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Ignorant Experts and Financial Fragility*

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Abstract

We study debt funding markets in which lenders can invest in financial expertise to reduce a cost of acquiring information about the underlying collateral. If the pledgeability of corporate income is low, lenders' information acquisition enhances liquidity, but they reduce expertise acquisition because of a hold-up problem. By contrast, if the pledgeability is high, information acquisition reduces liquidity, so that lenders can extract rents from firms by investing in expertise and creating fear of illiquidity. In this case, as information about collateral decays over time, there is growth in credit and expertise acquisition, making the economy more vulnerable to an aggregate shock. These results suggest that the growth of the financial sector is associated with prevalence of opaque assets and a subsequent crisis.

JEL Classification: D83, E44, G01.

Keywords: expertise, collateral, information acquisition, information sensitivity, liquidity.

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1 Introduction

The financial sector has aggressively acquired financial expertise. Philippon and Reshef (2012) demonstrate that in recent decades, the US financial industry has increased information technology spending and attracted highly talented workers compared to other sectors of the economy, and that these investments in financial expertise are strongly associated with a rise in remuneration in this sector.¹ The expertise allows financial firms to gather and process information about complex assets more easily and provide their financial services more efficiently. However, given that financial firms played a major role in the 2007–09 financial crisis (Gorton, 2010), the social value of their expertise has been questioned.² It is therefore imperative to investigate under what conditions and why the acquisition of expertise arises in the financial industry.

In this study, we examine expertise acquisition incentives in a model of debt funding markets, where expertise reduces the cost of acquiring information about the quality of the collateral. We show that equilibrium investment in expertise is inefficient, but for different reasons depending on the degree of pledgeability. If the pledgeability is low, information acquisition enhances liquidity, but investors reduce their investments in expertise because of a hold-up problem. By contrast, if the pledgeability is high, information acquisition causes illiquidity, thereby allowing investors with expertise to create fear of illiquidity and improve their bargaining positions with borrowers. In equilibrium, ignorant experts—investors that acquire expertise but do not use it to produce information—emerge. In this case, as information about collateral depreciates over time, both a credit boom and a growth in expertise occur, leaving financial markets vulnerable to an aggregate shock.

¹See also Goldin and Katz (2008) for an increase in talented workers in the financial industry and Kaplan and Rauh (2010) for their increasing representation among top income earners.

²Adair Turner, a former chairman of the UK’s Financial Services Authority, comments that: “There is no clear evidence that the growth in the scale and complexity of the financial system in the rich developed world over the last 20 to 30 years has driven increased growth or stability, and it is possible for financial activity to extract rents from the real economy rather than to deliver economy value” (Turner, 2010).

We build on the idea that symmetric ignorance can enhance liquidity in markets and its breakdown lead to a crisis, which has been advocated by [Gorton and Ordoñez \(2014\)](#), [Dang et al. \(2015\)](#), and [Holmström \(2015\)](#).³ When issuing “information-insensitive debt,” which provides no gain from acquiring information about the quality of underlying collateral, financial markets are free from adverse selection and highly liquid. However, when the debt becomes information-sensitive in response to a shock, private information production arises, and liquidity dries up. We explore the relationship between the information sensitivity of debt and expertise acquisition for a better understanding of recent developments in the financial sector.

In our environment, firms borrow funds from investors by offering short-term contracts to finance a project requiring a fixed investment. Because the pledgeability of cash flows from firms’ investment project is imperfect, as in [Holmström and Tirole \(1997, 1998\)](#), they need to pose an asset as collateral to make up for the lack of pledgeability. The assets used as collateral have a heterogeneous quality, high or low, which is unknown for investors and firms *ex ante*. However, after finding a firm, each investor can acquire information about the quality of collateral at a cost for the lending decisions; lending when the collateral is of high quality and refusing to lend when it is of low quality. We interpret the assets used as collateral as preexisting financial securities (e.g., asset- and mortgage-backed securities) that are so complex and opaque that agents find it difficult to evaluate their fundamental values without due diligence by experts.

The important feature of our model is that before finding a firm, each investor can acquire expertise that reduces a cost of information acquisition. Expertise acquisition incentives depend on the pledgeability of investment returns, which affects their preference for information acquisition about collateral. On the one hand, if the pledgeability is relatively low, average-quality collateral is not enough to cover the lack of pledgeability and thus, no firm obtains financing without information acquisition. This motivates

³The idea that information is value-destroying goes back to [Hirshleifer \(1971\)](#) who shows that public information restricts risk-sharing. See also [Gorton and Pennacchi \(1990\)](#).

firms to design financial contracts that induce information acquisition by investors and makes their expertise acquisition socially desirable. But, a trading friction in financial markets creates a hold-up problem for investors' investments in expertise. This results in under-investment in expertise. On the other hand, if the pledgeability is relatively high, average-quality collateral allows firms to obtain funds and so, all firms can finance efficient projects by preventing investors from acquiring information. In this case, information acquisition reduces the possibility of funding and thus, expertise acquisition is socially undesirable. Nonetheless, investors acquire expertise to use it as a threat to extract rents from firms rather than to use it for information production. This implies that over-investment in expertise arises.

In a dynamic model, we demonstrate how a decay of information about collateral over time leads to financial fragility. As in [Gorton and Ordoñez \(2014\)](#), we introduce idiosyncratic shocks that transform collateral that is of known quality into opaque collateral with high perceived quality. The firms with collateral that was known to be bad can obtain financing through uninformed lending after the shock hits; accordingly, information about collateral decays and credit expands over time. The rise in lending without information acquisition increases the opportunities for investors to extract rents, encouraging their expertise acquisition. However, the boom does not last so long time. As the boom lasts longer and expertise acquisition grows, investors are more likely to start to produce information about opaque collateral in response to aggregate shocks that reduce the average quality of collateral. The informational regime change from a state where no one acquires information about the true quality of collateral to a state where investors start to produce information leads to deterioration in funding liquidity and a decline in aggregate output. Thus, as opaque assets are more circulated in markets, credit and level of expertise grow, and the likelihood that a subsequent crisis will occur increases.

This result offers a coherent explanation for the recent financial crisis. Prior to the financial crisis, securitization, that is, the process of pooling and tranching a set of as-

sets, created large quantities of AAA-rated asset- and mortgage-backed securities from risky assets, such as subprime mortgages (Coval et al., 2009). Although these securitized products were complex and opaque, they were considered by investors to be safe and regularly used as collateral in the repo markets, where the overall size, from the dealers' perspective, of reverse repo markets was estimated to be roughly \$4 trillion (Copeland et al., 2014).⁴ However, the repo markets collapsed during the crisis and were recognized as the major source of financial instability (Gorton and Metrick, 2012).⁵ Gorton and Metrick (2010) demonstrate that haircuts on subprime-related assets were zero before the crisis but then increased and eventually reached 100 percent in 2009, whereas haircuts on non-subprime-related products reached about 20 percent. Our model implies that the growth in securitization that produces opaque assets and fuels a credit boom encourages an active acquisition of expertise for rent extraction, which makes information production and a subsequent collapse in markets more likely.

Related Literature: This paper is related to several strands of literature.

Our study builds on literature on theories of collateral. The existing models of collateral examine its impact on financial contracts in a variety of settings, such as adverse selection (Bester, 1985, 1987; Chan and Kanatas, 1985; Besanko and Thakor, 1987) and moral hazard (Chan and Thakor, 1987; Boot et al., 1991; Boot and Thakor, 1994). Recent literature (e.g., Di Maggio and Tahbaz-Salehi, 2015 and Parlatore, forthcoming) studies a model of collateralized loans by incorporating trading friction and relates the setup to a repo market. This literature typically focuses on incentive problems on the borrowers' side, while our focus is on the lenders' side. A few exceptions are Rajan and Winton (1995), Manove et al. (2001), and Inderst and Mueller (2007), who show that collateral in-

⁴Reverse repo markets comprise repo transactions in which dealers lend to their clients (e.g., hedge funds) or to other dealers. About 92% of this activity consists of bilateral reverse repo.

⁵A significant rise in margins in bilateral repos is observed in a market wherein dealers lend to clients such as hedge funds (Copeland et al., 2014). Copeland et al. (2014) and Krishnamurthy et al. (2014) document that, in contrast with bilateral repo markets, the tri-party repo markets, wherein dealers mainly borrowed funds from cash providers such as money market funds and security lenders, were relatively stable.

fluences project screening. Our work, in contrast, focuses on lenders' incentives to screen collateral and their expertise acquisition.

Our study also contributes to the growing literature on the compensation of finance employees. [Thanassoulis \(2012\)](#) and [Acharya et al. \(2016\)](#) show that the growth in compensation in the financial industry is driven by competition for managerial talent to yield high returns. In [Myerson \(2012\)](#), [Axelson and Bond \(2015\)](#) and [Biais and Landier \(2015\)](#), high financial sector compensation arises from the moral hazard problem. In our paper, however, a rise in compensation is due to the expertise that improves the ability to evaluate financial claims.

This line of work is also related to the literature concerned with the optimal level of financial expertise.⁶ [Glode et al. \(2012\)](#), [Biais et al. \(2015\)](#), [Fishman and Parker \(2015\)](#), and [Bolton et al. \(2016\)](#) develop models in which excessive acquisition of expertise occurs. [Kurlat \(forthcoming\)](#) demonstrates that too much expertise is acquired for junk bond underwriting and venture capital. In these works, however, having more expertise means producing more information. In contrast, our model treats expertise acquisition and information acquisition separately so that decay of information can go hand-in-hand with growth in expertise acquisition, leading to boom and bust. Moreover, in contrast to their works, we show that investment in expertise is inefficiently high when the pledgeability is high but inefficiently low when the pledgeability is low. This suggests that policy implications differ depending on the pledgeability.

