5}
\]

The larger the predatory output is, the more operating loss the entrant suffers. However, predatory output exceeding the threshold \( \bar{q}_I^P \) is not profitable for the incumbent, because it makes the incumbent’s profit worse than that without predation. We call the threshold output level \( \bar{q}_I^P(q_E) \) the maximal plausible predatory output and the entrant’s loss due to this maximal plausible predatory output \(-\pi^E(q_E, \bar{q}_I^P(q_E))\) the maximal plausible predatory loss \( \bar{L}^P(q_E) \):

\[
\bar{L}^P(q_E) = -\pi^E(q_E, \bar{q}_I^P(q_E)) = \sup \{ -\pi^E(q_E, q_I) | q_I \in Q^P_I(q_E) \}. \tag{6}
\]

To proceed with production of \( q_E \), the entrant’s precautionary liquidity holding has to cover operating loss caused by any plausible predatory output \( q_I \in Q^P_I(q_E) \). That is, the liquidity constraint \( B \geq \bar{L}^P(q_E) \) has to be satisfied at \( q_I = \bar{q}_I^P(q_E) \):

\[
B \geq \bar{L}^P(q_E). \tag{7}
\]

If condition \( B \geq \bar{L}^P(q_E) \) is not satisfied, the incumbent can enjoy predatory profit \( \pi^I(0, q_I) \), larger than \( \pi^I(q_E, q^R_I(q_E)) \), by choosing some predatory output \( q_I \in Q^P_I(q_E) \) and obstructing the entrant from borrowing a large enough additional loan. If \( B \geq \bar{L}^P(q_E) \) is satisfied, the entrant can stay
0° We want to see an equilibrium where the entrant prevents predation; the incumbent’s equilibrium output maximizes the duopoly profit $\pi^E(q_E, q_I)$ given the entrant’s $q_E$.

1° The incumbent could benefit from predation if and only if the incumbent could get the entrant to exit by playing a predatory output less than $\bar{q}_I^P(q_E)$.

2° $L^P(q_E) := -\pi^E(q_E, \bar{q}_I^P(q_E))$ is thus the maximum plausible loss of the entrant in case of predation.

3° As long as the entrant can stay in the market even if he suffers a loss of $L^P(q_E)$, the incumbent does not prey on him. To guarantee that the entrant stays, the liquidity constraint requires him to have precautionary liquidity $B \geq L^P(q_E)$.

*Figure 2:* The maximum plausible predatory loss $L^P$ and the non-predation condition given $q_E$.  

15
in the market as long as the incumbent’s output is within plausible levels, i.e., $q_I \in Q^P_I(q_E)$. 

Thus, in period 1, the incumbent gives up preying on the entrant and chooses $q^{BR}_I(q_E)$. We call the inequality (7) the non-predation condition.

In period 0, foreseeing the non-predation condition (7), the entrant optimizes his output $q_E$ and initial borrowing $B - w_0 \geq 0$:

$$\max_{q_E \in Q_E, B \in \mathbb{R}_+} \pi^E(q_E) - r(B - w_0) \quad \text{s.t.} \quad B \geq \bar{L}^P(q_E), B - w_0 \geq 0. \quad (8)$$

Let $(q^4_E, B^4)$ be the solution of this problem and $q^4_I = q^{BR}_I(q^4_E)$. The non-predation condition (7) shows that the threat of predation creates the entrant’s need for excess liquidity. Were there no threat of predation, the entrant could finance the entire production cost $C^E(q^4)$ with an additional loan and would not have to raise any precautionary liquidity as long as the actual output profile $q^4$ yields a positive profit for the entrant.

### 4.2 Distortion in the product market

We confirm here that the non-predation condition imposes an additional marginal cost on the entrant’s output and thus makes him less aggressive. We determine $q^4_E$, $q^4_I$ and $\bar{q}^P_I(q^4_E)$ analytically. To justify this, we make the following assumption on the strategy space, similar to Assumption 2.

**Assumption 3.** Let $\hat{q}^4_E$ be the solution of (8), $\hat{q}^4_I$ be $q^{BR}_I(q^4_E)$ and $\hat{q}^P_I(q^4_E)$ be the maximal plausible predatory output (5) when $q_i$ can take any real number. The output space $Q$ contains $q^4$ and $\hat{q}^P_I(q^4_E)$:

$$\hat{q}^4_E \in Q_E, \quad \hat{q}^4_I, \hat{q}^P_I(q^4_E) \in Q_I.$$

For such a $Q$, the solution $q^4_E$ of (8), $q^4_I = q^{BR}_I(q^4_E)$ and the solution $\hat{q}^P_I(q^4_E)$ of (5) at $q_E = q^4_E$ coincide with these $\hat{q}^4$ and $\hat{q}^P_I(q^4_E)$.

First, the maximal plausible predatory output $\bar{q}^P_I(q^4_E)$ gets larger as the entrant chooses larger $q_E$. An increase in $q_E$ decreases the incumbent’s optimal duopoly profit $\pi^I(q_E, q^{BR}_I(q_E))$. 

16
This makes predation more attractive for the incumbent and thus larger predatory output becomes profitable. That is, \( \bar{q}_I^P(q_E) \) becomes larger. Analytically we obtain

\[
\frac{d\bar{q}_I^P(q_E)}{dq_E} = \frac{\pi_I^E(q_E, \bar{q}_I^{BR}(q_E))}{\pi_I^I(0, \bar{q}_I^P(q_E))} > 0
\]

by differentiating \( \pi_I^E(q_E, \bar{q}_I^{BR}(q_E)) = \pi_I^I(0, \bar{q}_I^P(q_E)) \) with respect to \( q_E \). (See (5).)

We can decompose the effect of a marginal increase in \( q_E \) on \( \bar{L}^P \) into direct and indirect effects:

\[
\frac{d\bar{L}^P}{dq_E}(q_E) = \underbrace{-\pi_E^E(q_E, \bar{q}_I^P(q_E))}_{\text{Direct effect}} - \pi_I^E(q_E, \bar{q}_I^P(q_E)) \times \frac{d\bar{q}_I^P}{dq_E}(q_E). \underbrace{-\pi_I^E(q_E, \bar{q}_I^P(q_E)) \times \frac{d\bar{q}_I^P}{dq_E}(q_E)}_{\text{Indirect effect}}
\]

The direct effect is the increase in \( \bar{L}^P \), holding the incumbent’s output fixed, caused by the increase in the entrant’s output. The indirect effect is the increase caused by the change in the incumbent’s maximal plausible predatory output \( \bar{q}_I^P \).

