# Ignorant Experts and Financial Fragility

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**Abstract**

We examine expertise acquisition incentives in a model of debt funding markets in which expertise reduces the cost of acquiring information about underlying collateral. Lenders acquiring expertise gain advantages in financial contracts with borrowers and extract rents from them by creating fear of information production that gives rise to illiquidity. As information about collateral decays over time, there is growth in credit and expertise acquisition, making the economy more vulnerable to an aggregate shock. This result suggests that the growth in the financial sector is associated with the prevalence of opaque assets and a subsequent crisis.

**JEL Classification:** D82, E44, G01.

**Keywords:** expertise, financial sector, financial crises, information sensitivity.

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# 1 Introduction

The financial industry has aggressively acquired financial expertise. Philippon and Reshef (2012) show that in recent decades, the US financial sector has increased IT spending and attracted highly talented workers compared to other sectors of the economy. They also show that these investments in expertise are strongly associated with a growth in remuneration in the sector.[1] The expertise allows financial firms to gather and process information about complex assets more easily and provide their services more efficiently. However, given that financial firms played a major role in the 2007–09 financial crisis, the social value of their expertise has been questioned.[2] Therefore, it is necessary to investigate why the trend of an increasing expertise acquisition occurred within the financial industry and how this trend could be accountable for the financial crisis.

In this study, we develop a model of debt funding markets in which investors acquire financial expertise to reduce the cost of acquiring information about the quality of the collateral. Information acquisition causes illiquidity, so that costly expertise acquisition is socially wasteful. However, investors are willing to acquire expertise to threaten firms with the fears of information acquisition and improve bargaining positions with firms, which allows for the emergence of ignorant experts—investors that acquire expertise but do not use it to produce information. In this case, the depreciation of information about collateral over time leads to both a credit boom and growth in expertise acquisition, leaving financial markets vulnerable to an aggregate shock. This finding offers an explanation about the linkage between the prevalence of opaque assets, the growth in the financial sector, and the financial crisis.

We build on the idea that symmetric ignorance can enhance liquidity in markets and that its breakdown can lead to a crisis, as advocated by Gorton and Ordoñez (2014), Dang

[1] See 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.

[2] Adair Turner, a former chairman of the UK's Financial Services Authority, comments in Turner (2010) 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 economic value".

et al. (2015), and Holmström (2015).[3] When issuing "information-insensitive debt," in which there is no advantage 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 ensues, 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.

As in Gorton and Ordoñez (2014), we consider a dynamic model in which firms borrow funds from investors by offering short-term collateralized debt to finance a project. The assets used as collateral have a heterogeneous quality, high or low. Every period, firms may be hit by idiosyncratic shocks that transform collateral with known quality into opaque collateral with high perceived quality. That is, after receiving the idiosyncratic shock, firms have collateral of which the true quality is unknown for the investors and firms. However, after finding a firm, each investor can acquire information about the quality of collateral at a cost for making lending decisions—lending when the collateral is of high quality and refusing to lend when it is of low quality. Thus, information acquisition can reduce the possibility of funding. We interpret the assets 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 expert due diligence.

There are two important departures from Gorton and Ordoñez (2014). First, they assume investment projects featuring Leontief technology, whereas we assume a fixed-sized investment project. Second, in their model, the cost of information acquisition is exogenously given, whereas in our model, each investor can acquire expertise that reduces the cost of information acquisition before finding a firm. Under this setup, firms with opaque collateral want to prevent investors from acquiring information even by promising them high compensation, and thus anticipating this result, investors acquire expertise and create the

[3] The idea that information can destroy economic value goes back to Hirshleifer (1971), who shows that public information restricts risk sharing. See also Gorton and Pennacchi (1990).

fears of information acquisition.

We demonstrate how the decay of information about collateral over time leads to the emergence of ignorant experts and financial fragility. The firms with collateral known as low quality can obtain financing through uninformed lending after the idiosyncratic 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, booms do not last indefinitely. As a boom continues and expertise acquisition grows, investors are more likely to produce information about opaque collateral in response to aggregate shocks that reduce the collateral's average quality. This informational regime change, from a state in which no one acquires information about the collateral's true quality to a state in which investors start to produce information, leads to a deterioration in funding liquidity and a decline in aggregate output. Thus, as opaque assets circulate more widely in markets, credit and the level of expertise will grow, and the likelihood of a subsequent crisis increases.

The main contribution of this paper is to show that the emergence of ignorant experts leads to a credit boom, due to their ignorance, and a subsequent crisis, due to their expertise. This offers a coherent explanation for the recent financial crisis. Prior to the financial crisis, securitization, or the process of pooling and tranching a set of assets, 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 were regularly used as collateral in the repo markets. During this time period, we also observed the growth in finance; the financial sector share of GDP increased from about 5 percent in 1980 to about 8 percent in 2006 (Greenwood and Scharfstein, 2013, Philippon, 2015).