Our paper is also related to the burgeoning literature that attributes the adverse selection problem to the cause of financial crises (e.g., [Kurlat, 2013](#); [Chari et al., 2014](#); [Guerrieri and Shimer, 2014](#); [Bigio, 2015](#)). These papers, however, treat information asymmetry as exogenous. In contrast, our model features endogenous information asymmetry, as in [Gorton and Ordoñez \(2014\)](#), which concurs with our view that circulation of opaque as-

⁶[Philippon \(2010\)](#), [Cahuc and Challe \(2012\)](#), and [Shakhnov \(2018\)](#) also focus on the optimal size of the financial sector. They argue that the difference between private and social returns of entrepreneurship draws too many individuals into the financial sector and discourages productive activity.

sets generates a credit boom followed by a crisis at the point of informational regime change. The difference is that their model assumes that the level of expertise (i.e., cost of information acquisition) is exogenously given, whereas we allow for the acquisition of expertise. The different modeling allows us to show that the credit boom entails the growth in the financial sector, which makes the financial market more sensitive to a negative aggregate shock.

Outline: The remainder of the paper is organized as follows. [Section 2](#) describes the setting of the static model. [Section 3](#) analyzes two benchmark cases, of which in the first, investors cannot produce private information about the quality of underlying collateral, and in the second, everyone knows the true quality of collateral ex ante. These exercises allow us to clarify the key mechanism through which information about collateral affects financial contracts. [Section 4](#) characterizes the equilibrium of the static model. [Section 5](#) extends the static model into the dynamic setting wherein there is a depreciation of information about collateral over time. [Section 6](#) concludes.

2 Static Model

In this section, we describe the setup of the model.

The economy has a single good used for investment and consumption. There are two types of continuum of agents with unit mass: investors and firms. Both agents are risk-neutral and derive utility from consumption at the end of the period. While firms have no endowment of goods, investors are endowed with a sufficient amount of goods. Firms are protected by limited liability.

Each firm has a project that requires a fixed investment $I > 0$. It produces nothing in the case of failure and returns $R > 0$ in the case of success. The project is subject to moral hazard, as in [Holmström and Tirole \(1997, 1998\)](#). The firm can choose whether to behave or misbehave secretly. In the case of behaving, the project succeeds with probability $p \in$

$(0, 1]$. In the case of misbehaving, the firm enjoys private benefit $B > 0$ but must accept that the probability of success decreases by $\Delta p \in (0, p)$. We assume that the project has positive net present value (NPV) if a firm behaves but negative NPV even with the inclusion of private benefit if the firm misbehaves.

Assumption 1 $pR > I > (p - \Delta p)R + B$.

Each firm owns a legacy asset, which has two types of quality: good and bad. The asset is good with probability $\phi \in [0, 1]$ and bad with probability $1 - \phi$. At the end of the period, the owner of an asset receives C units of goods if the asset is good and nothing if it is bad. No one knows the true quality of assets at the beginning of the period. We view these assets as preexisting financial securities, including mortgage-related securities, and consider that the complexity of their design makes it difficult to estimate their real value.

To run a project, firms need to rely on external financing. Each firm is randomly matched with a single investor, and the firm makes a take-it-or-leave-it offer to the investor. The assumptions of random matching and bilateral contract are intended to capture the fact that the new complex securities are mainly traded in an over-the-counter market (e.g., [Duffie et al., 2005](#)). The financial contract has the following structure: (i) the investor contributes I ; (ii) when the project succeeds, the investor receives R^i and the firm receives $R - R^i$ from its cash flow; and (iii) when the project fails, both parties do not receive anything from the investment return, and the investor seizes the collateral the firm poses with probability $x \in [0, 1]$. We discuss more general contracts in [Section 4.5](#).

After receiving the financial contract offered by a firm but before deciding whether to accept the offered contract, an investor can produce costly private information about the quality of collateral that the firm pledges. By paying $\gamma \in [0, \gamma_{max}]$ units of goods, each investor knows the true quality of collateral perfectly. The cost of information acquisition γ can be interpreted as an inverse measure of the investor's financial expertise, that is, investors with lower γ have more expertise.⁷ The underlying idea is that investors who

⁷In an alternative setup, investors with more expertise receive a more accurate signal on the quality of

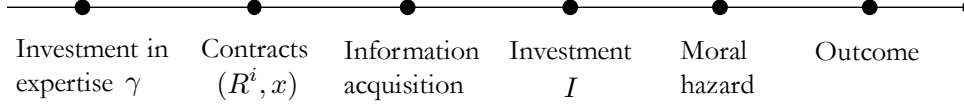


Figure 1: Timing

have more financial expertise find it easier to gather and process information about the complex assets. The important feature of our model is that the level of expertise γ is an endogenous variable. Before financial contracts are offered, each investor chooses γ incurring a cost $\psi(\gamma_{max} - \gamma)$, with $\psi \geq 0$ and $\psi' \geq 0$. While γ is publicly observable, acquisition of information is unobservable.

The timing of events is as follows. Each investor chooses the level of financial expertise γ . Then, each firm is matched with a single investor and offers a financial contract (R^i, x) . After receiving the contract, the investor decides whether to acquire costly information about the quality of the collateral that the firm pledges and whether to provide funds. If the investor accepts the contract, the firm runs a project and chooses either to behave or misbehave. If the investor rejects the contract, both the firm and the investor keeps holding their own endowment. Finally, all outcomes are realized, outputs are shared as contracted, and consumption occurs. **Figure 1** summarizes the timing of the model.

Finally, we define an equilibrium in the following way.

Definition 1 (Equilibrium) *A perfect Bayesian equilibrium is given by firms' contracts (R^i, x) , their choice between behaving and misbehaving, investors' expertise γ , their decisions on information acquisition and financing, and all agents' beliefs concerning the quality of assets such that the following conditions are satisfied:*

- *Firms' contracts (R^i, x) and their choice between behaving and misbehaving are optimal where beliefs and the investors' strategies are taken as given;*
- *The investors' decisions on expertise γ , information acquisition, and financing are optimal, where beliefs and the firms' strategies are taken as given;*

underlying collateral by paying a fixed cost. Although this approach makes the analysis more complicated, the main conclusions remain unchanged.

- Beliefs are consistent with Bayes' rule, given equilibrium strategies, whenever possible.

3 Symmetric Ignorance versus Full Information

In this section, for the benchmark cases, we suppose that investors cannot acquire information (or expertise). We focus on two information regimes: the first is symmetric ignorance, where no one knows the true quality of collateral, and the second is full information, where everyone knows the quality of collateral. By comparing the two cases, we study the key relationship between information about collateral and funding liquidity.

Let $\tilde{\phi}$ be agents' conjecture about a probability that collateral is good. In the case of symmetric ignorance, the conjecture on the probability of good collateral is $\tilde{\phi} = \phi$ for any firm. In the case of full information, $\tilde{\phi} = 1$ for firms with good collateral and $\tilde{\phi} = 0$ for those with bad collateral. A firm designs a contract (R^i, x) by solving the following optimization problem:

$$\max_{R^i, x} p(R - R^i) - (1 - p)x\tilde{\phi}C \quad (1)$$

subject to

$$pR^i + (1 - p)x\tilde{\phi}C \geq I, \quad (2)$$

$$p(R - R^i) - (1 - p)x\tilde{\phi}C \geq 0, \quad (3)$$

$$p(R - R^i) - (1 - p)x\tilde{\phi}C \geq (p - \Delta p)(R - R^i) - (1 - p + \Delta p)x\tilde{\phi}C + B, \quad (4)$$

$$0 \leq x \leq 1. \quad (5)$$

The objective function (1) is the firm's net expected payoff. (2) is the individual rationality (IR) constraint for investors, which requires that investors earn non-negative payoff from financial contracts. (3) is the IR constraint for firms. (4) is the incentive compatibility (IC) constraint, which requires that firms prefer behaving to misbehaving. (5) is the feasibility

constraint.

A decrease in compensation for an investor R^i increases the firm's payoff (1) and strengthens the incentive to behave from (4). This leads the firm to decrease R^i until investors break even, that is, the IR constraint (2) is binding. Then, (1) is rewritten as $pR - I$, meaning that the firm that obtains financing receives a payoff equal to the entire social surplus. Since (3) is not binding, any contract (R^i, x) that satisfies (2) with equality, the IC constraint (4), and the feasibility constraint (5) is the optimal. Given that a higher x relaxes (4), financing actually occurs if

$$\rho + \tilde{\phi}C \geq I, \quad (6)$$

where

$$\rho \equiv p \left(R - \frac{B}{\Delta p} \right). \quad (7)$$

(6) means that if the sum of the expected pledgeable cash flows from firms' project ρ and their collateral $\tilde{\phi}C$ exceeds the cost of investment I , the firm secures financing.

The following proposition describes the effect of information about collateral on investors' financing decision.