The indirect effect is always positive because \( \bar{q}_I^P(q_E) \) increases with \( q_E \) and \( \pi_I^E < 0 \). The direct effect may be positive and thus the sign of the overall effects is ambiguous in general. However, at least in a neighborhood of the benchmark equilibrium, it is positive. Since \( \pi_E^E(q_E, \bar{q}_I^P(q_E)) > \pi_I^E(q_E, \bar{q}_I^P(q_E)) \) (by \( \pi_E^E < 0 \) and \( \pi_I^E < 0 \)), the predatory output \( \bar{q}_I^P(q_E) \) decreases the entrant’s marginal net profit \( \pi_E^E \) from that at the benchmark equilibrium, \( \pi_E^E(q_I^\dagger) \), which is negative by (2), i.e., \( 0 = \pi_E^E(q_I^\dagger) \equiv \pi_E^E(q_I^\dagger) + \pi_I^E(q_I^\dagger)(q_I^{BR})'(q_E^\dagger) \). Hence the direct effect \( -\pi_E^E(q_E, \bar{q}_I^P(q_E)) \) is also positive at \( q_E = q_E^\dagger \). Therefore, the overall effect is positive around \( q_E^\dagger \). That is, the entrant needs more liquidity to increase its supply and prevent predation. The need for excess liquidity increases the marginal cost of \( q_E \) and thus makes the entrant less aggressive, unless the entrant has enough start-up liquidity to protect himself from predation in the benchmark equilibrium.

**Proposition 1.** Consider the case where the entrant faces the cash-in-advance constraint and the incumbent’s output \( q_I \) is verifiable. Suppose Assumptions 1–3.

1) Without enough precautionary liquidity of the entrant, the incumbent could exclude the
entrant by producing excess output. The entrant needs to raise excess precautionary liquidity at the time of entry in order to prevent predation, even if he can borrow an additional loan after entry: \( B^\dagger \geq \bar{L}^P(q^\dagger_E) \)

2) Suppose \( r > 0 \) and that the entrant’s start-up liquidity does not cover the maximal plausible predatory loss against the benchmark equilibrium output \( q^\dagger_E \), i.e., \( w_0 < \bar{L}^P(q^\dagger_E) \). Then the need for excess liquidity adds an extra marginal cost for the entrant. Consequently, the entrant’s output level becomes smaller and the incumbent’s becomes larger: \( q^\dagger_E < q^\dagger_I \) and \( q^\dagger_I > q^\dagger_I \).

3) Fix the interest rate \( r \) initially at \( r_0 > 0 \). Suppose that \( w_0 < \bar{L}^P(q^\dagger_E) \) at \( r = r_0 \). Then \( dq^\dagger_E/dr > 0 \) at \( r = r_0 \) as long as the derivative exists.\(^6\)

Proof. See Appendix A. \( \square \)

Remark. If the additional loan is prohibited, the entrant’s precautionary liquidity needs to cover the entire production cost. The above argument implies that it should cover \( C^E(q_E, \bar{q}^P_I(q_E)) \), not just \( C^E(q_E, q^BR_I(q_E)) \). In contrast, securing a credit line makes the lender commit to the additional loan. Then in order to prevent predation, she must remain committed to the loan even after observing predatory outputs up to \( \bar{q}^P_I(q_E) \). As long as a commitment fee is charged, it is the same as raising precautionary liquidity to \( B = \bar{L}^P(q_E) \) with the initial loan. \((r \) is interpreted as the commitment fee rate.) \( \blacksquare \)

5 Unverifiability and endogenous borrowing constraint

5.1 Unverifiability and timing of loans

So far, we have not assumed any financial imperfection: the entrant can finance an initial loan of any amount just by accepting the interest rate \( r \). If there is any imperfection, we would expect it to amplify the distortion in the product market. Here we present the theoretical possibility of endogenous financial imperfection caused by unverifiable predation. With the
limited liability of the entrant, predation can be used as an excuse to avoid repayment. This opportunity results in an endogenous borrowing constraint on the initial loan and prevents the entrant from raising enough precautionary liquidity.

To formalize this idea, we start by assuming that $q_I$ is unverifiable, while the entrant’s choices $B$ and $q_E$ and all the functions are verifiable. This makes the entrant’s actual profit $\pi^E(q_E, q_I)$ also unverifiable. That is, after period 2, the entrant’s actual liquidity holding is not verifiable and thus the court cannot enforce repayment of the loan by the entrant. On the other hand, we assume that the entrant’s exit from the market is verifiable. In this case, it is verifiable that the entrant has not spent any money and thus still holds all his precautionary liquidity $B$; thus, the court can enforce repayment up to $B$.

We are interested in the possibility that such unverifiability about his rival’s choice $q_I$ affects the entrant’s ability to borrow a large enough initial loan to raise precautionary liquidity against predation. As a base model, we assume that the additional lender is different from the initial lender and does not commit to additional lending (an uncommitted additional loan). But all of our propositions hold even if we assume that the additional loan is unavailable (no additional loan) or committed to by the initial lender (credit line). We consider these two cases as a supplement to the base model.

If agreed to, the additional loan covers the difference between the entrant’s precautionary liquidity holdings and his production costs. We assume that the additional lender agrees to the loan if and only if the repayment of the additional loan is assured from the verifiable information available in period 2.

The initial loan contract is designed to get the entrant to voluntarily repay his loans and report $q_I$ truthfully. To create an incentive for him to voluntarily repay it, we assume that the entrant has a non-monetary asset $V$ at the time of entry and mortgages it to borrow the initial loan. The mortgage may go into liquidation; the liquidation value $\bar{V}$ is assumed to be smaller than the private continuation value $\bar{V}$.

As the initial lender takes the start-up asset as collateral, we assume that the additional
lender has priority to be repaid from product sales. Although this financial structure is just an assumption, we feel it is realistic: we imagine a situation in which the entrant puts up physical assets to start the business as collateral for an initial loan, and inventories and accounts receivable as collateral for an additional loan.\textsuperscript{8}

5.2 Financial contract

The initial loan contract $C$ consists of the following.

- $B - w_0 \in \mathbb{R}$: the amount of the initial loan.
- $q_E \in Q_E$: the entrant’s output.
- $M$: the set of available messages sent by the entrant in period 2.
- $D : M \rightarrow \mathbb{R}$: the (monetary) repayment in period 4 if the entrant sends message $m \in M$ in period 2.
- $\beta : M \rightarrow [0, 1]$: the liquidation policy, i.e., the proportion of the mortgaged asset $V$ that the lender takes over at the end of period 4. We assume that the asset is divisible. That is, the proportion $\beta$ can take any value in $[0, 1]$, not only $\{0, 1\}$.

We assume that the contract $C$ is made public and thus is common knowledge for everyone in the economy, as well as being verifiable in court.

At the beginning of period 2, the entrant announces message $m \in M$, after observing the output levels $q_E$ and $q_I$ in period 1. We assume that the additional lender receives the same message $m$ as the initial lender, which reduces the information problem encountered by the additional lender.

In period 3, the additional loan is repaid immediately after the entrant achieves the revenue $R^E(q)$. Notice that after the additional loan is wholly repaid, the entrant has liquidity of $\pi^E(q) + B$ in the end of period 3.
Figure 3: The events in the unverifiable case with an uncommitted additional loan. New events and changes are written in sans serif.
In period 4, the initial loan is repaid according to the repayment schedule \( D \). In addition, the initial lender liquidates the proportion \( \beta(m) \in [0, 1] \) of the mortgaged asset and gains the liquidation value \( \beta(m)V \). The entrant retains the rest of the asset and gains the private continuation value \( (1 - \beta(m))\bar{V} \). We assume \( \bar{V} > V > 0 \). In contrast to the monetary repayment \( D \), we define the \textbf{total repayment} \( \delta \) as the monetary repayment \( D \) plus the entrant’s loss of the private value from liquidation of the mortgaged asset: \( \delta(m) := D(m) + \beta(m)\bar{V} \).