Subsequently, the repo markets collapsed during the crisis and were recognized as a major source of financial instability (Gorton and Metrick, 2012).[4] Gorton and Metrick (2010)

[4] A significant rise in margins in bilateral repos is observed in a market wherein dealers lend to clients (Copeland et al., 2014). Copeland et al. (2014) and Krishnamurthy et al. (2014) document that, in contrast

demonstrate that haircuts on subprime-related assets were zero before the crisis but then increased to 100 percent by 2009. By contrast, haircuts on non-subprime-related products increased from zero percent to approximately 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 increases the likelihood of information production and a subsequent collapse in markets.

**Related literature:** Our study contributes to the literature on the optimal level of financial expertise. Glode et al. (2012), Biais et al. (2015), Fishman and Parker (2015), Bolton et al. (2016), and Kurlat (2019) argue that there is excessive acquisition of financial expertise. While in these studies, having more expertise means producing more information, our model treats expertise acquisition and information acquisition separately, and thereby shows that information decay can go hand-in-hand with increasing expertise acquisition and lead to a boom and bust cycle. Asano (2021) analyzes expertise acquisition in a similar model but focuses on the relationship between financial market developments and financial expertise. In contrast, our study stresses the linkage between the growth in financial expertise and boom-bust cycles. Philippon (2010), Cahuc and Challe (2012), and Shakhnov (2018) examine the optimal size of the financial sector by considering the allocation of talents between the financial and nonfinancial (productive) sectors.

Our paper is also related to the literature on the relationship between adverse selection and financial crises. Although this literature primarily treats information asymmetry as exogenous (e.g., Kurlat, 2013; Chari et al., 2014; Guerrieri and Shimer, 2014; Bigio, 2015), Gorton and Ordoñez (2014, 2020) develop a model of endogenous information asymmetry and show that a depletion of information about collateral generates a credit boom followed by a crisis at the point of informational regime change. We offer two contributions relative to Gorton and Ordoñez (2014, 2020). First, while they assume that the level of expertise (i.e.,

to bilateral repo markets, the tri-party repo markets, in which dealers mainly borrowed funds from cash providers (such as money market funds and security lenders) were relatively stable.

the cost of information acquisition) is exogenously given, we allow for expertise acquisition and show that it arises as opaque collateral becomes circulated. Second, the prevalence of opaque collateral accompanied by the growth in expertise makes the economy more vulnerable to aggregate shocks than without the growth in expertise.

**Outline:** The remainder of the paper is organized as follows. Section 2 describes the setting of the static model. Section 3 characterizes the equilibrium behavior within periods. Section 4 analyzes the dynamics. Section 5 presents our conclusions.

# 2 Model

In this section, we describe the setup of the model. Section 2.1 introduces the basic environment and Section 2.2 imposes parametric assumptions.

## 2.1 Environment

The economy has a single good that is used for investment and consumption. Time is discrete and continues forever: $t = 0, 1, 2, \ldots$. The model is populated by overlapping generations of a continuum of agents with unit mass who live for two periods as young and old. Agents derive utility from consumption at the end of each period and are risk-neutral with no discounting between periods. When young, each agent becomes an investor and is endowed with a sufficient amount of goods. When old, each agent becomes a firm and is 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. We also assume that firms are protected by limited liability.

A project that each firm has requires a fixed investment $I > 0$. It produces nothing in the case of failure and produces 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

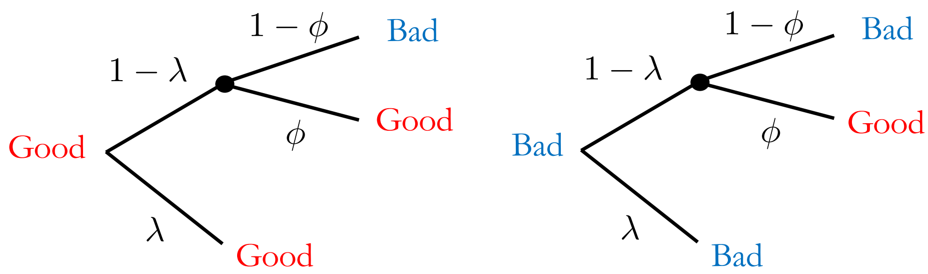


Figure 1: Idiosyncratic shock

$p \in (0, 1]$. In the case of misbehaving, the firm enjoys private benefit $B > 0$ but must accept that the probability of success decreases by $\Delta p \in (0, p)$.