Proposition 1 (Information and financial contract) *Suppose that [Assumption 1](#) holds and investors cannot acquire private information about the quality of collateral. Then, there are four cases:*

- (i) *If $\rho \geq I$, there exists an optimal contract in which collateral pledging is unnecessary ($x = 0$), so that all firms obtain financing, regardless of beliefs about collateral $\tilde{\phi}$.*
- (ii) *If $0 < I - \rho \leq \phi C$, then in any optimal contract, collateral pledging is needed ($x > 0$). In the case of symmetric ignorance, all firms secure financing, whereas in the case of full information, only firms with good collateral secure financing.*
- (iii) *If $\phi C < I - \rho \leq C$, then in the case of symmetric ignorance, no firm secures financing,*

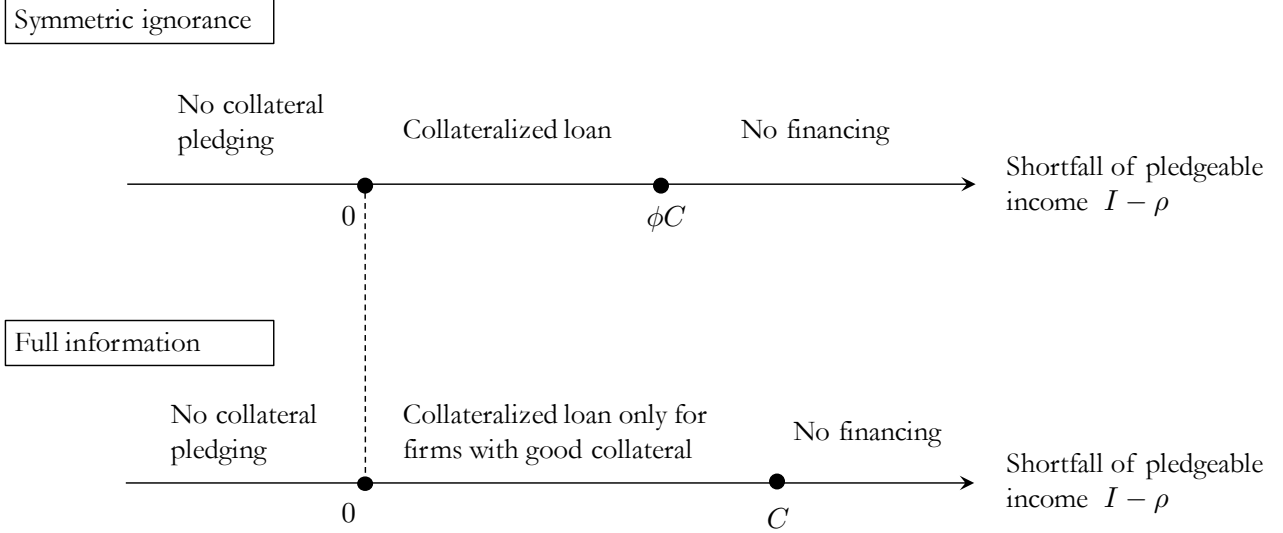


Figure 2: Financial contract in each information regime

whereas in the case of full information, only firms that pledge good collateral secure financing.

(iv) If $I - \rho > C$, no financing occurs, regardless of $\tilde{\phi}$.

Proposition 1 states that the relationship between information about collateral and the financial contract depends on a firm's level of pledgeable cash ρ compared with investment I . The result is summarized in **Figure 2**. If the pledgeability is high enough that investors can recoup their investment from cash flows alone ($\rho \geq I$), or low enough that firms cannot obtain financing regardless of collateral quality ($\rho < I - C$), there is no role for collateral. If the pledgeability is of intermediate level ($0 < I - \rho \leq C$), collateral is necessary to fill the gap between the cost of financing and the pledgeable income, and information about collateral quality matters in the financial contract.

When the shortfall $I - \rho$ is relatively small ($0 < I - \rho \leq \phi C$), (6) holds with $\tilde{\phi} = 1$ and ϕ but not with $\tilde{\phi} = 0$. This means that with full information, firms whose collateral is identified as bad are not funded, and net aggregate output results in $\phi(pR - I)$. However, with symmetric ignorance, the economy benefits from cross-subsidization of firms with bad collateral by those with good collateral. Expected collateral value suffices to make up for the lack of pledgeable cash, and the economy achieves the first-best level of net

aggregate output $pR - I$. Thus, in the case of symmetric ignorance, financial markets are more liquid and net aggregate output is larger than in the case of full information.

When the shortfall $I - \rho$ is relatively large ($\phi C < I - \rho \leq C$), (6) holds with $\tilde{\phi} = 1$ but not with $\tilde{\phi} = \phi$ and 0. This implies that under symmetric ignorance, collateral is no longer enough to cover the lack of pledgeable cash, and financing does not occur. By contrast, under full information, firms whose collateral is known to be good are still able to cover their investment need. Therefore, full information enhances liquidity and increases output compared with symmetric ignorance.

In the remainder of this paper, to ensure that collateral plays a role in financial contracts, we assume the intermediate level of pledgeability:

Assumption 2 $0 < I - \rho \leq C$.

4 Equilibrium Analysis

In this section, we return to the original model in which no one knows the true quality of collateral at the beginning of the period and investors can acquire expertise and private information about collateral. First, [Section 4.1](#) and [Section 4.2](#) analyze the case of high pledgeability, $\rho \geq I - \phi C$, in which information about collateral reduces liquidity from [Proposition 1](#). Then, [Section 4.3](#) analyzes the case of low pledgeability, $\rho < I - \phi C$, in which information about collateral enhances liquidity. [Section 4.4](#) analyzes efficiency in both cases and shows that investors over-invest in expertise in the case of high pledgeability and under-invest in expertise in the case of low pledgeability. [Section 4.5](#) discusses assumptions.

4.1 Optimal Contract

Given that investors can acquire information about collateral at a cost γ , firms optimally choose between a financial contract that triggers information acquisition (referred to as

information-sensitive debt) or one that does not trigger information acquisition (referred to as *information-insensitive debt*). We show that when the pledgeable cash is high enough ($\rho \geq I - \phi C$), issuing information-insensitive debt enhances liquidity, but this may be costly to firms because they need to promise investors compensation commensurate with their expertise to prevent information acquisition.

First, consider firms offering an information-insensitive debt contract (R_{II}^i, x_{II}) . Firms choose the contract (R_{II}^i, x_{II}) to maximize

$$p(R - R_{II}^i) - (1 - p)x_{II}\phi C \quad (8)$$

subject to

$$pR_{II}^i + (1 - p)x_{II}\phi C \geq I, \quad (9)$$

$$p(R - R_{II}^i) - (1 - p)x_{II}\phi C \geq 0, \quad (10)$$

$$R - R_{II}^i + x_{II}\phi C \geq \frac{B}{\Delta p}, \quad (11)$$

$$0 \leq x_{II} \leq 1, \quad (12)$$

$$pR_{II}^i + (1 - p)x_{II}\phi C - I \geq \phi \left[pR_{II}^i + (1 - p)x_{II}C - I \right] - \gamma. \quad (13)$$

Similar to the optimization problem (1)-(5) with $\tilde{\phi} = \phi$, the objective function (8) is the firm's net payoff, (9) is the IR constraint for investors, (10) is the IR constraint for firms, (11) is the IC constraint, and (12) is the feasibility constraint.

The additional constraint is (13), which ensures that investors' payoff without acquiring information (the left-hand side) is larger than the payoff with acquiring information (the right-hand side). If investors acquire information, they accept the offered contract and provide funds if the firm has good collateral and refuse if the firm has bad collateral

from [Assumption 2](#). The constraint (13) is rewritten as

$$(1 - \phi) \left(I - pR_{II}^i \right) \leq \gamma. \quad (14)$$

While the right-hand side of (14) is the cost of acquiring information, the left-hand side of (14) is the benefit of acquiring information; the investor who meets the firm with bad collateral with probability $1 - \phi$ can avoid a loss of $I - pR_{II}^i$ by not lending.

Firms have incentives to reduce a repayment R_{II}^i to increase their payoff. When γ is high, we can ignore the constraint (14) so that the optimal contract problem becomes equivalent to the benchmark problem (1)-(5) with $\tilde{\phi} = \phi$; that is, (9) binds and firms receive the whole social surplus $pR - I$. However, when γ is low, R_{II}^i is determined at which (14) binds because a lower R_{II}^i strengthens the investors' incentives to acquire information. This means that for investors with lower γ , firms must lower the benefit of information production by increasing repayment R_{II}^i and reducing the expected loss that informed investors are able to avoid.

The mechanism through which the lower- γ investors require higher compensation R_{II}^i does not necessarily imply that they earn positive net payoff. If firms can decrease the probability of losing collateral x_{II} until (9) binds, investors still break even. However, because a higher R_{II}^i reduces firms' stake $R - R_{II}^i$ and weakens their commitment to behave, they must choose x_{II} to satisfy the IC constraint (11) rather than the IR constraint (9) if γ is sufficiently low. In this case, (9) is not binding and the firm leaves rent for the investor.⁸

Lemma 1 *Suppose that Assumptions 1 and 2 hold. If $I - \rho \leq \phi C$ and $\gamma \geq \underline{\gamma}_{II} \equiv (1 - \phi) [I - \rho - p \min \{pR - \rho, \phi C\}]$, firms can borrow funds by offering information-insensitive*

⁸See [Dang \(2008\)](#), who also shows that in asset markets, a party responding to a take-it-or-leave-it-offer can extract some surplus of the transaction when the offer is designed to deter information acquisition.

debt contracts, which yield the firms' net payoff,

$$U_{II}^f = \begin{cases} pR - I & \text{if } \overline{\gamma_{II}} \leq \gamma, \\ pR - I - \frac{(1-p)(1-\phi)(I-\rho) - \gamma}{p(1-\phi)} & \text{if } \underline{\gamma_{II}} \leq \gamma < \overline{\gamma_{II}}, \end{cases} \quad (15)$$

where $\overline{\gamma_{II}} \equiv (1-p)(1-\phi)(I-\rho) \geq \max\{0, \underline{\gamma_{II}}\}$, and the investors' net payoff,

$$U_{II}^i = \begin{cases} 0 & \text{if } \overline{\gamma_{II}} \leq \gamma, \\ \frac{(1-p)(1-\phi)(I-\rho) - \gamma}{p(1-\phi)} & \text{if } \underline{\gamma_{II}} \leq \gamma < \overline{\gamma_{II}}. \end{cases} \quad (16)$$

Otherwise, firms cannot offer information-insensitive contracts.