We emphasize that \( D \) should be the actual effective amount, not just the face value, of the repayment. Suppose that the entrant announces the incumbent’s output level directly. When the entrant reports \( m = \tilde{q}_I \) as the incumbent’s output in period 2 and continues production, this report implies that the entrant’s liquidity holding is \( \pi^E(q_E, \tilde{q}_I) + B \) in the beginning of period 4.\(^9\) If the face value of the repayment \( D(\tilde{q}_I) \) exceeds this amount, it cannot be fully paid and the actual repayment is reduced to the amount of the entrant’s liquidity holding. This is \textbf{the entrant’s limited liability constraint}.

Additionally, the initial lender would not agree on the loan if he expects a loss. Let us interpret \( r \) as the interest rate spread between deposits and investment in risk-free assets for the lender. The equilibrium repayment plus the liquidation value should cover the risk-free future value of the loan \( (B - w_0)(1 + r) \). This is the \textbf{initial lender’s participation condition}. The initial loan contract should be \textbf{valid} in the sense that it satisfies limited liability and the initial lender’s participation condition.

\cite{Zusai2013} considers a contract with an exit option and unverifiability of the outsider’s strategy but no physical uncertainty. To pin down the posterior belief about the outsider’s strategy and thus its correlation with the agent’s message in non-equilibrium outcomes, the paper considers sequential equilibria in the game after the contracting party agrees on the contract, and proves the revelation principle. The revelation principle guarantees that a sequential equilibrium outcome achieved in a general form of the contract is also implemented in a contract in which the agent directly announces the outsider’s strategy or exits and, if
he wants to stay, truthfully reports the actual strategy of the outsider.\textsuperscript{11} Because this revelation principle is applicable to our model, we let the entrant announce directly the incumbent’s output $q_I$, \textit{as long as he wants to stay in the market}. Otherwise, his exit is verifiable and $q_I$ is no longer related to the entrant’s liquidity holding; so if he wants to exit, we let him announce only an intent to exit. So the message space here is the set of the incumbent’s output levels $Q^S_I$ that will allow the entrant to stay and the set of messages $M_0$ that imply an intent to exit. We assume that the additional lender would not offer the additional loan if she receives a message in $M_0$.\textsuperscript{12}

5.3 Endogenous borrowing constraint

There are four necessary conditions for a non-predatory equilibrium under unverifiablity of predation. Let $q^*$ be the equilibrium output profile. Given the entrant’s truth-telling, the additional loan is available after sending message $\tilde{q}_I$ if and only if $\pi^E(q^*_E, \tilde{q}_I) + B \geq 0$. That is,

$$Q^S_I = \{ \tilde{q}_I \in Q_I | \pi^E(q^*_E, \tilde{q}_I) + B \geq 0 \}. \quad (9)$$

As we argued in the last section, to prevent predation, the additional loan needs to be available after any plausible predation:

$$q^P_I \in Q^S_I \quad \text{for any} \quad q^P_I \in Q^P_I(q_E^*), \quad \text{i.e.,} \quad Q^P_I(q_E^*) \subset Q^S_I. \quad (10)$$

The first necessary condition for a non-predatory equilibrium is this condition to block predation.

Second, truth-telling must be compatible with the entrant’s incentives. Given that the entrant wants to stay, he can choose any message in $Q^S_I$, especially the one that minimizes the total repayment. To guarantee truth-telling, the total repayment of any message in $Q^S_I$
should be equal to the minimum:

\[ \hat{\delta} := \min_{\tilde{q}_I \in Q_I^S} \delta(\tilde{q}_I). \]

So the incentive compatibility condition for the entrant to report truthfully is

\[ \delta(\tilde{q}_I) = \hat{\delta} \quad \text{for any } \tilde{q}_I \in Q_I^S. \] (11)

Third, to get the initial loan contract accepted, the initial lender’s participation constraint has to be satisfied in the equilibrium outcome. Given the equilibrium output levels \( q^* \), it is

\[ D(q^*_I) + \beta(q^*_I)V \geq (B - w_0)(1 + r). \] (12)

Finally, the monetary repayment schedule in a valid contract has to satisfy limited liability. Given the entrant’s truth-telling, the limited liability condition reduces to

\[ D(\tilde{q}_I) \leq \pi^E(q^*_E, \tilde{q}_I) + B \quad \text{whenever } \tilde{q}_I \in Q_I^S. \] (13)

The next theorem says that these four constraints jointly impose a non-trivial condition (14) on the entrant’s equilibrium output \( q^*_E \). We look at the entrant’s messaging strategies after observing the incumbent’s equilibrium output \( q^*_I \) and after a plausible predatory output \( q^*_P \in Q_I^P(q^*_E) \). We call the condition (14) the non-predation condition under unverifiability of the incumbent’s output.

**Theorem 1.** Consider a non-predatory equilibrium with a valid initial loan contract under unverifiability of the incumbent’s output. Then, the entrant’s equilibrium output \( q^*_E \) satisfies

\[ (1 + r)^{-1}V + w_0 \geq L^P(q^*_E). \] (14)

**Proof.** Since \( V > \underline{V} \) and \( \beta \geq 0 \), the participation condition (12) sets a lower bound on the
total repayment after the equilibrium output \( q^*_I \) is announced:

\[
\delta(q^*_I) = D(q^*_I) + \beta(q^*_I)\bar{V} \geq (B - w_0)(1 + r). \tag{15}
\]

Since \( \beta \in [0,1] \) and \( \bar{V} > 0 \), the limited liability condition \([13]\) sets an upper bound on the total repayment after a plausible predatory output \( q^*_P \) is announced:

\[
\delta(q^*_P) = D(q^*_P) + \beta(q^*_P)\bar{V} \leq \pi^E(q^*_E, q^*_P) + B + \bar{V}. \tag{16}
\]

Finally, since \( Q^P_I(q^*_E) \subset Q^S_I \), the incentive compatibility condition \([11]\) implies \( \delta(q^*_P) = \delta(q^*_I) \) for any \( q^*_P \in Q^P_I(q^*_E) \). Combining the two bounds \([15]\) and \([16]\) with this, we obtain

\[
\pi^E(q^*_E, q^*_P) + B + \bar{V} \geq \delta(q^*_P) = \delta(q^*_I) \geq (B - w_0)(1 + r),
\]

\[
\implies \bar{V} + (1 + r)w_0 \geq -\pi^E(q^*_E, q^*_P) + rB
\]

for any \( q^*_P \in Q^P_I(q^*_E) \). Further, since \( q^*_P \in Q^P_I(q^*_E) \subset Q^S_I \) means \( B \geq -\pi^E(q^*_E, q^*_P) \) by \([9]\), this implies

\[
\bar{V} + (1 + r)w_0 \geq -\pi^E(q^*_E, q^*_P)(1 + r) \quad \text{for all } q^*_P \in Q^P_I(q^*_E),
\]

i.e., \( (1 + r)^{-1}\bar{V} + w_0 \geq \sup\{-\pi^E(q^*_E, q^*_P)|q^*_P \in Q^P_I(q^*_E)\} = \bar{L}^P(q^*_E). \]

\[\square\]