One unit of indivisible asset, which has two types of quality, good and bad, is distributed only to each agent of the initial generation ($t = 0$). A fraction $\phi \in [0, 1]$ of the initial agents receive a good asset, and a fraction $1 - \phi$ of the initial agents receive a bad asset. While the intrinsic value of a good asset is $C > 0$, the intrinsic value of a bad asset is zero. Only when an 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 assume that at $t = 0$, all agents are fully informed about the true value of the assets. However, 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 $\phi$ 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 1. When the true quality of the collateral is known, the shock makes the quality opaque, and then no one knows the true quality of the collateral. We view these assets as preexisting financial securities, such as 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: in period $t$, (i) the investor contributes $I$; (ii) when the project succeeds, the investor receives $R_t^i$ and the firm receives $R - R_t^i$ from its cash flow; and (iii) when the project fails, both parties receive nothing from the investment return, and the investor seizes the collateral.[5]

After receiving a financial contract from a firm but before deciding whether to accept the contract, an investor can produce costly private information about the quality of the collateral that the firm pledges. By paying $\gamma_t \in [0, \gamma_{max}]$ units of goods, each investor knows the true quality of the collateral perfectly. The cost of information acquisition $\gamma_t$ can be interpreted as an inverse measure of the investor's financial expertise at period $t$. This means investors with lower $\gamma_t$ have more expertise. The underlying idea is that investors who have more financial expertise find it easier to gather and process information about complex assets. The important feature of our model is that the level of expertise $\gamma_t$ is an endogenous variable. Before financial contracts are offered, each investor chooses $\gamma_t$, incurring a cost $\psi(\gamma_{max} - \gamma_t)$, with $\psi \geq 0$ and $\psi' \geq 0$. While $\gamma_t$ is publicly observable, the acquisition of information is unobservable. We assume that when the investor acquires private information, the information becomes public. This assumption allows all agents to share beliefs on collateral and restores information symmetry.

Figure 2 shows the sequence of events within a period. Each investor (or young agent) chooses the level of financial expertise $\gamma_t$ and then, idiosyncratic shocks occur. Each firm (or old agent) is matched with a single investor and offers financial contracts $R_t^i$. After receiving the contract, the investor decides whether to acquire information about the quality of the pledged collateral and then whether to accept the offered contract. If the investor accepts the

[5] Even if we consider a more general contract that allows the investor to seize collateral with some probability, our results remain unchanged. See Asano (2021) in detail.

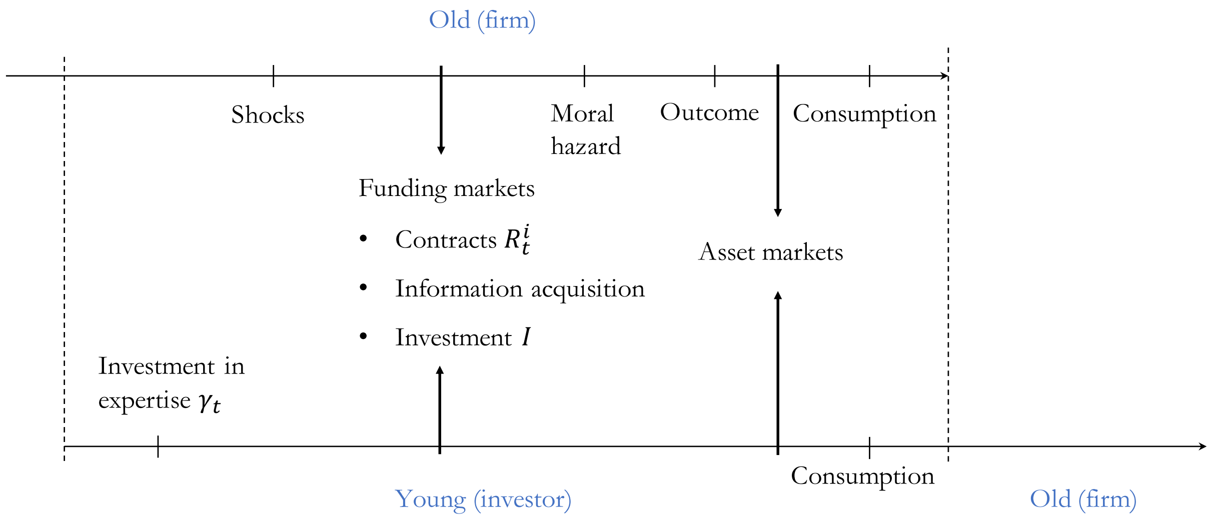


Figure 2: Timeline

contract, the firm starts to run a project and chooses between behaving and misbehaving. If the investor rejects the contract, both the firm and the investor continue holding their own endowments. Then, all outcomes are realized. At the end of the period, the owner of each asset decides whether 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. Finally, consumption takes place.

We define an equilibrium in the following way.

**Definition 1** *An equilibrium is given by the firms' contracts $R_t^i$, their choice between behaving and misbehaving, investors' expertise $\gamma_t$, their decisions on information acquisition and financing, and firms' and investors' beliefs, such that the following conditions are satisfied:*

- *Firms' contracts $R_t^i$ and the choice between behaving and misbehaving are optimal, where beliefs and the investors' strategies are taken as given;*

- *The investors' decisions on expertise $\gamma_t$, information acquisition, and financing are optimal, where beliefs and the firms' strategies are taken as given;*

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

## 2.2 Parametric assumptions

We make two parametric assumptions. First, if a firm behaves, project has positive net present value (NPV), whereas if the firm misbehaves, the project has negative NPV, even with the inclusion of private benefit:

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

Second, the moral hazard problem is relatively severe so that collateral is necessary to compensate for the lack of pledgeability:

**Assumption 2** $\phi C \geq I - p\left(R - \frac{B}{\Delta p}\right) > 0$,

The first inequality implies that the expected collateral value $\phi C$ covers the gap between the cost of financing $I$ and the pledgeable income $p\left(R - \frac{B}{\Delta p}\right)$. The second inequality implies that firms whose collateral is known as bad cannot obtain financing.