Proof. See [Appendix A](#). ■

Lemma 1 implies that if the level of expertise is in the intermediate range ($\underline{\gamma_{II}} \leq \gamma < \overline{\gamma_{II}}$), the investors earn a net positive payoff ($U_{II}^i > 0$), and as the level of expertise is higher, they are able to extract larger rents from firms (U_{II}^f is increasing in γ and U_{II}^i is decreasing in γ). In information-insensitive contracts, financial expertise allows investors to improve their bargaining position with firms that have all the bargaining power by creating fear of information acquisition. However, if the level of expertise is sufficiently high ($\gamma < \underline{\gamma_{II}}$), firms must either lose on the financial contract, resulting in the violation of (10), or cannot pose more collateral, resulting in the violation of (12). Either way, firms do not obtain financing by issuing information-insensitive debt.

Then, we consider that firms optimally design the information-sensitive debt contract (R_{IS}^i, x_{IS}) . An informed investor funds only a firm with good collateral. This implies that once investors accept the offered contract, the firms correctly infer that their collateral is good in equilibrium. The optimal information-sensitive contract is the solution of the

following problem:

$$\max_{R_{IS}^i, x_{IS}} \phi \left[p(R - R_{IS}^i) - (1 - p)x_{IS}C \right] \quad (17)$$

subject to

$$\phi \left[pR_{IS}^i + (1 - p)x_{IS}C - I \right] - \gamma \geq 0, \quad (18)$$

$$\phi \left[p(R - R_{IS}^i) - (1 - p)x_{IS}C \right] \geq 0, \quad (19)$$

$$R - R_{IS}^i + x_{IS}C \geq \frac{B}{\Delta p}, \quad (20)$$

$$0 \leq x_{IS} \leq 1, \quad (21)$$

$$(1 - \phi) \left(I - pR_{IS}^i \right) > \gamma. \quad (22)$$

The firm maximizes the net expected payoff (17) subject to the IR constraint for the investor (18), the IR constraint for the firm (19), the IC constraint (20), the feasibility constraint (21), and the constraint that triggers information acquisition (22).

Characterization of the optimal contract inducing information acquisition is straightforward. A lower R_{IS}^i increases the firms' profit (17) and relaxes the constraints (20) and (22). Thus, the firms decrease R_{IS}^i until (18) binds and obtain the entire social surplus $\phi(pR - I) - \gamma$, where they have to incur the cost of information acquisition γ . This implies that any financial contract (R_{IS}^i, x_{IS}) that satisfies (18) with equality and the remaining constraints is optimal. A higher x_{IS} and a lower R_{IS}^i relaxes the constraints (20) and (22), making financing more likely. The following lemma characterizes the financing condition in the case of information-sensitive contracts.

Lemma 2 *Suppose that Assumptions 1 and 2 hold. If*

$$\gamma \leq \gamma_{IS} \equiv \phi \min \{ (1 - p)(1 - \phi)C, \rho + C - I, pR - I \},$$

firms can borrow funds by offering information-sensitive debt contracts, which yields the firms' net payoff,

$$U_{IS}^f = \phi(pR - I) - \gamma, \quad (23)$$

and the investors' net payoff, $U_{IS}^i = 0$. Otherwise, firms cannot offer information-sensitive contracts.

Lemma 2 implies that if the level of expertise is sufficiently high ($\gamma \leq \gamma_{IS}$), firms can offer information-sensitive contracts, and a higher level of expertise increases their payoffs (U_{IS}^f is decreasing in γ). In contrast with information-insensitive contracts, financial expertise increases the total surplus from the financial contract and investors must earn zero payoff. If the level of expertise is sufficiently low ($\gamma > \gamma_{IS}$), at least one of the constraints (19), (20), and (22) is violated, meaning that firms cannot obtain financing by offering information-sensitive contracts.

Based on **Lemma 1** and **Lemma 2**, a firm chooses between information-insensitive and information-sensitive contracts to maximize its payoff. As shown in **Figure 3**, the firm's payoff depends on γ . U_{II}^f is nondecreasing in γ from (15), whereas U_{IS}^f is decreasing in γ from (23). Thus, the firm chooses to offer information-insensitive contracts if $U_{II}^f \geq U_{IS}^f$, that is, $\gamma \geq \gamma^c$ given by

$$\gamma^c \equiv \frac{1 - \phi}{p(1 - \phi) + 1} \left[p(1 - p) \frac{B}{\Delta p} - (1 - p\phi)(pR - I) \right], \quad (24)$$

and if information-insensitive contracts are feasible, that is, $\gamma \geq \underline{\gamma}_{II}$. This implies that if γ is sufficiently high that $\gamma \geq \max\{\underline{\gamma}_{II}, \gamma^c\}$, firms offer information-insensitive contracts.

Whether firms with good collateral secure financing when $\gamma < \max\{\underline{\gamma}_{II}, \gamma^c\}$ depends on parameters. If $\gamma \leq \gamma_{IS}$, firms can offer information-sensitive contracts and those with good collateral obtain financing. However, if $\gamma > \gamma_{IS}$, no firm secures financing. While **Figure 3a** illustrates the situation in which for all γ , either information-insensitive or information-sensitive contracts are chosen, **Figure 3b** shows the situation in which for

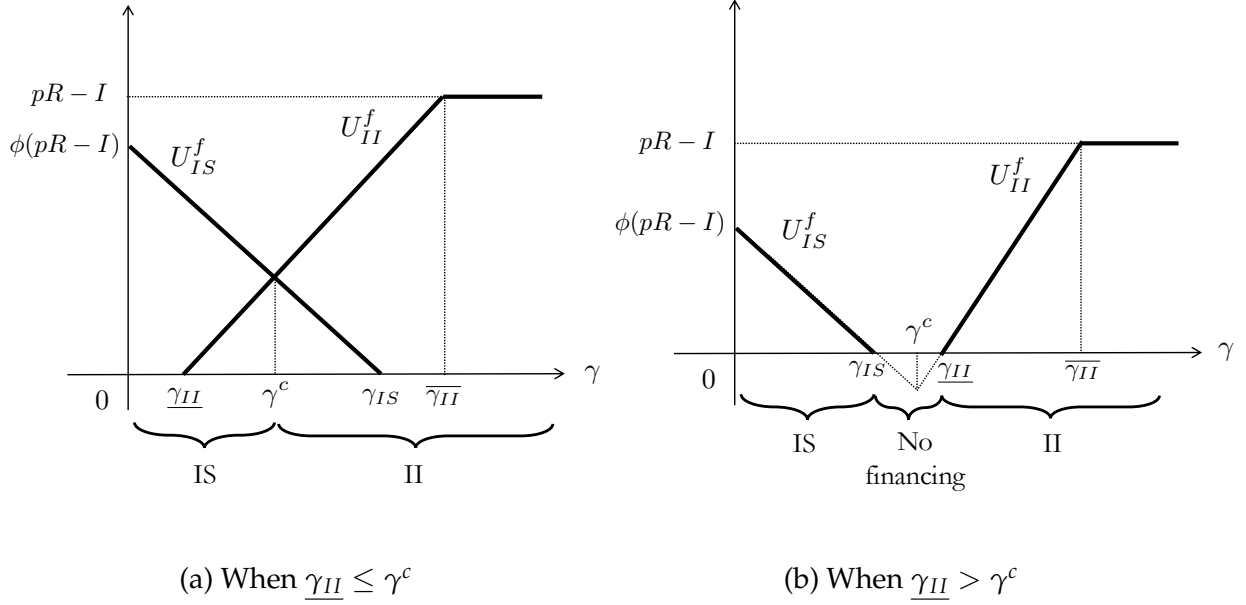


Figure 3: The comparison of payoffs between information-insensitive contracts and information-sensitive contracts when $\underline{\gamma}_{II} = (1 - \phi) [I - (1 - p)\rho - p^2R]$ and $\gamma_{IS} = \phi(pR - I)$ some γ , financial markets collapse.

The following proposition summarizes the result of equilibrium contract.

Proposition 2 (Optimal financial contract) *Suppose that Assumptions 1 and 2 hold and that $I - \rho \leq \phi C$.*

- (i) *If $\gamma \geq \max\{\underline{\gamma}_{II}, \gamma^c\}$, firms choose information-insensitive contracts.*
- (ii) *If $\gamma < \max\{\underline{\gamma}_{II}, \gamma^c\}$ and $\gamma \leq \gamma_{IS}$, firms choose information-sensitive contracts.*
- (iii) *Otherwise, they cannot secure financing.*

4.2 Acquisition of Financial Expertise

Anticipating that firms offer a financial contract depending on γ , each investor chooses γ . From Lemma 1, Lemma 2, and Proposition 2, investors' payoffs in the stage of optimal

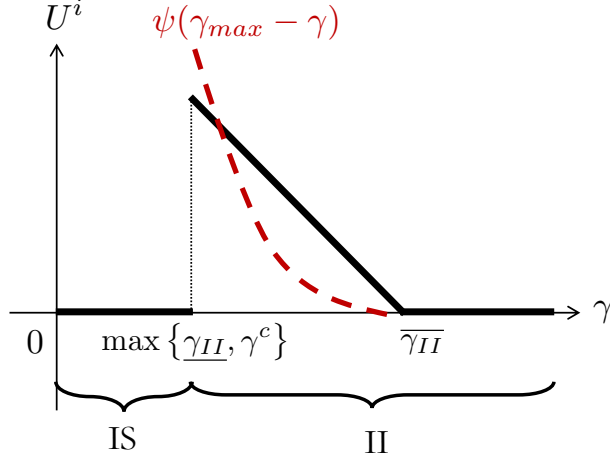


Figure 4: Investors' payoff

contracting are given by:

$$U^i(\gamma) = \begin{cases} \frac{(1-p)(1-\phi)(I-\rho) - \gamma}{p(1-\phi)} & \text{if } \max\{\underline{\gamma}_{II}, \gamma^c\} \leq \gamma < \overline{\gamma}_{II}, \\ 0 & \text{otherwise,} \end{cases} \quad (25)$$

as depicted in [Figure 4](#). If $\max\{\underline{\gamma}_{II}, \gamma^c\} \leq \gamma < \overline{\gamma}_{II}$, investors with lower γ earn higher payoffs by using their expertise as a threat to firms that offer information-insensitive contracts; otherwise, the investors must break even.