**Remark.** As long as \( Q^S_I \) requires the conditions \([10]\)–\([13]\), \([17]\) must hold. In the initial loan contract without commitment to additional lending, \( Q^S_I \) is implied from \( B \) as \([9]\). If a credit line is committed to, \( Q^S_I \) should be written in the contract: the lender commits to additional lending if he receives message \( \bar{q}_I \in Q^S_I \). As long as a commitment fee is charged, we have the same condition \([14]\). \( r \) is again interpreted as the commitment fee rate.) Even if not,
implies \( \bar{V} + w_0 \geq \bar{L}(q_E) \). Under the assumption that an additional loan is unavailable, the entrant’s precautionary liquidity needs to cover the entire production cost \( C^E(q^*_E, q_I) \) for any foreseen \( q_I \in Q^S_I \): we have \( B \geq C^E(q^*_E, q_I) \), instead of \( B \geq -\pi^E(q_E, q^*_I) \), for all \( q_I \in Q^S_I \). Then, (17) implies \( \bar{V} + (1 + r)w_0 \geq \bar{L}(q_E) + rC^E(q^*_E, q^*_I(q^*_E)) \), which is stronger than (14).

(14) is just a necessary condition for a non-predatory equilibrium; we also expect the entrant and the initial lender to design the loan contract \( C \) so as to maximize the entrant’s profit subject to the non-predation condition (14), anticipating the incumbent’s non-predatory optimal output decision:

\[
q^*_E = \arg \max_{q \in Q_E} \left\{ \bar{\pi}^E(q) - r\bar{L}(q) \mid (1 + r)^{-1}\bar{V} + w_0 \geq \bar{L}(q) \right\}, \tag{18a}
\]

\[
q^*_I = q^*_I^{BR}(q^*_E) = \arg \max_{q \in Q_I} \pi^I(q^*_E, q_I). \tag{18b}
\]

The next theorem says that this output profile is indeed implemented in a sequential equilibrium in the game after the entrant and the lender agree on a standard debt contract. In this contract, the entrant borrows as much as the discounted private value of the mortgaged start-up assets and repays the loan and the interest whenever he has enough liquidity to repay. If not all of the loan is repaid, the rest is covered by liquidation of the mortgaged assets. The total repayment \( \delta \) is kept constant at \( \bar{V} \), regardless of the message, as long as the entrant continues business. To commit to continuation of the business against plausible predation, the entrant lets the initial lender take over all of his assets and liquidity when he quits.

**Theorem 2.** Suppose Assumption 1. In the unverifiable case, there exists a non-predatory equilibrium with the output profile \( q^* \) such as (18), as long as \( \bar{\pi}^E(q^*) \geq 0 \). The initial loan contract \( C \) consists of \( B - w_0 = (1 + r)^{-1}\bar{V} \) and

\[
M = Q^S_I \cup \{m_0\};
\]
\[ D(m_0) = B, \quad \beta(m_0) = 1; \]
\[ D(\tilde{q}_I) = \begin{cases} 
(B - w_0)(1 + r) & \text{if } \pi^E(q^*_E, \tilde{q}_I) + B \geq (B - w_0)(1 + r), \\
\pi^E(q^*_E, \tilde{q}_I) + B & 0 \\
1 - D(\tilde{q}_I)/\bar{V} & 1 - D(\tilde{q}_I)/\bar{V} \end{cases} \]
\[ \beta(\tilde{q}_I) = \begin{cases} 
0 & \text{if } \pi^E(q^*_E, \tilde{q}_I) + B \geq (B - w_0)(1 + r), \\
1 - D(\tilde{q}_I)/\bar{V} & \text{if } \pi^E(q^*_E, \tilde{q}_I) + B \in [0, (B - w_0)(1 + r)). \]

**Proof.** See Appendix B. We verify that these strategies constitute a sequential equilibrium with the output profile \( q^* \) in the game after the initial loan contract shown above is accepted. \( \square \)

In summary, in a non-predation equilibrium, the entrant’s output \( q_E \) is restricted by his start-up capital \( w_0 \) and the private value of his asset \( \bar{V} \) through the non-predation condition. Combined with the comparative statics in part 3 of Proposition 1, this implies further distortion in the product market outcome.

**Proposition 2.** Consider the case where the entrant faces a cash-in-advance constraint and the incumbent’s output \( q_I \) is not verifiable.

1) There is a threat of predation, and thus the entrant needs to raise excess precautionary liquidity to avoid predation.

2) Because of unverifiability, an entrant with small start-up capital, i.e., \( w_0 + \bar{V} \leq \bar{L}^P(q^*_E) \), cannot finance precautionary liquidity large enough to produce the benchmark output. With Assumptions [1], [2] and [3], this implies that the entrant’s output shrinks further from the verifiable case, whether the additional loan is uncommitted, committed, or unavailable. Consequently, the incumbent’s output further expands.

**6 Discussion**

In this section, we discuss the structural assumptions underlying our model. The discussion below clarifies the applicability of each proposition.
Product market structure

The Stackelberg timing structure is to ensure the existence of pure-strategy equilibrium, as well as to simply formalize the incumbent’s opportunity to prey on the entrant. In the working paper version (Zusai, 2012), we allow the entrant to decide on \( q_E \) at the same time as the incumbent, i.e., in period 1; all propositions remain the same, provided that equilibrium exists. If the interest rate on the additional loan is zero or \( q_I \) is unverifiable, there is a pure-strategy equilibrium in the Cournot version of the game.

The variable \( q_i \) can be anything that is committed to, must be paid before achieving sales and determines competence in the subsequent product market. We can think \( R^i(q) \) as the reduced form of firm \( i \)'s profit in the product market competition given the state of competence \( q \). For example, we can interpret \( q_i \) as the capacity or the size of production facilities. We allow the possibility that the incumbent runs the production facilities at a low operation rate after he succeeds at excluding the entrant from the market by setting a predatory large “capacity” \( q_I \). Such a low operation rate with a large predatory capacity yields lower profit than at a high (efficient) rate with a smaller capacity. It just means in our model that \( q_I \) is not equal to \( q_I^{BR}(0) \), the optimal monopoly capacity in the absence of the entrant.

Financial structure, the cash-in-advance constraint, and trade credits

In our model, there are two types of loans—initial and additional loans. Without an additional loan, the model sounds very restrictive. In addition, having two types of loans, we separate loans to finance precautionary liquidity (the initial loan) from loans just to pay production costs (the additional loan); one of our propositions (part 1 of Propositions 1 and 2) is the existence of excess precautionary liquidity due to threat of predation, which is clarified by this separation. We have considered various possibilities about additional lending and various types of the initial lender’s commitment and confirmed that the basic conclusions of each proposition are valid for each variation.
Our “additional loan” includes a wide range of financing instruments, e.g., deferred payment of costs and advance draw of sales. Thus our “cash-in-advance constraint” just means that the entrant must pay all production costs with his precautionary liquidity, short or long-term bank loans, and trade credits.