# 3 Equilibrium Analysis

In this section, we characterize equilibrium behavior within a period. Let $\tilde{\phi}$ be agents' conjecture about the probability that a firm's collateral is good. Given the information structure about collateral, the beliefs about collateral $\tilde{\phi}$ take three values: $0, \phi$, and 1. When the collateral is identified as bad (good), the beliefs about the collateral become $\tilde{\phi} = 0$ ($\tilde{\phi} = 1$). When the quality of collateral is unknown because of idiosyncratic shocks, the beliefs are represented by $\tilde{\phi} = \phi$. As in Gorton and Ordoñez (2014), the distribution of beliefs about collateral value, $f_t(\tilde{\phi})$, is the unique state variable in period $t$. Thus, given this state variable, all agents choose the optimal strategies in each period.

We begin by analyzing asset markets in Section 3.1. Section 3.2 focuses on funding markets and characterizes the optimal financial contract. Section 3.3 derives the equilibrium level of financial expertise.

## 3.1 Asset markets

Because investors use an asset as collateral in the next period, they evaluate the asset more highly than do the firms. This implies that a firm that holds an asset becomes a seller, whereas an investor that does not hold the asset becomes a buyer. Since both the investor and the firm have common beliefs about 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.

## 3.2 Funding markets

Given that investors can acquire information about collateral at a cost of $\gamma_t$, firms with collateral $\tilde{\phi} = \phi$ 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*). When firms have collateral $\tilde{\phi} =$ 0 or 1, however, they necessarily choose information-insensitive debt because investors do not have incentives to acquire information. We show that for firms with collateral $\tilde{\phi} = \phi$, issuing information-insensitive debt enhances liquidity, but this may be costly because they need to promise investors a compensation that is commensurate with the level of their expertise to prevent information acquisition.

### 3.2.1 Information-insensitive debt

Consider a situation where a firm with collateral $\tilde{\phi}$ offers an information-insensitive debt contract $R^i_{t,II}$ to an investor with expertise $\gamma_t$. The optimal contract problem is as follows:

$$\max_{R^i_{t,II}} p(R - R^i_{t,II}) - (1-p)\tilde{\phi}C \tag{1}$$

subject to

$$pR^i_{t,II} + (1-p)\tilde{\phi}C \geq I, \tag{2}$$

$$p(R - R^i_{t,II}) - (1-p)\tilde{\phi}C \geq 0, \tag{3}$$

$$p(R - R^i_{t,II}) - (1-p)\tilde{\phi}C \geq (p - \Delta p)(R - R^i_{t,II}) - (1 - p + \Delta p)\tilde{\phi}C + B, \tag{4}$$

$$pR^i_{t,II} + (1-p)\tilde{\phi}C - I \geq \tilde{\phi}\left[pR^i_{t,II} + (1-p)C - I\right] - \gamma_t. \tag{5}$$

The objective function (1) is the firm's net payoff. (2) and (3) are the individual rationality (IR) constraints for the investor and the firm, respectively, requiring that agents earn non-negative payoff from financial contracts. (4) is the incentive compatibility (IC) constraint, which requires that the firm prefers behaving to misbehaving.

(5) ensures that the investors' payoff without information acquisition (the left-hand side) is larger than the payoff with information acquisition (the right-hand side). When investors acquire information, they accept the offered contract and provide funds if the firm has good collateral and refuse the offered contract if the firm has bad collateral from Assumption 2. The constraint (5) is rewritten as

$$(1-\tilde{\phi})\left(I - pR^i_{t,II}\right) \leq \gamma_t. \tag{6}$$

The left-hand side of (6) represents the benefit of acquiring information. The investor who encounters a firm with bad collateral with probability $1-\tilde{\phi}$ can avoid a loss of $I - pR^i_{t,II}$ by not lending. If this benefit is smaller than the cost of acquiring information $\gamma_t$, the investor chooses not to acquire information.

First, suppose that (6) is not binding. A decrease in compensation for the investor $R^i_{t,II}$ increases the firm's payoff (1) and strengthens the incentive to behave from (4). This leads the firm to decrease $R^i_{t,II}$ until the IR constraint (2) is binding; that is, the expected repayment is: $pR^i_{t,II} = I - (1-p)\tilde{\phi}C$. Then, (4) can be rewritten as

$$p\left(R - \frac{B}{\Delta p}\right) + \tilde{\phi}C \geq I, \tag{7}$$

which means that if the sum of the expected pledgeable cash flows from the project $p\left(R - \frac{B}{\Delta p}\right)$ and collateral value $\tilde{\phi}C$ exceeds the cost of investment $I$, the firm secures financing. We can confirm that from Assumption 2, (7) does not hold for firms with bad collateral ($\tilde{\phi} = 0$) and thus they cannot obtain financing. In contrast, for firms with collateral $\tilde{\phi} = \phi$ or 1, (7) holds, implying that they obtain financing and receive payoffs equal to the entire social surplus $pR - I$, where (3) is not binding.