The equilibrium level of expertise is given by

$$\gamma^* \equiv \operatorname{argmax}_{\gamma \in [0, \gamma_{max}]} U^i(\gamma) - \psi(\gamma_{max} - \gamma). \quad (26)$$

To guarantee that investors acquire expertise in equilibrium, i.e., $\gamma^* < \gamma_{max}$, and γ^* is unique, we make the following assumption:

Assumption 3 γ_{max} and the function $\psi(\gamma_{max} - \gamma)$ are such that

1. $\underline{\gamma}_{II} < \gamma_{max} \leq \overline{\gamma}_{II}$,
2. $\psi(0) = 0, \psi' > 0, \psi'' > 0$, and $\lim_{\gamma \rightarrow \gamma_{max}} \psi'(\gamma_{max} - \gamma) < \frac{1}{p(1-\phi)}$.

The cost function $\psi(\gamma_{max} - \gamma)$ that satisfies this assumption is illustrated in [Figure 4](#).

Under **Assumption 3**, it immediately follows that

$$\gamma^* = \begin{cases} \gamma_{max} - \psi'^{-1}\left(\frac{1}{p(1-\phi)}\right) & \text{if } \frac{1}{p(1-\phi)} < \psi'\left(\gamma_{max} - \max\{0, \underline{\gamma}_{II}, \gamma^c\}\right) \\ \max\{0, \underline{\gamma}_{II}, \gamma^c\} & \text{otherwise.} \end{cases} \quad (27)$$

When $\psi'\left(\gamma_{max} - \max\{0, \underline{\gamma}_{II}, \gamma^c\}\right)$ is sufficiently high, the equilibrium level of expertise is determined at the point at which its marginal benefit equals its marginal cost. When $\psi'\left(\gamma_{max} - \max\{0, \underline{\gamma}_{II}, \gamma^c\}\right)$ is sufficiently low, investors acquire expertise to the point where additional acquisition of expertise either stops firms from offering information-insensitive contracts or is impossible: $\gamma^* = \max\{0, \underline{\gamma}_{II}, \gamma^c\}$. In both cases, there is expertise acquisition but never information acquisition in equilibrium.

Proposition 3 (Emergence of ignorant experts) *Suppose that Assumptions 1–3 hold and that $I - \rho \leq \phi C$. Then, in equilibrium, the level of financial expertise γ^* is given by (27), and all firms obtain financing without inducing information acquisition.*

4.3 Low Pledgeability

To highlight the effect of pledgeability ρ on expertise acquisition, this section considers the case of low pledgeability $\rho < I - \phi C$, where information-insensitive contracts are not feasible from **Lemma 1**. At the stage of optimal contracting, a firm offers information-sensitive contracts for an investor with $\gamma \leq \gamma_{IS}$ and cannot obtain financing from an investor with $\gamma > \gamma_{IS}$ from **Lemma 2**. Under this situation, investors with any γ have zero payoff, $U^i(\gamma) = 0$. As a result, (26) implies that expertise acquisition does not take place.

The following proposition characterizes the equilibrium in the case of low pledgeability.

Proposition 4 *Suppose that Assumptions 1 and 2 hold and that $I - \rho > \phi C$. Then, the equilibrium level of expertise is given by $\gamma^* = \gamma_{max}$. If $\gamma_{max} \leq \gamma_{IS}$, information acquisition arises and only firms with good collateral obtain financing. If $\gamma_{max} > \gamma_{IS}$, no firm secures financing.*

The result of no expertise acquisition is due to a hold-up problem. By investing in expertise and reducing the cost of information acquisition, investors allow firms offering information-sensitive contracts to earn higher payoffs. Once the investment has been sunk, however, firms with full bargaining power offer contracts that yield zero payoff for investors. Because the investors anticipate that they are unable to recoup the cost of their investment in expertise, there is no incentive to make such an investment.

By comparing Proposition 3 and Proposition 4, we confirm that high pledgeability is associated with large compensation for investors, a high level of their expertise, no screening, and large aggregate output. This suggests that economies with well-developed financial markets have a larger size of the financial sector and achieve a higher level of economic development than those with underdeveloped financial markets.

4.4 Efficiency

We now turn to efficiency. Consider that a social planner chooses the financial contract and level of expertise to maximize firms' payoff subject to the same information frictions as the equilibrium analysis. The planner cannot observe quality of assets, firms' choices between behaving and misbehaving, or investors' information acquisition. The key difference from the equilibrium analysis is that the planner has the ability to commit to financial contracts.

When pledgeability is high enough that $I - \rho \leq \phi C$, it is socially desirable to prevent investors from acquiring information from Proposition 1. Thus, the planner's problem is to choose $(R_{II}^i, x_{II}, \gamma)$ that maximizes (8), subject to the IR constraint for firms (10), the IC constraint (11), the feasibility constraint (12), the information-non-acquisition constraint

(14), and investors' IR constraint,

$$pR_{II}^i + (1 - p)x_{II}\phi C - I - \psi(\gamma_{max} - \gamma) \geq 0. \quad (28)$$

(28) is different from (9) because the investment in expertise is not sunk. In this optimization problem, an increase in γ relaxes (14) and (28), thereby increasing the firm's payoff. The socially optimal level of γ is given by $\gamma^S = \gamma_{max}$. Then, since (28) becomes the same as (9), the financial contract (R_{II}^i, x_{II}) that the planner designs is the same as the solution of the optimization problem (8)-(13) with $\gamma = \gamma_{max}$. As a result, the planner facing information frictions achieves the first-best allocation.

By contrast, when pledgeability is low such that $I - \rho > \phi C$, information enhances liquidity from Proposition 1 so that the planner's problem is to choose $(R_{IS}^i, x_{IS}, \gamma)$ that maximizes (17), subject to the IR constraint for the firm (19), the IC constraint (20), the feasibility constraint (21), the information-acquisition constraint (22), and the IR constraint for investors,

$$\phi \left[pR_{IS}^i + (1 - p)x_{IS}C - I \right] - \gamma - \psi(\gamma_{max} - \gamma) \geq 0. \quad (29)$$

Since (29) is binding, the firm's payoff becomes $\phi(pR - I) - \gamma - \psi(\gamma_{max} - \gamma)$. The planner chooses γ to maximize this payoff without taking into account the remaining constraints because a lower γ merely relaxes (20) and (22). Thus, the socially optimal level of γ is given by $\gamma^S = \max\{\gamma_{max} - \psi'^{-1}(1), 0\}$. The planner is indifferent to any contract (R_{IS}^i, x_{IS}) that satisfies (29) with equality and the remaining constraints.

Proposition 5 (Inefficiency of expertise acquisition) *Suppose that Assumptions 1–3 hold. If $I - \rho \leq \phi C$, the socially optimal level of expertise satisfies $\gamma^S = \gamma_{max} > \gamma^*$. If $I - \rho > \phi C$, it satisfies $\gamma^S = \max\{\gamma_{max} - \psi'^{-1}(1), 0\} < \gamma^*$.*

Proposition 5 emphasizes the importance of commitment. When pledgeability is high enough, information production generates illiquidity and investment in expertise is merely

a waste of resources. The planner with the ability to commit to financial contracts refrains from acquisition of expertise. Without the commitment, however, investors can use expertise as a threat to improve their bargaining position with firms. This motivates investors to acquire expertise. Thus, over-investment in expertise arises in equilibrium.

In contrast, when pledgeability is sufficiently low, information production increases the total surplus from the financial contracts and investments in expertise are value-enhancing activities. Although in equilibrium, investors do not acquire expertise because of a hold-up problem, the planner with the commitment ability overcomes this problem. Thus, under-investment in expertise arises in equilibrium.

Proposition 5 suggests that policy implications differ depending on the pledgeability. On the one hand, in an economy with well-developed financial markets, investors acquire expertise excessively, so that there is a need for the government to discourage the acquisition of expertise. One measure is to introduce a cap on investors' compensation R^i . Since firms find it more difficult to deter investors' information acquisition, the bonus limits can reduce rents that the investors extract and discourage their incentives to acquire expertise. On the other hand, in an economy with underdeveloped financial markets, the government can improve social welfare by encouraging investors to acquire expertise and screen collateral with a low cost. This may justify subsidies for the financial firms that play a role in examining the quality of collateral.

4.5 Discussion about Assumptions

Here, several assumptions are worth emphasizing.

Financial contracts: We could consider a more general contract (T, R^i, x) that allows for flexible up-front payments from the investor to the firm $T \geq I$. However, the firm could not gain through this additional dimension. If the information-non-acquisition constraint binds and investors earn a positive payoff, a higher T increases the loss of lending to a firm with bad collateral and requires a higher repayment to deter information acqui-

sition, which makes the IC constraint more difficult to satisfy. Otherwise, since firms that secure financing receives the entire social surplus, a higher T does not affect their payoff, while making it more difficult for them to raise funds. Thus, $T = I$ is the optimal choice for the firms.