Trade credits such as “net 30” are commonly used and work as a substitute of short-term bank loans especially for financially weak firms. But, if we regard foregone discounts in case of late payment as hidden interests of the credits, trade credits are much more expensive than bank loans.\textsuperscript{13} Young firms indeed tend to delay payments and thus miss discounts.\textsuperscript{14} Besides, suppliers typically use credit scores such as Paydex to determine a customer’s eligibility and limit of trade credits.\textsuperscript{15} A new entrepreneur has to start from small limit of credit until accumulating a good credit score; furthermore, the tendency of late payment makes it difficult. So trade credit, which is included in our “additional loans,” is not a complete solution of the cash-in-advance constraint.\textsuperscript{16}

The key in our loan structure is commitment to the initial financing at the time of entry. This point leads us to reconsider the meaning of the “entrant” in our model. We expect an entrant to be subject to the CIA constraint because he is new to the industry and thus has yet established creditworthiness and long-term relationship to defer payment or get an advance draw unconditionally. The “entrant” in our model can be an incumbent in reality. For example, we should consider an entrant as our “incumbent” if the actual entrant is a large conglomerate and can subsidize the new business with profits from its other businesses or if the entrant is supported unconditionally by the government or by a large business group.\textsuperscript{17}

**Unverifiability and monitoring**

Let us consider unverifiability of the incumbent’s “output” $q_I$ and the entrant’s profit $\pi^E$. We should note the distinction between unverifiability and unobservability. Even if $q_I$ is unverifiable, the entrant may directly observe $q_I$ or predict it with high accuracy by extensive
marketing research. He could even present the marketing data about the rival’s strategy and its impact on his own business to the lenders so as to convince them of profitability of his entry plan.

What we mean by unverifiability is that anybody (especially the lenders) cannot legally verify that such observation and prediction coincide with the actual $q_I$ (or $\pi^E$). Although this evidence could be enough for antitrust lawsuits, here we consider lawsuits to enforce the loan contract. To enforce repayment, the court needs to know whether the entrant actually has enough money to repay the loan. Furthermore, because the incumbent is a rival in the product market and not a party to the entrant’s loan contract, it is hard to expect that the incumbent would be willing to provide verifiable evidence of the actual $q_I$ for the entrant’s lenders, which would help the entrant finance his costs according to our propositions.

Note that in the unverifiable case, repayment does not rely on the court for enforcement of the contract. Unverifiability prevents the court from enforcing full repayment of the loan. The lender instead has to encourage the entrant to voluntarily repay the whole loan by using liquidation of collateral as a threat.

We do not insist that $q_I$ or $\pi^E$ is always unverifiable. Our propositions rather suggest that an entrant should make things verifiable for better financing. For example, in a Japanese “main bank system” (Hoshi, Kashyap, and Scharfstein [1991]), a borrower has his business activity monitored by “main banks” through keeping all transactions in the bank’s account and inviting a banker to be an accounting director. This guarantees verifiability of the borrower’s liquidity holding and enables the lender to enforce repayment of the whole loan.

One might feel that our verifiable and unverifiable cases are too extreme. In between, we could think of a stochastically verifiable case, where the lender gets verifiable information about $q_I$ or $\pi^E$ with some probability. On the other hand, so-called “costly state verification”, usually meaning that the principal (the lenders) surely obtain verifiable information at some cost, should fall into our verifiable case.
Equity versus debt financing

In our model, the “entrant” receives all remaining profits and assets after his loan repayments, while he devotes all of his start-up capital to the business. So the equity investors should be regarded as parts of the “entrant,” not as the initial “lenders” in our model.

Lerner (1995) studies the disk drive industry in 1980–88, seeing changes in equity financing as shocks to the entrant’s financial strength. He tests whether price wars were triggered by entries of financially weak rivals. In 1980–83, a venture company was able to easily raise start-up capital with equity finance. In this era of “capital market myopia,” prices were wholly determined by the products’ attributes, independent of the financial weakness of the entrants. In 1984–88 when entrepreneurs suddenly faced difficulty in securing equity financing, prices were significantly lower in the presence of financially weak rivals.

This empirical result is comparable with our propositions. In the early 1980s, “capital market myopia” enabled the entrants to raise enough start-up capital $w_0$. Thus, they satisfied the non-predation condition and could avoid predation. In the late 80s, the difficulty of securing equity financing forced the entrants to enter the industry with much less start-up capital. Hence, they could not obtain sufficient precautionary liquidity and as a result, the incumbents were more aggressive.

7 Concluding remarks

We see that the threat of predation creates the demand for excess precautionary liquidity that is not spent in equilibrium. This is consistent with numerous empirical findings that generally report positive relationship between competitive pressure and cash holding (Hoberg, Phillips, and Prabhala, 2013; Fresard, 2010). But the need to raise precautionary liquidity by means of long-term loan adds an extra marginal cost of the entrant’s production and thus makes him less aggressive. Furthermore, we prove that if the incumbent’s strategy and thus the entrant’s actual profit are unverifiable, the entrant faces a restricted supply of excess liquidity.
and has to shrink his business further; though, close monitoring of the entrant’s business by banks or trade creditors may alleviate this informational problem. Empirical research thus needs to take care of endogeneity between loan supply and liquidity demand under competitive pressure and also to pay attention to the entrant’s relationship with banks and trade creditors.

The excess liquidity is kept only to show the entrant’s financial healthiness and commitment to stay in the market. It does not contribute to production at all. When liquidity supply is limited in the economy, such demand for precautionary liquidity crowds out real liquidity demand for production and investment. Hence a policy that weakens the threat of predation improves macroeconomic efficiency by releasing excess liquidity holdings. As argued by Holmström and Tirole (1998), availability of a credit line might eliminate inefficiency in the monetary market, as well as possibly reducing interest payments. But we would wonder how to make the lender’s commitment observable and credible. Cash or liquidity holding would be relatively easy to see. Basic balance sheet information may be disclosed formally and publicly in a large industry. It can be disclosed initially only to banks and suppliers, but such information can be shared to rival firms from mouth to mouth in a small local business community.