Then, we check the condition under which (6) is not binding. In the case of firms with collateral $\tilde{\phi} = 1$, (6) is always satisfied because they do not have incentives to acquire information. In the case of firms with collateral $\tilde{\phi} = \phi$, $R^i_{t,II}$ can be determined at which (6) binds instead of (2) because a lower $R^i_{t,II}$ strengthens the investors' incentives to acquire information. However, if $\gamma_t$ is sufficiently high such that

$$\gamma_t \geq \overline{\gamma_{II}} \equiv (1-p)(1-\phi)\phi C, \tag{8}$$

then (6) does not bind.

In contract, if $\gamma_t$ is in the intermediate range such that $\underline{\gamma_{II}} \leq \gamma_t < \overline{\gamma_{II}}$ where

$$\underline{\gamma_{II}} \equiv (1-\phi)\left[(1-p)\phi C - pR + I\right], \tag{9}$$

then (6) binds so that the expected repayment is: $pR^i_{t,II} = I - \frac{\gamma_t}{1-\phi}$. This means that for the investor with lower $\gamma_t$, the firm must lower the benefit of information production by increasing repayment $R^i_{t,II}$ and reducing the expected loss that the informed investor is able to avoid. In this case, the investor earns a net positive payoff.

Finally, if $\gamma_t$ is sufficiently low such that $\gamma_t < \underline{\gamma_{II}}$, the firm does not obtain funds through information-insensitive debt because the repayment $R^i_{t,II}$ must be so high that the firm loses money.

**Lemma 1** *Suppose that Assumptions 1 and 2 hold and firms offer information-insensitive debt contracts.*

*(i) Firms with collateral $\tilde{\phi} = 1$ obtain financing and receive the net payoff $pR - I$, whereas the investors' net payoff is zero.*

*(ii) Firms with collateral $\tilde{\phi} = \phi$ obtain financing and receive the net payoff,*

$$U^f_{II}(\gamma_t) = \begin{cases} pR - I & \text{if } \overline{\gamma_{II}} \leq \gamma_t, \\ pR - I - (1-p)\phi C + \dfrac{\gamma_t}{1-\phi} & \text{if } \underline{\gamma_{II}} \leq \gamma_t < \overline{\gamma_{II}}, \end{cases} \tag{10}$$

*whereas the investors receive the payoff,*

$$\begin{cases} 0 & \text{if } \overline{\gamma_{II}} \leq \gamma_t, \\ (1-p)\phi C - \dfrac{\gamma_t}{1-\phi} & \text{if } \underline{\gamma_{II}} \leq \gamma_t < \overline{\gamma_{II}}; \end{cases} \tag{11}$$

*if $\gamma_t < \underline{\gamma_{II}}$, the firms obtain no financing.*

*(iii) Firms with collateral $\tilde{\phi} = 0$ obtain no financing.*

Lemma 1 implies that if the level of expertise is in the intermediate range ($\underline{\gamma_{II}} \leq \gamma_t < \overline{\gamma_{II}}$), as the level of expertise is higher, the investor is able to extract larger rents from firms. In information-insensitive contracts, financial expertise allows investors to improve their bargaining position with firms that have all the bargaining power by creating the fear of information acquisition.

### 3.2.2 Information-sensitive debt

Next, we consider that a firm offers the information-sensitive debt contract $R^i_{t,IS}$ for an investor with $\gamma_t$. Since firms with collateral $\tilde{\phi} = 0$ or 1 do not issue the information-sensitive debt, we focus on firms with collateral $\tilde{\phi} = \phi$. The optimal information-sensitive contract is the solution for the following problem:

$$\max_{R^i_{t,IS}} \phi \left[p(R - R^i_{t,IS}) - (1-p)C\right] \tag{12}$$

subject to

$$\phi \left[pR^i_{t,IS} + (1-p)C - I\right] - \gamma_t \geq 0, \tag{13}$$

$$\phi \left[p(R - R^i_{t,IS}) - (1-p)C\right] \geq 0, \tag{14}$$

$$R - R^i_{t,IS} + C \geq \frac{B}{\Delta p}, \tag{15}$$

$$(1-\phi)\left(I - pR^i_{t,IS}\right) > \gamma_t. \tag{16}$$

The firm maximizes the net expected payoff (12), subject to the IR constraint for the investor (13), the IR constraint for the firm (14), the IC constraint (15), and the constraint that triggers information acquisition (16).