Search frictions: We thus far assume that once a firm meets an investor and fails to borrow funds, the firm cannot find another investor. This eliminates the competition between investors and allows them to extract rents from firms. If firms are on the short side of the market and can search for an investor without costs, the firms would try to borrow funds from investors with a level of expertise that maximizes the firms' payoff. Because a lower level of expertise decreases investors' compensation and increases firms' payoffs, investors have an incentive to slightly decrease their levels of expertise compared with other investors. The competition among investors discourages expertise acquisition.

5 Dynamics

This section extends the static model of [Section 2](#) into a dynamic setting. [Section 5.1](#) describes the setup of the dynamic model. Following [Gorton and Ordoñez \(2014\)](#), the distribution of beliefs about collateral value is the unique state variable, creating dynamic linkage. [Section 5.2](#) shows how investors' compensation and level of expertise grow and credit expands as information about collateral decays over time,. [Section 5.3](#) introduces a negative aggregate shock on asset quality that can lead to a crisis.

5.1 Setting

Time is discrete and continues forever: $t = 0, 1, 2, \dots$. The model is populated by overlapping generations of a continuum of agents with unit mass who live for two periods as young and old. They are risk-neutral with no discounting between periods and their preferences over consumption streams are represented by $c^y + c^o$. When young, agents

become investors and are endowed with a sufficient amount of goods. When old, they become firms and are endowed with a project but no goods. We assume that goods are perishable and there is no storage technology. This means that firms need external financing.

One unit of asset, which has two types of quality, is distributed only to each agent of the initial generation; a fraction ϕ of the initial agents receive a good asset, and a fraction $1 - \phi$ of the initial agents receive a bad asset. The intrinsic value of a good (bad) asset is $C(0)$, and when the owner of the asset extracts its intrinsic value, it disappears. This means that an asset is storable and can be transferred to the next generation and used as collateral unless its owner consumes its intrinsic value. We also assume that an asset is indivisible.

Every period, the quality of the asset may change because of idiosyncratic shocks. For each asset, the idiosyncratic shock does not hit with probability $\lambda \in (0, 1)$ and hits with probability $1 - \lambda$ regardless of the quality of the asset. While the quality of the asset that does not receive the shock remains unchanged, the quality of the asset that receives the shock becomes good with probability ϕ and bad with probability $1 - \phi$. While the shock is observable, whether the asset becomes good or bad after the shock is unobservable. The structure of idiosyncratic shocks is depicted in [Figure 5](#). Under this specific structure, when the true quality of collateral is identified and the beliefs on the probability of good collateral are given by $\tilde{\phi} = 0$ or $\tilde{\phi} = 1$, the shock makes the quality unknown and changes the associated belief to $\tilde{\phi} = \phi$. When an asset that is of unknown quality and has the belief $\tilde{\phi} = \phi$ receives the shock, the belief does not change.

[Figure 6](#) shows the sequence of events within a period. Each investor (young individual) acquires expertise and, then, idiosyncratic shocks occur. Each firm (old individual) is matched with an investor and offers financial contracts (R^i, x) . The investor decides whether to acquire information and whether to accept the offer. If the investor accepts the offer, the firm chooses between behaving and misbehaving. Then, all outcomes are

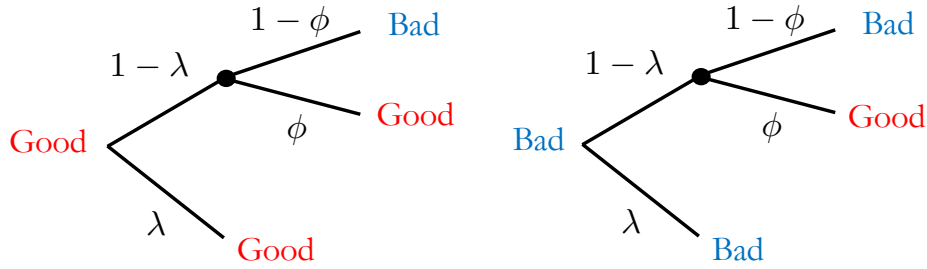


Figure 5: Idiosyncratic shock

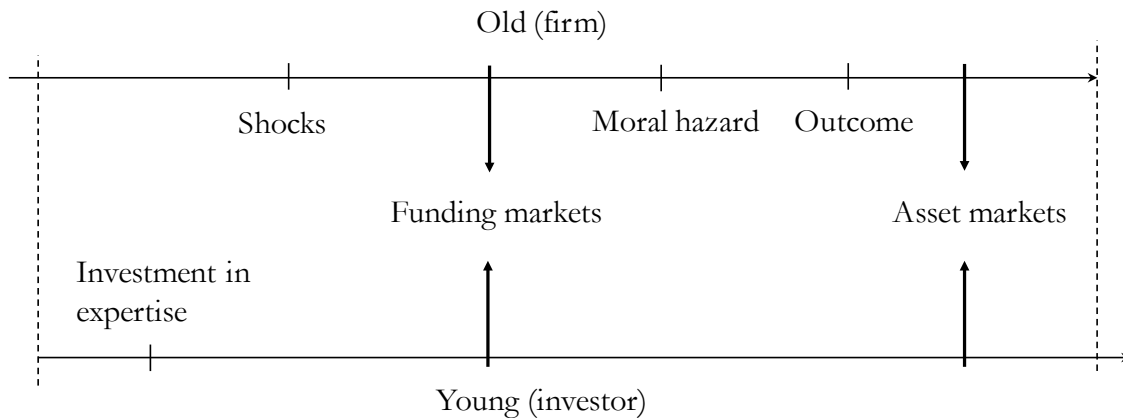


Figure 6: Timeline

realized. At the end of the period, the owner of each asset decides whether to consume its intrinsic value, to hold the asset, or to sell it to the owner’s counterpart. For simplicity, we assume that when assets are traded, a buyer makes a take-it-or-leave-it offer to a seller.

We assume that when the investor acquires private information, the information becomes public. This assumption simplifies the analysis by allowing all agents to share beliefs on collateral and restores information symmetry at the end of the period.

5.2 Credit Boom and Escalating Levels of Expertise

We begin by analyzing asset markets. Because investors use an asset as collateral in the next period, they evaluate the value of asset more highly than firms. This implies that a firm that holds an asset becomes a seller, whereas an investor who does not hold the asset becomes a buyer. Under the situation where both the investor and the firm have

common beliefs on collateral, $\tilde{\phi}$, the investor offers the transfer price $\tilde{\phi}C$ that makes the firm indifferent between selling the asset and consuming the intrinsic value.

This price setting allows us to apply the result of the static model directly to the dynamic model in which the beliefs $\tilde{\phi}$ take three values (0, ϕ , and 1) and the distribution of beliefs $\tilde{\phi}$ is the unique state variable. When firms have collateral with $\tilde{\phi} = 0$ or $\tilde{\phi} = 1$, they offer the optimal contract while ignoring investors' information acquisition, as analyzed in [Section 3](#). While firms with collateral $\tilde{\phi} = 1$ offer a financial contract that solves the optimization problem (1)-(5), firms with collateral $\tilde{\phi} = 0$ cannot secure financing. When firms have collateral with $\tilde{\phi} = \phi$, they choose between contracts that induce information acquisition or not, as analyzed in [Section 4](#). We from now on assume that pledgeable cash flows ρ are sufficiently high that information about collateral reduces liquidity:

Assumption 4 $0 < I - \rho \leq \phi C$.

This is a stronger assumption than [Assumption 2](#) and ensures that on the equilibrium path, firms with collateral $\tilde{\phi} = \phi$ offer information-insensitive contracts from [Proposition 3](#).

We assume that at the initial period ($t = 0$), all agents are fully informed about the true value of assets. This means that at $t = 0$, there is no opaque collateral (i.e., collateral with belief $\tilde{\phi} = \phi$) and only firms that have collateral with belief $\tilde{\phi} = 1$ obtain funds. [Figure 7](#) illustrates the transitional dynamics with a numerical example. In every period, some firms receive a shock and have collateral with belief $\tilde{\phi} = \phi$, which allows them to secure financing by offering information-insensitive contracts. Correspondingly, the fraction of opaque collateral increases over time (upper-left panel); after t period, the distribution of beliefs concerning the probability of good collateral, $f(\tilde{\phi})$, is given by $f(0) = \lambda^t(1 - \phi)$, $f(\phi) = 1 - \lambda^t$, and $f(1) = \lambda^t\phi$. Because firms with bad collateral are able to invest in projects after receiving the shock, net aggregate output, given by $(1 - \lambda^t + \lambda^t\phi)(pR - I)$, rises over time (upper-right panel).