On the other hand, if the incumbent cannot know the entrant’s cash holding at all, excess liquidity may not work effectively to deter predation. Probably, in such situations, the entrant may show off its financial strength in a costly way such as building large facilities or placing extensive advertisement. To shed light on informational roles of cash holding in product market competition, it would be an interesting extension to incorporate imperfect observation of the entrant’s liquidity holding into our model.
A Proof of Proposition 1

Proof. The first part comes from the analysis in the main text; see (8). The second and third parts are proven by analytically characterizing the solution $\hat{q}_E^{\dagger}$ of this optimization problem (8) as if $q_E$ and $q_I$ can be any real number, thanks to Assumption 3: it guarantees $\hat{q}^{\dagger} = q^{\dagger}$. For the second part, we consider the Karash-Kuhn-Tucker necessary conditions on the optimum $(\hat{q}_E^{\dagger}, B^{\dagger})$: there exist non-negative multipliers $\lambda^{\dagger}$ and $\mu^{\dagger}$ such that

\begin{align*}
\text{FOC on } q_E: & \quad \tilde{\pi}_E^E(\hat{q}_E^{\dagger}) = \lambda^{\dagger} \bar{L}^{P'}(\hat{q}_E^{\dagger}), \quad (19) \\
\text{FOC on } B: & \quad r = \lambda^{\dagger} + \mu^{\dagger}, \quad (20) \\
\text{CS on } \lambda: & \quad \lambda^{\dagger}(B^{\dagger} - \bar{L}^{P}(\hat{q}_E^{\dagger})) = 0, \quad (21) \\
\text{CS on } \mu: & \quad \mu^{\dagger}(B^{\dagger} - w_0) = 0. \quad (22)
\end{align*}

If $\lambda^{\dagger} = 0$, then (19) and (20) reduce to $\tilde{\pi}_E^E(\hat{q}_E^{\dagger}) = 0$ and $r = \mu^{\dagger}$. By $\tilde{\pi}_{EE}^E < 0$ and (2), the former implies $\hat{q}_E^{\dagger} = q_E^{\dagger}$. By $r > 0$, the latter implies $B^{\dagger} = w_0$ from (22). Thus we have $w_0 = B^{\dagger} \geq \bar{L}^{P}(\hat{q}_E^{\dagger})$: a contradiction.

Hence $\lambda^{\dagger} > 0$, which implies $B^{\dagger} = \bar{L}^{P}(\hat{q}_E^{\dagger})$ from (21). By $\pi_{EI}^E < 0$, $q_{iBR}(q_E) \leq \bar{q}_{i}^{P}(q_E)$, $\bar{\pi}_{i}^{E} < 0$ and $\bar{q}_{i}^{P'} > 0 > q_{iBR}'$, we have

\begin{align*}
\bar{L}^{P'}(q_E) & \equiv -\pi_{E}^{E}(q_E, q_{i}^{P}(q_E)) - \pi_{i}^{E}(q_E, q_{i}^{P}(q_E)) \cdot \bar{q}_{i}^{P'}(q_E) \\
& > -\tilde{\pi}_{E}^{E}(q_E) \equiv -\pi_{E}^{E}(q_E, q_{iBR}(q_E)) - \pi_{i}^{E}(q_E, q_{iBR}(q_E)) \cdot q_{iBR}'(q_E)
\end{align*}

for any $q_E$. Thus $\lambda^{\dagger} > 0$ and (19) imply $(1 + \lambda^{\dagger})\tilde{\pi}_{E}^{E}(q_E^{\dagger}) > \tilde{\pi}_{E}^{E}(q_E^{\dagger}) - \lambda^{\dagger} \bar{L}^{P'}(q_E^{\dagger}) = 0$; i.e., $\tilde{\pi}_{E}^{E}(q_E^{\dagger}) > 0$. By $\tilde{\pi}_{EE}^{E} < 0$ and (2), this implies $\hat{q}_E^{\dagger} < q_E^{\dagger}$. Consequently, $\hat{q}_{i}^{\dagger} = q_{iBR}(\hat{q}_E^{\dagger}) > q_{i}^{\dagger} = q_{iBR}(q_E^{\dagger})$.

The third part comes from conventional comparative statics. If $\bar{L}^{P}(\hat{q}_E^{\dagger}) > w_0$, (22) implies $\mu^{\dagger} = 0$ and further $r = \lambda^{\dagger}$ by (20). So the optimal $\hat{q}_E^{\dagger}$ is indeed the maximizer of $\tilde{\pi}_{E}^{E}(q_E) - r\bar{L}^{P}(q_E)$. The first-order necessary condition is $\tilde{\pi}_{E}^{E}(\hat{q}_E^{\dagger}) = r\bar{L}^{P'}(\hat{q}_E^{\dagger})$ and the
second-order necessary condition is \( \tilde{\pi}_{EE}^E(q_E^\dagger) - r\tilde{L}^{pn}(q_E^\dagger) \leq 0 \). Differentiation of the first-order condition w.r.t. \( r \) yields

\[
\{ \tilde{\pi}_{EE}^E(q_E^\dagger) - r\tilde{L}^{pn}(q_E^\dagger) \} \frac{dq_E^\dagger}{dr} = \tilde{L}^{pn}(q_E^\dagger).
\]

The RHS is equal to \( \tilde{\pi}_{EE}^E(q_E^\dagger)/r > 0 \). Thus, the second-order condition implies \( dq_E^\dagger/dr < 0, \) if the derivative exists.

\[\square\]

**B Proof of Theorem 2**

Proof. Notice that \( Q^P_I(q_E^\dagger) \subset Q^S_I = \{ q_I \in Q_I | \pi^E(q_E^\dagger, \tilde{q}_I) + B \geq 0 \} \), since \( q^\dagger_E \) is the solution of (18a) and thus satisfies \( \tilde{L}^p(q_E^\dagger) \leq (1 + r)^{-1} \tilde{V} + w_0 = B. \)

Let the entrant’s messaging strategy \( \sigma^*_M \) be

\[
\begin{align*}
\sigma^*_M(q_I | q_I) &= 1 & \text{if } q_I \in Q^S_I, \\
\sigma^*_M(m_0 | q_I) &= 1 & \text{if } q_I \notin Q^S_I, \\
\sigma^*_M(\tilde{q}_I | q_I) &= 0 & \text{for any } q_I \in Q_I, \tilde{q}_I \in Q^S_I \setminus \{ q_I \}.
\end{align*}
\]

Here, for each \( m \in M \) and \( q_I \in Q_I \), \( \sigma^*_M(m | q_I) \) is the probability that the entrant announces message \( m \) after observing \( q_I \).

The (pure) output strategies \( q^* \) as in (18) and the messaging strategy \( \sigma^*_M \) constitute a sequential equilibrium with the following belief \( \mu^* \) in the subgame after the entrant and the initial lender agree on the contract \( C \): for each \( q_I \in Q_I \), the belief \( \mu^* \) is

\[
\mu^*(q_I | \tilde{q}_I) = I(q_I, \tilde{q}_I) \quad \text{for each } \tilde{q}_I \in Q^S_I,
\]

\[
\mu^*(q_I | m_0) = (1 - I^S(q_I))/(\#Q_I - \#Q^S_I).
\]

Here \( I(q_I, q'_I) \) is the indicator function for \( q_I = q'_I \) and \( I^S(q_I) \) is the one for \( q_I \in Q^S_I \).
Receiving message \(m\), the initial and additional lenders believe that the incumbent chose \(q_I\) with probability \(\mu^*(q_I|m)\).

The belief \(\mu^*\) is consistent with the sequence of perturbed strategy profiles \(\{\sigma^k\}_{k \in \mathbb{N}}\) such as

\[
\sigma^k_I(q_I) := \frac{1}{\sqrt{k \# Q_I}} + \left(1 - \frac{1}{\sqrt{k}}\right) I(q_I, q_I^*) \quad \text{for each } q_I \in Q_I;
\]

\[
\sigma^k_M(\bar{q}_I|q_I) := \frac{1}{2k \# Q^S_I} + \left(1 - \frac{1}{k}\right) I(q_I, \bar{q}_I) \quad \text{for each } q_I \in Q_I, \bar{q}_I \in Q^S_I;
\]

\[
\sigma^k_M(m_0|q_I) := \frac{1}{2k} I^S(q_I) + \left(1 - \frac{1}{2k}\right) (1 - I^S(q_I)) \quad \text{for each } q_I \in Q_I.
\]

Here, for each \(q_I \in Q_I\), \(\sigma^k_I(q_I)\) is the probability that the incumbent chooses \(q_I\) under the perturbed strategy profile \(\sigma^k\).