It is straightforward to characterize the optimal contract inducing information acquisition. A lower $R^i_{t,IS}$ increases the firm' profit (12) and relaxes the constraints (15) and (16). Thus, the firm decreases $R^i_{t,IS}$ until (13) binds; that is, the expected repayment is: $pR^i_{t,IS} = I - (1-p)C + \frac{\gamma_t}{\phi}$. Since (15) is satisfied under Assumption 2, if $\gamma_t$ is sufficiently low such that

$$\gamma_t \leq \gamma_{IS} \equiv \phi \min\left\{(1-p)(1-\phi)C, pR - I\right\}, \tag{17}$$

then (14) and (16) are also satisfied, and thus financing occurs. The firm receives the entire social surplus $\phi(pR - I) - \gamma_t$, where the firm has to incur the cost of information acquisition $\gamma_t$. Otherwise, at least one of the constraints (14) and (16) are violated and financing does not occur. The following lemma summarizes this argument.

**Lemma 2** *Suppose that Assumptions 1 and 2 hold and firms with collateral $\tilde{\phi} = \phi$ offer* *information-sensitive debt contracts. They obtain financing and receive the payoff,*

$$U_{IS}^{f}(\gamma_t) = \phi(pR - I) - \gamma_t \quad \text{if } \gamma_t \leq \gamma_{IS}, \tag{18}$$

*whereas the investors' payoff is zero; if* $\gamma_t > \gamma_{IS}$*, the firms obtain no financing.*

Lemma 2 implies that if the level of expertise is sufficiently high, greater expertise benefits firms with opaque collateral but not investors, in contrast to information-insensitive contracts.

### 3.2.3 Optimal contract

Based on Lemma 1 and Lemma 2, a firm with collateral $\tilde{\phi} = \phi$ chooses between information-insensitive and information-sensitive contracts to maximize its payoff. As shown in Figure 3, the firm's payoff depends on $\gamma_t$. $U_{II}^{f}$ is nondecreasing in $\gamma_t$ from (10), whereas $U_{IS}^{f}$ is decreasing in $\gamma_t$ from (18). On the one hand, the firm chooses to offer information-insensitive contracts if $U_{II}^{f} \geq U_{IS}^{f}$, that is, $\gamma_t \geq \gamma^c$ given by

$$\gamma^c \equiv \frac{1-\phi}{2-\phi}\left[(1-p)\phi C - (1-\phi)(pR - I)\right], \tag{19}$$

and if information-insensitive contracts are feasible, that is, $\gamma_t \geq \underline{\gamma_{II}}$. That is, if $\gamma_t$ is sufficiently high that $\gamma_t \geq \max\{\underline{\gamma_{II}}, \gamma^c\}$, firms offer information-insensitive contracts. On the other hand, if $\gamma_t < \max\{\underline{\gamma_{II}}, \gamma^c\}$ and $\gamma_t \leq \gamma_{IS}$, firms offer information-sensitive contracts. The following proposition summarizes the result of the equilibrium contract.

**Proposition 1 (Optimal financial contract)** *Suppose that Assumptions 1 and 2 hold.*

*(i) Firms with collateral* $\tilde{\phi} = 1$ *offer information-insensitive contracts.*

*(ii) Firms with collateral* $\tilde{\phi} = \phi$ *offer contracts depending on their investors' expertise* $\gamma_t$*:*

*(a) If* $\gamma_t \geq \max\{\underline{\gamma_{II}}, \gamma^c\}$*, they choose information-insensitive contracts.*

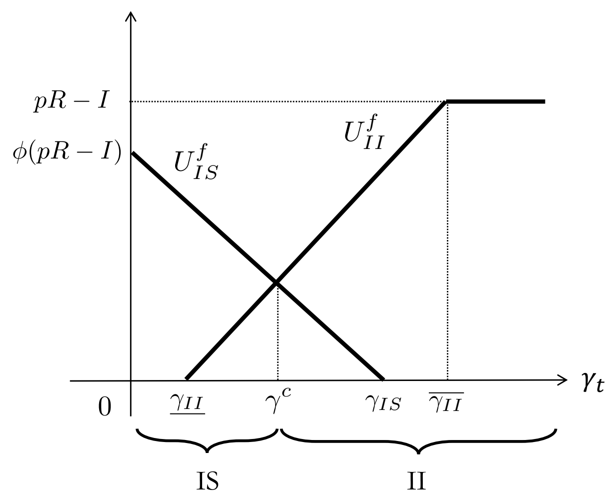


Figure 3: The comparison of payoffs of firms with collateral $\tilde{\phi} = \phi$ between information-insensitive contracts and information-sensitive contracts when $\underline{\gamma_{II}} \leq \gamma^c$ and $\gamma_{IS} = \phi(pR - I)$

*(b) If* $\gamma_t < \max\{\underline{\gamma_{II}}, \gamma^c\}$ *and* $\gamma_t \leq \gamma_{IS}$*, they choose information-sensitive contracts.*