The opportunity of information-insensitive lending allows investors to increase their

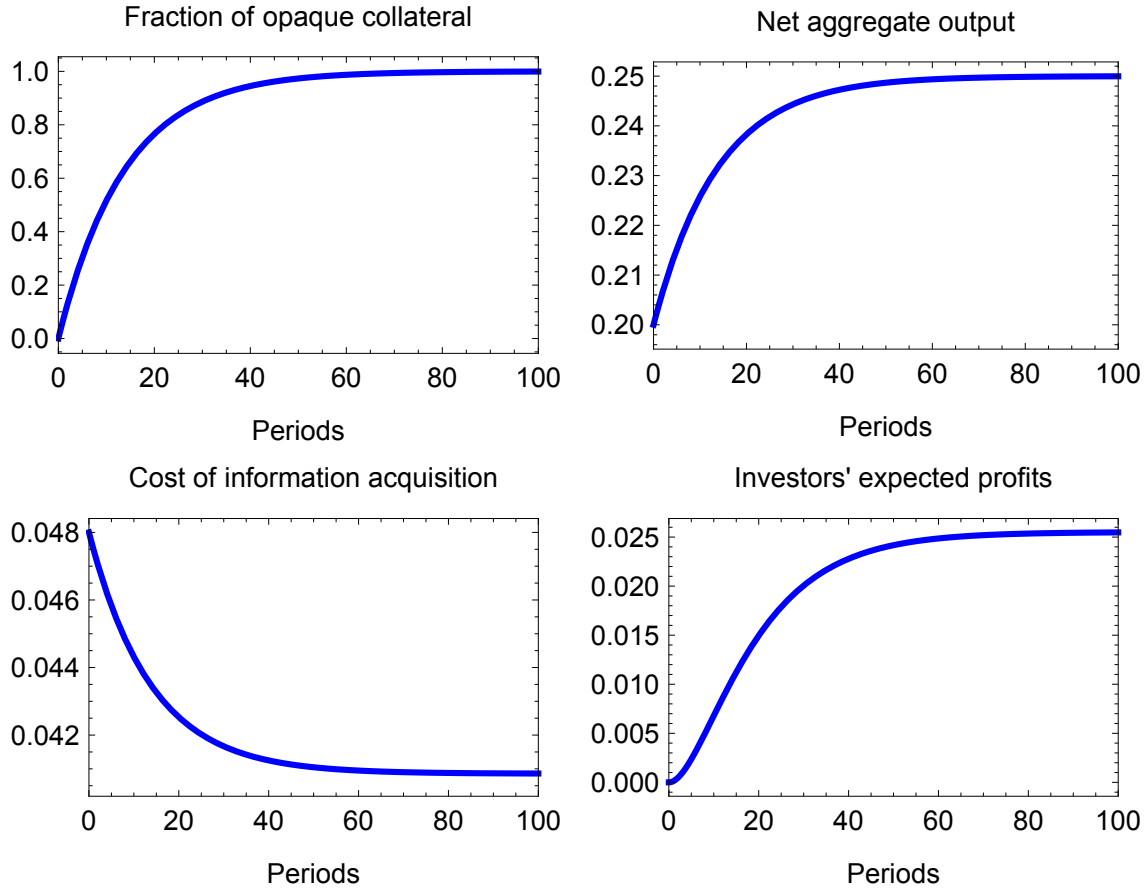


Figure 7: Dynamics

Notes: The horizontal axis represents periods from $t = 0$ to $t = 100$. We assume $\psi(\gamma_{max} - \gamma) = \frac{1}{2d}(\gamma_{max} - \gamma)^2$ and $\gamma_{max} = \overline{\gamma_{II}}$. The parameters used are $p = 0.7, R = 2.5, \Delta p = 0.3, I = 1.5, B = 0.45, C = 1.3, \phi = 0.8, \lambda = 0.93,$ and $d = 0.01$.

compensation by acquiring expertise. The equilibrium level of expertise is determined to maximize investors' payoff:

$$\gamma_t^* \equiv \operatorname{argmax}_{\gamma \in [0, \gamma_{max}]} (1 - \lambda^t) U^i(\gamma) - \psi(\gamma_{max} - \gamma). \quad (30)$$

In contrast with (26), investors meet firms with collateral $\tilde{\phi} = \phi$ with probability $f(\phi)$. This implies that as a fraction of opaque collateral increases, investors have a greater opportunity to extract rents by information-insensitive lending and are more willing to acquire expertise. Thus, as time goes by, the cost of information acquisition, γ_t^* , decreases (lower-left panel) and investors' expected profits, $(1 - \lambda^t) U^i(\gamma_t^*) - \psi(\gamma_{max} - \gamma_t^*)$, increase (lower-right panel).

Proposition 6 *Suppose that Assumptions 1, 3, and 4 hold and that at the initial period, there is full information about asset quality. A fraction of opaque collateral, net aggregate output, levels of expertise, and expected profits for investors grow over time.*

Proposition 6 highlights the linkage between prevalence of opaque assets, a credit boom, and growth in the financial sector. This captures the important aspects during the run-up to the financial crisis. Before the crisis, dramatic growth in securitization produced opaque financial securities and fueled a credit boom. Concurrently with this financial innovation, the financial industry grew; the financial sector share of GDP has increased from about 5 percent in 1980 to about 8 percent in 2006 (Greenwood and Scharfstein, 2013, Philippon, 2015). Our model suggests that an increase in the use of securitized products in financial transactions leads the financial sector to invest more in expertise and extract larger rents from the corporate sector of the economy.

5.3 Financial Fragility

Next, we introduce negative aggregate shocks on asset quality. We assume that the aggregate shock makes fraction $(1 - \eta)$, with $\eta \in (0, 1)$, of good assets become bad assets.

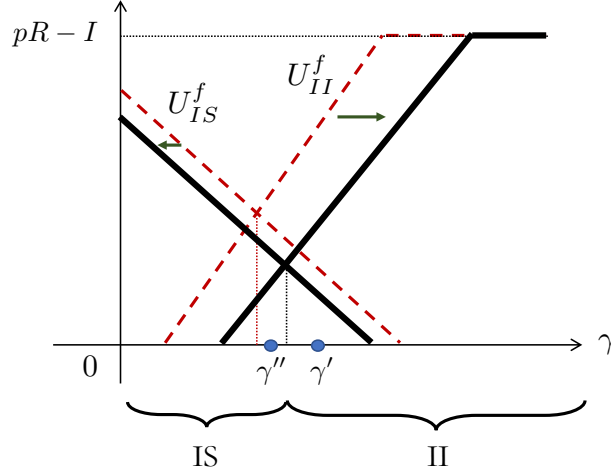


Figure 8: Effect of an aggregate shock on financial contracts when $\underline{\gamma_{II}} \leq \gamma^c$

Agents can observe whether the aggregate shock hits but cannot observe who receives the shock. Thus, the aggregate shock changes beliefs $\tilde{\phi} = \phi$ into $\tilde{\phi} = \eta\phi$ and beliefs $\tilde{\phi} = 1$ into $\tilde{\phi} = \eta$, while $\tilde{\phi} = 0$ remains unchanged. Suppose that the aggregate shock hits unexpectedly after the acquisition of expertise by investors but before financial contracts.⁹ This implies that when the aggregate shock hits, investors cannot adjust levels of expertise, but firms that have collateral with belief $\tilde{\phi} = \eta\phi$ or $\tilde{\phi} = \eta$ can design financial contracts given such beliefs.

Figure 8 illustrates the impact of aggregate shocks on the payoff of firms with collateral $\tilde{\phi} = \phi$ and the financial contracts when $\underline{\gamma_{II}} \leq \gamma^c$. After the belief is reduced to $\tilde{\phi} = \eta\phi$, the expected payoff of the firm that offers information-sensitive contracts decreases because the probability of financing decreases. The expected payoff of firms that offer information-insensitive contracts also decreases because the increased probability that an investor meets a firm with bad collateral strengthens information acquisition incentives and leads to greater rents for the investor. If the aggregate shock $1 - \eta$ is sufficiently small, the latter effect dominates the former, implying that the information-sensitive region widens and the information-insensitive region narrows.

⁹We consider only the unexpected aggregate shock for simplicity. Even if agents anticipate that the aggregate shock hits, as long as the probability that the shock hits is sufficiently small, investors do not refrain from acquiring expertise and our result remains unchanged.

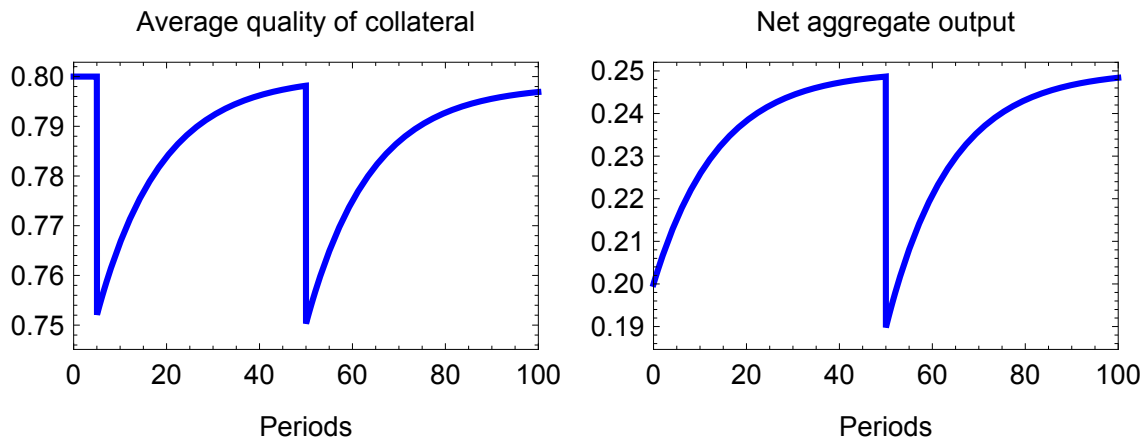


Figure 9: The boom and bust

Notes: The horizontal axis represents periods from $t = 0$ to $t = 100$. We assume that $\eta = 0.94$ and aggregate shocks hit in periods $t = 5$ and $t = 50$.