The strategy profile \(\sigma^k\) induces the Bayesian belief \(\mu^k\) as follows. If \(\bar{q}_I \in Q^S_I \setminus \{q_I^*\}\), the belief \(\mu^k(\cdot|\bar{q}_I)\) is given by

\[
\mu^k(q_I|\bar{q}_I) := \frac{\sigma^k_I(q_I)\sigma^k_M(\bar{q}_I|q_I)}{\sum_{q_I' \neq \bar{q}_I, q_I^*} \sigma^k_I(q_I')\sigma^k_M(\bar{q}_I|q_I')} + \sigma^k_I(\bar{q}_I)\sigma^k_M(\bar{q}_I|\bar{q}_I) + \sigma^k_I(q_I^*)\sigma^k_M(q_I^*|\bar{q}_I)
\]

\[
= \frac{\# Q_I - 2 + \{1 + 2(k - 1)\# Q^S_I\} + \{1 + (\sqrt{k} - 1)\# Q_I\}}{\sqrt{k \# Q_I} + 2 (k - 1) \# Q^S_I}^{-1}
\]

for each \(q_I \neq \bar{q}_I, q_I^*\),

\[
\mu^k(\bar{q}_I|\bar{q}_I) = 1 - \sum_{q_I \neq \bar{q}_I} \mu^k(q_I|\bar{q}_I) = 1 - (\sqrt{k} \# Q_I - 1) \left[\sqrt{k} \# Q_I + 2(k - 1) \# Q^S_I\right]^{-1},
\]

\[
\mu^k(q_I^*|\bar{q}_I) = \frac{\sigma^k_I(q_I^*)}{\sigma^k_I(q_I)} \mu^k(q_I|\bar{q}_I) \quad \text{(with any } q_I \neq \bar{q}_I, q_I^*)
\]

\[
= \left\{1 + (\sqrt{k} - 1)\# Q_I\right\} \left[\sqrt{k} \# Q_I + 2(k - 1) \# Q^S_I\right]^{-1}.
\]
\( \mu^k(q_t|q_i^*) \) is given by

\[
\mu^k(q_t|q_i^*) = \frac{\sigma_i^k(q_t)\sigma_M^k(\tilde{q}_i|q_t)}{\sum_{q_i' \neq q_i} \sigma_i^k(q_t)\sigma_M^k(\tilde{q}_i|q_t') + \sigma_i^k(\tilde{q}_i)\sigma_M^k(\tilde{q}_i|\tilde{q}_i)} \\
= \frac{(\sqrt{k}\#Q_I)^{-1}(2k\#Q_I^S)^{-1}}{\sqrt{k}\#Q_I + 1 - \frac{1}{\sqrt{k}}} \left( 1 + \frac{1}{\sqrt{k}} \right) \left( 1 - \frac{1}{\sqrt{k}} \right) \\
= \left[ \#Q_I - 1 + \left\{ 1 + (\sqrt{k} - 1)\#Q_I \right\} \left\{ 1 + 2(k - 1)\#Q_I^S \right\} \right]^{-1} \\
= \left[ \sqrt{k}\#Q_I + (2 - 1)\#Q_I^S \left\{ 1 + (\sqrt{k} - 1)\#Q_I \right\} \right]^{-1}
\]

for each \( q_i \neq q_i^* \).

\( \mu^k(q_i^*|q_i^*) = 1 - \sum_{q_i \neq q_i^*} \mu^k(q_t|q_i^*) \)

\[
= 1 - (\#Q_I - 1) \left[ \sqrt{k}\#Q_I + 2(k - 1)\#Q_I^S \left\{ 1 + (\sqrt{k} - 1)\#Q_I \right\} \right]^{-1}
\]

\( \mu^k(\cdot|m_0) \) is given by

\[
\mu^k(q_t|m_0) \\
= \sigma_i^k(q_t)\sigma_M^k(m_0|q_t) \\
\times \left[ \sigma_i^k(q_t^*)\sigma_M^k(m_0|q_t^*) + \sum_{q_i' \in Q_I \setminus \{ q_t^* \}} \sigma_i^k(q_t^*)\sigma_M^k(m_0|q_t') + \sum_{q_i' \notin Q_I^S} \sigma_i^k(q_t^*)\sigma_M^k(m_0|q_t') \right]^{-1} \\
= \left( \frac{1}{\sqrt{k}\#Q_I} + 1 - \frac{1}{\sqrt{k}} \right) \left( 1 - \frac{1}{\sqrt{k}} \right) \left( \#Q_I^S - 1 \right) \left( 1 - \frac{1}{\sqrt{k}} \right) \\
= \left[ 1 + (\sqrt{k} - 1)\#Q_I \right] \left\{ 1 + (\sqrt{k} - 1)\#Q_I \right\}^{-1} \left( 1 - \frac{1}{\sqrt{k}} \right) \\
= \left[ \frac{2k + \sqrt{k} - 2}{2k - 1}\#Q_I - 2k - 2\#Q_I^S \right]^{-1}
\]

for each \( q_i \notin Q_I^S \).

\( \mu^k(q_t|m_0) = \frac{\sigma_M^k(m_0|q_t)}{\sigma_M^k(m_0|q_t')} \mu^k(q_t'|m_0) \) (with any \( q_t' \notin Q_I^S \))

\[
= \frac{1}{2k} \left[ \frac{2k + \sqrt{k} - 2}{2k - 1}\#Q_I - 2k - 2\#Q_I^S \right]^{-1}
\]

36
\[
\begin{align*}
&= \left[ (2k + \sqrt{k} - 2) #Q_I - (2k - 2) #Q_I^S \right]^{-1} \quad \text{for each } q_I \in Q_I^S \setminus \{ q_I^* \}, \\
\mu^k(q_I^* | m_0) &= \frac{\sigma^k_I(q_I^* | m_0)}{\sigma^k_I(q_I^*)} \mu^k(q_I | m_0) \quad \text{(with any } q_I \in Q_I^S \setminus \{ q_I^* \}) \\
&= \frac{1}{\left( \frac{2k - \sqrt{k} + 1}{k} \right)} \left[ (2k + \sqrt{k} - 2) #Q_I - (2k - 2) #Q_I^S \right]^{-1} \\
&= \{ 1 + (\sqrt{k} - 1) #Q_I \} \left[ (2k + \sqrt{k} - 2) #Q_I - (2k - 2) #Q_I^S \right]^{-1}.
\end{align*}
\]

Take the limits as \( k \to \infty \). For each \( \tilde{q}_I \in Q_I^S \setminus \{ q_I^* \}, \mu^k(\tilde{q}_I | q_I^*) \) converges to \( 1 \). \( \mu^k(q_I | q_I^*) \) converges to \( 1 \). \( \mu^k(q_I | m_0) \) converges to \( (#Q_I - #Q_I^S)^{-1} \) for each \( q_I \notin Q_I^S \). Therefore, \( \mu^k \to \mu^* \).