*(c) Otherwise, they cannot secure financing.*

*(iii) Firms with collateral* $\tilde{\phi} = 0$ *cannot secure financing.*

## 3.3 Acquisition of Financial Expertise

From Lemma 1, Lemma 2, and Proposition 1, the investor's payoff in the stage of optimal contracting depends on the firm's collateral $\tilde{\phi}$ and the investor's expertise $\gamma_t$. If the investor meets the firm with collateral $\tilde{\phi} = 0$ or 1, the investor receives nothing regardless of $\gamma_t$. If the investor meets the firm with collateral $\tilde{\phi} = \phi$, the investor's payoff is given by

$$U^i(\gamma_t) = \begin{cases} (1-p)\phi C - \dfrac{\gamma_t}{1-\phi} & \text{if } \max\left\{\underline{\gamma_{II}}, \gamma^c\right\} \leq \gamma_t < \overline{\gamma_{II}}, \\ 0 & \text{otherwise,} \end{cases} \tag{20}$$

as depicted in Figure 4. If $\max\{\underline{\gamma_{II}}, \gamma^c\} \leq \gamma_t < \overline{\gamma_{II}}$, investors with lower $\gamma_t$ earn higher payoffs by using their expertise as a threat to firms that offer information-insensitive contracts; otherwise, the investors earn zero payoff.

Anticipating that these financial contracts are offered, each investor chooses $\gamma_t$. Given

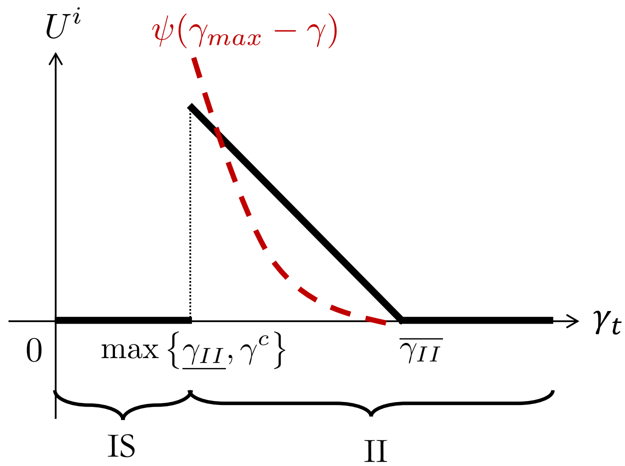


Figure 4: Investors' payoff when they meet firms with collateral $\tilde{\phi} = \phi$

that investors meet firms with collateral $\tilde{\phi} = \phi$ with probability $f_t(\phi)$ at the funding market, the equilibrium level of expertise is given by

$$\gamma_t^* \equiv \underset{\gamma_t \in [0, \gamma_{max}]}{\operatorname{argmax}} \; f_t(\phi) U^i(\gamma_t) - \psi(\gamma_{max} - \gamma_t). \tag{21}$$

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

**Assumption 3** *$\gamma_{max}$ and the cost function $\psi(\cdot)$ are such that*

1. $\underline{\gamma_{II}} < \gamma_{max} \leq \overline{\gamma_{II}}$,

2. $\psi(0) = 0, \psi' > 0, \psi'' > 0,$ *and* $\lim_{\gamma_t \to \gamma_{max}} \psi'(\gamma_{max} - \gamma_t) < \frac{1}{1-\phi}$.

The cost function that satisfies this assumption is illustrated in Figure 4.

Under Assumption 3, it immediately follows that

$$\gamma_t^* = \begin{cases} \gamma_{max} - \psi'^{-1}\left(\frac{f_t(\phi)}{1-\phi}\right) & \text{if } \frac{f_t(\phi)}{1-\phi} < \psi'\left(\gamma_{max} - \max\{0, \underline{\gamma_{II}}, \gamma^c\}\right), \\ \max\{0, \underline{\gamma_{II}}, \gamma^c\} & \text{otherwise.} \end{cases} \tag{22}$$

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

**Proposition 2 (Emergence of ignorant experts)** *Suppose that Assumptions 1–3 hold. Then, in equilibrium, the level of financial expertise $\gamma_t^*$ is given by (22) and all firms with collateral $\tilde{\phi} = \phi$ or 1 obtain financing by issuing information-insensitive debt.*

# 4 Dynamics

This section analyzes the dynamics of the model. Section 4.1 shows how investors' compensations and levels of expertise grow and the credit expands as information about collateral decays over time. Section 4.2 introduces a negative aggregate shock on asset quality and shows that as levels of expertise grow, a crisis is more likely to happen.

## 4.1 Credit boom and escalating levels of expertise

At $t = 0$, there is no opaque collateral and only firms that have collateral $\tilde{\phi} = 1$ obtain funds. With the specific structure of idiosyncratic shocks, the shock makes the quality unknown and changes the associated belief from $\tilde{\phi} = 0$ or $\tilde{\phi} = 1$ to $\tilde{\phi} = \phi$. When a firm with collateral $\tilde{\phi} = \phi$ receives the shock, the belief does not change.

Figure 5 illustrates the transitional dynamics with a numerical example. In every period, some firms receive a shock and have collateral $\tilde{\phi} = \phi$, 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, $f_t(\tilde{\phi})$, is given by: $f_t(0) = \lambda^t(1 - \phi)$, $f_t(\phi) = 1 - \lambda^t$, and $f_t(1) = \lambda^t\phi$. Because firms with bad collateral are able to invest in projects after receiving the shock, the net aggregate output, given by $(1 - \lambda^t + \lambda^t\phi)(pR - I)$, increases over time (upper-right panel).