In this case, whether the aggregate shock induces informational regime change depends on the level of expertise. When investors have a low level of expertise (for example, γ' in Figure 8), the firms with collateral $\tilde{\phi} = \eta\phi$ choose information-insensitive contracts. However, when investors acquire a high level of expertise (for example, γ''), the shock induces the firms with collateral $\tilde{\phi} = \eta\phi$ to choose information-sensitive rather than information-insensitive contracts.¹⁰

Figure 9 shows how the economy fluctuates in response to aggregate shocks. To simplify the explanation, we assume that the aggregate shock $1 - \eta$ is sufficiently small that firms with collateral $\tilde{\phi} = \eta\phi$ offer information-insensitive contracts in the equilibrium path. After the first shock is realized (in period 5), the fraction of good assets decreases from ϕ to $\eta\phi$, and then moves back to the original level, ϕ , because of idiosyncratic mean reverting shocks, as displayed in the left panel. Despite the negative aggregate shock, the credit boom continues (the right panel). As shown in the lower-left panel of Figure 7, when the fraction of the opaque collateral is small, investors have not acquired enough

¹⁰When $\underline{\gamma}_{II} \leq \gamma^c$ and the aggregate shock $1 - \eta$ is sufficiently large, both the information-sensitive and information-insensitive regions could narrow and the region of no financing could widen. When $\underline{\gamma}_{II} > \gamma^c$, the aggregate shock necessarily narrows the information-sensitive and information-insensitive regions and widens the region of no financing. Under these situations, the aggregate shock can prevent firms with collateral $\tilde{\phi} = \eta\phi$ from obtaining funds. However, since this possibility does not change our qualitative result, we focus on the situation in which the firms can issue either information-insensitive or information-sensitive debt even after the aggregate shock hits.

expertise, and thus firms with opaque collateral can continue to choose information-insensitive contracts. However, when the increase in opaque collateral and the corresponding credit boom last long enough, investors acquire a high level of expertise. In this case, as shown in [Figure 8](#), the aggregate shock induces the firms with opaque collateral to select information-sensitive contracts. As a result, if their collateral is identified as bad, they cannot obtain financing, and net aggregate output must decrease. Indeed, when an aggregate shock hits in period 50, it causes a sharp drop in aggregate output. Then, the economy begins to recover and net aggregate output grows again.

Proposition 7 *Suppose that Assumptions 1, 3, and 4 hold and that at the initial period, there is full information about asset quality. Assume that $\eta\phi \geq \phi^c$, where*

$$\phi^c \equiv 1 + \frac{1}{p} - \sqrt{\frac{1}{p} + \frac{(1-p)B/\Delta p}{p(pR-I)}} < 1. \quad (31)$$

There exists time t^c such that if $t < t^c$, a negative aggregate shock on collateral does not affect aggregate output, and if $t \geq t^c$, the shock generates a crisis.

Proof. See [Appendix B](#). ■

[Proposition 7](#) has a different implication from that in [Gorton and Ordoñez \(2014\)](#). In their setup, where the level of expertise is exogenously given, the possibility that an aggregate shock causes a decline in output is independent of a fraction of opaque collateral. In contrast, our model predicts that the possibility that the shock generates a drop in output rises as a fraction of opaque collateral increases because this encourages the acquisition of expertise and leaves the financial market more vulnerable to a shock. This difference implies that a credit boom with growth in expertise tends to cause a large crash compared to one without growth in expertise.

6 Conclusion

This study analyzes inefficiencies in expertise acquisition in a model of debt funding markets, in which the expertise enables the production of information about the underlying collateral at a low cost. We show that the reason for inefficient expertise acquisition differs depending on the degree of pledgeability. If the pledgeability is low, investors' information acquisition can enhance liquidity, but they refrain from the acquisition of expertise because of a hold-up problem. However, if the pledgeability is high, information acquisition generates illiquidity, which allows investors to improve their bargaining position with firms by acquiring expertise. In equilibrium, investors acquire expertise but provide funds to firms without producing information. The emergence of such ignorant experts leads to a credit boom, due to their ignorance, and a subsequent crisis, due to their expertise. Our theory proposes a novel explanation that links prevalence of opaque assets with growth in the financial sector and the financial crisis.

One important issue we did not discuss is the effect of public information. We assumed that there is no asymmetric information between firms and investors unless they produce private information. However, investors may have superior information on the quality of underlying collateral even without producing information because they have higher ability to process public information and understand the value of securities. Ex ante informational asymmetry would enhance investors' ability to extract rents because firms fear that investors may receive bad signals about collateral from public information and be more willing to acquire private information. The interaction between public information and private information acquisition and its impact on financial firms' compensation and expertise acquisition would be an important issue for future research.

Appendix A Proof of Lemma 1

Proof. A lower R_{II}^i increases the firm's profit and makes (11) more likely to hold. The firm decreases R_{II}^i until (9) or (14) hold as equality.

First, suppose that (9) is binding. In this case, firms that secure financing obtain the payoff $U_{II}^f = pR - I$, so that (10) is not binding. Thus, they are indifferent to R_{II}^i and x_{II} if they obtain financing. Since a lower R_{II}^i and a higher x_{II} relaxes (11), the financial contract that gives the firms the entire social surplus can be offered as long as (i) (12) holds with equality ($x_{II} = 1$) and (11) and (14) are satisfied, that is, $I - \rho \leq \phi C \leq \frac{\gamma}{(1-p)(1-\phi)}$ or (ii) (14) holds with equality and (11) and (12) are satisfied, that is, $I - \rho \leq \frac{\gamma}{(1-p)(1-\phi)} \leq \phi C$. Thus, if

$$I - \rho \leq \frac{\gamma}{(1-p)(1-\phi)}, \quad (32)$$

(9) is binding and firms' payoff is given by $U_{II}^f = pR - I$.

Next, suppose that (32) does not hold, that is, $\overline{\gamma_{II}} > \gamma$. This implies that (14) binds but (9) holds with strict inequality. Since R_{II}^i is determined by (14) holding with equality, the firm's profit (8) becomes $U_{II}^f = pR - I - (1-p)x_{II}\phi C + \gamma/(1-\phi)$. Because U_{II}^f is decreasing in x_{II} , the firm decreases x_{II} until (11) binds:

$$x_{II}\phi C = \frac{1}{p} \left[I - \rho - \frac{\gamma}{1-\phi} \right].$$

In this case, the firm secures financing as long as (10) and (12) are satisfied, that is, $\underline{\gamma_{II}} \leq \gamma$.

Note that

$$\overline{\gamma_{II}} - \underline{\gamma_{II}} = p(1-\phi) \left[pR - I + \min \left\{ \phi C - p \frac{B}{\Delta p}, 0 \right\} \right] \geq 0$$

from Assumption 1 and the condition $I - \rho \leq \phi C$. Finally, if γ is so small that $\underline{\gamma_{II}} > \gamma$, financing does not occur. ■

Appendix B Proof of Proposition 7

Proof. Proposition 2 suggests that the information-insensitive region is $\gamma \geq \max\{\underline{\gamma}_{II}, \gamma^c\}$. $\underline{\gamma}_{II} = (1 - \phi) [I - \rho - p \min\{pR - \rho, \phi C\}]$ is decreasing in ϕ , while γ^c is decreasing in ϕ when $\phi \geq \phi^c$ because the total differentiation of (24) with respect to γ^c and ϕ yields

$$\frac{d\gamma^c}{d\phi} = \frac{(pR - I)([p(1 - \phi) + 1]^2 - p) - p(1 - p)B/\Delta p}{[p(1 - \phi) + 1]^2},$$

where the numerator is decreasing in ϕ and negative when $\phi = 1$ from Assumption 4. After an aggregate shock that reduces the belief $\tilde{\phi} = \phi$ to $\tilde{\phi} = \eta\phi$, $\underline{\gamma}_{II}$ increases to

$$\hat{\underline{\gamma}}_{II} \equiv (1 - \eta\phi) [I - \rho - p \min\{pR - \rho, \eta\phi C\}], \quad (33)$$

and, if $\eta\phi \geq \phi^c$, $\hat{\gamma}^c$ also increases to

$$\hat{\gamma}^c \equiv \frac{1 - \eta\phi}{p(1 - \eta\phi) + 1} \left[p(1 - p) \frac{B}{\Delta p} - (1 - p\eta\phi)(pR - I) \right]. \quad (34)$$

Thus, $\max\{\underline{\gamma}_{II}, \gamma^c\} < \max\{\hat{\underline{\gamma}}_{II}, \hat{\gamma}^c\}$, implying that the aggregate shock makes the information-insensitive region narrower.

Suppose that the first aggregate shock hits in period t . If $\gamma_t^* \geq \max\{\hat{\underline{\gamma}}_{II}, \hat{\gamma}^c\}$, firms that have collateral with belief $\tilde{\phi} = \eta\phi$ issue information-insensitive debt, and the shock does not affect aggregate output given by $(1 - \lambda^t + \lambda^t\phi)(pR - I)$. If $\gamma_t^* < \max\{\hat{\underline{\gamma}}_{II}, \hat{\gamma}^c\}$, firms with collateral $\tilde{\phi} = \eta\phi$ issue information-sensitive debt or cannot receive financing. In either case, aggregate output declines.

From (30), the equilibrium level of expertise is given by

$$\gamma_t^* = \begin{cases} \gamma_{max} - \psi'^{-1} \left(\frac{1 - \lambda^t}{p(1 - \phi)} \right) & \text{if } \frac{1 - \lambda^t}{p(1 - \phi)} < \psi' \left(\gamma_{max} - \max\{0, \underline{\gamma}_{II}, \gamma^c\} \right) \\ \max\{0, \underline{\gamma}_{II}, \gamma^c\} & \text{otherwise,} \end{cases} \quad (35)$$

where γ_t^* is nonincreasing in time t . Thus, if $\lim_{t \rightarrow \infty} \gamma_t^* < \max\{\hat{\gamma}_{II}, \hat{\gamma}^c\}$, there exists a threshold $t^c \in [0, \infty)$ such that for $t < t^c$, an aggregate shock does not affect output, and for $t \geq t^c$, the shock causes a drop in output; otherwise, for any t , the aggregate shock does not affect output. ■

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