Now we check sequential rationality. Any message \( \tilde{q}_I \in Q_I^S \) implies \( \mu^*(\tilde{q}_I | q_I^*) = 1 \) and \( \pi^E(q_E^*, \tilde{q}_I) + B \geq 0 \). So the additional loan is available.\(^{21}\) The total repayment followed by any such message \( \tilde{q}_I \in Q_I^S \) is the same as \( \delta(\tilde{q}_I) = (B - w_0)(1 + r) = \bar{V} \), which yields net profit \( \pi^E(q_E^*, q_I) + B + \bar{V} - \delta(\tilde{q}_I) = \pi^E(q_E^*, q_I) + B \) for the entrant after all the loans are repaid. In contrast, message \( m_0 \) yields the total repayment \( \delta(m_0) = B + \bar{V} \) and thus the net profit \( B + \bar{V} - \delta(m_0) = 0 \). \( \sigma^*_M(q_I | q_I^*) = 1 \) is the entrant’s optimal messaging strategy, as long as \( \pi^E(q_E^*, q_I) + B \geq 0 \), i.e., \( q_I \in Q_I^S \). Otherwise, the entrant chooses \( m_0 \) to exit.

In period 1, the incumbent could get the entrant to exit by setting \( q_I \) such that \( \pi^E(q_E, q_I) + B < 0 \), i.e., \( q_I \notin Q_I^S \). Such \( q_I \) yields the predatory profit \( \pi^I(0, q_I) \), which is smaller than \( \pi^I(q^*) \) by \( Q_I^P(q_E^*) \subset Q_I^S \). Any output size \( q_I \in Q_I^S \) yields the duopoly profit \( \pi^I(q_E^*, q_I) \), which is maximized at \( q_I = q_I^* \). So \( q_I^* \) is the optimal output choice for the incumbent.

### Notes

\(^1\) Precisely speaking, \cite{Telser1966} predicts that a rational incumbent would try to buy out the entrant, instead of just giving up the monopoly profit. He also suggests that the incumbent should use the threat of predation to reduce the takeover bid of the entrant’s company. However, since Telser’s model takes the amount of precautionary liquidity (‘reserve’) as exogenously given, he concludes that an entrant should have plenty of liquidity to increase the takeover bid.

\(^2\) \cite{Snyder1996} introduces renegotiation, and \cite{KhannaSchroder2010} allow variable output/price
levels in the BS model. Fernández-Ruiz (2004) is a version of adverse selection. Poitevin (1989) constructs a different model from these and investigates the entrant’s choice between equity and debt financing in a one-shot game and also allows a variable output level. Since Poitevin (1989) is closest to our model, we provide a detailed comparison later in this section. Marquez (2010) also sheds light on the choice of financial methods, especially between bank loans and public debt financing, from the viewpoint of information and monitoring. See footnote 18.


4 The success of such local businesses depends mainly on how well the owner knows the local market and maintains his business, rather than on making costly and risky innovation. Taylor and Archer (1994) suggest ten principles and 273 Kaizen (improving) suggestions for a local retailer competing against giant supermarkets such as Walmart. The basic message there is to know the business environment, to keep good relationships with customers and to improve management on a daily basis. It is noteworthy that their banking strategies are to keep and share financial and business information with bankers and to help them monitor the business, as well as to arrange for credit lines before needing money but not to use up these lines.

5 If (3) is not satisfied, the entrant cannot pay the production cost from his precautionary liquidity alone.

6 We obtain this result by applying the envelop theorem to constraint optimization problem (8) with respect to $r$ as if each firm could choose any real number for $q_i$. To retain this result in the equilibrium with the finite strategy (output) space $Q$, $Q$ should be adjusted with $r$ so that Assumption 3 holds for each $r$.

7 Of course, a truthful report of $q_I$ is also needed to assess how large of an additional loan is required to continue business. Alternatively, we can say that the entrant first reports the amount of the additional loan he demands, from which $q_I$ can be inferred. The revelation principle allows us to reduce the analysis of outcomes under such ‘indirect’ reporting of unverifiable information to outcomes under direct messaging (a direct mechanism).


9 Here we assume that the liquidation value (the continuation value, resp.) is linear in the proportion of the asset that the lender (the entrant, resp.) takes over in period 4. But all of our propositions, esp. the non-predation condition (14), remain the same as long as its minimum is 0 and its maximum is $V$ ($\nabla$, resp.)

10 If he gives up production and exits the market, limited liability does not matter, because it is verifiable.
that the entrant exits and nothing is spent from $B$.

11Zusai (2012) proves it specifically for the Cournot version of our model.

12It is assumed for simplification of the explanation in the main text. In Theorem 2, the message $m_0 \in M_0$ implies a belief that puts nonzero weight only on the incumbent’s output levels that render the entrant unable to repay the additional loan. See footnote 21.

13Actually firms (even small business owners) generally prefer bank loans. See Danielson and Scott (2004).

14See Petersen and Rajan (1994). As a result of late payment, young firms have lower Paydex scores: see Board of Governors of the Federal Reserve System (2012).

15See Kallberg and Udell (2003a) and Kallberg and Udell (2003b) about usage of Paydex in U.S.

16Fisman and Love (2003) suggest that trade credit does not help start up of new firms, though it helps growth of incumbent firms in countries with weak financial intermediaries.

17From empirical study on French business groups, Boutin, Cestone, Fumagalli, Pica, and Serrano-Velarde (2013) find that cash holding of an entrant’s affiliated business group indeed encourages entry while that of the incumbent’s group discourages its rival from entry.

18Marquez (2010) argues that, provided that a bank can tell not only the realized profit but also fundamentals and potential profitability of the borrower’s business, a bank loan can prevent predation more effectively than public debt financing.

19It would be easier for trade creditors to monitor the borrower’s business and gather verifiable information as well as to enforce the repayment with threat of terminating supply (Petersen and Rajan, 1997). From Japanese database on small businesses, Tsuruta (2008) finds that trade credit lowers the interest rate of bank loans, possibly because trade creditors have good monitoring ability and weaken banks’ informational advantage. But close monitoring is costly and thus may not be utilized for small and new customers who have yet made long-run relationship with suppliers. So, in a start-up stage of a small business where trade creditors rely on the credit score, trade credits may not significantly alleviate the informational problem.

20Lerner (1995) uses two criteria to identify a financially weak firm. First, the firm should specialize in disk drive manufacturing, which means the absence of internal financing from other business. Second, the firm’s equity capital should be below the median of all samples. These are consistent with our definition of the “entrant with little start-up capital”, as we discuss in this section.

21Message $m_0 \in M_0$ implies $q_t \notin Q^E_t$ and thus $\pi^E(q^*_E, q_t) + B < 0$ for any $q_t$ in the support of posterior belief $\mu^*(\cdot | m_0)$. Hence, an additional loan is indeed not available.
References


BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM (2012): “Report to the Congress on the Availability of Credit to Small Businesses,”.