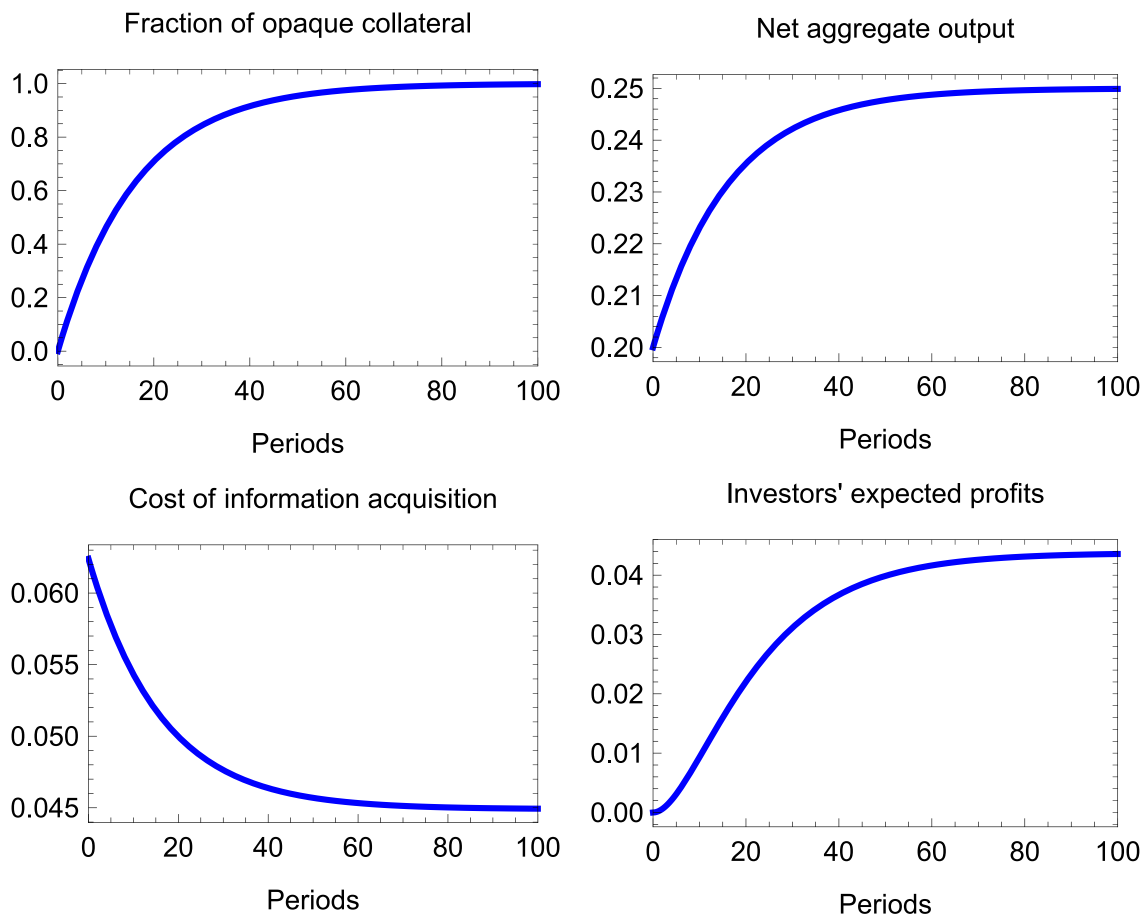


Figure 5: Dynamics

*Notes:* The horizontal axis represents periods from $t = 0$ to $t = 100$. We assume $\psi(\gamma_{max} - \gamma_t) = \frac{1}{2d}(\gamma_{max} - \gamma_t)^2$ 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 $d = 0.0035$.

This implies that as a fraction of the 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 passes, the cost of information acquisition, $\gamma_t^*$, 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 3** *Suppose that Assumptions 1–3 hold. A fraction of opaque collateral, net aggregate output, levels of expertise, and expected profits for investors grow over time.*

Proposition 3 highlights the linkage between the 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. During this period, the financial industry grew; the financial sector share of GDP 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.

## 4.2 Financial fragility

Next, we introduce negative aggregate shocks on asset quality. We assume that a negative aggregate shock makes the fraction $(1-\eta)$, with $\eta \in (0,1)$, of good assets become bad assets. 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 beliefs $\tilde{\phi} = 0$ remain unchanged. Suppose that the aggregate shock hits unexpectedly after the acquisition of expertise by investors, but before the offering of financial contracts.[6] This implies that when the aggregate shock hits, investors cannot adjust their levels of expertise, but firms that have collateral with belief $\tilde{\phi} = \eta\phi$ or $\tilde{\phi} = \eta$ can design financial contracts.

Figure 6 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 offering 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-

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

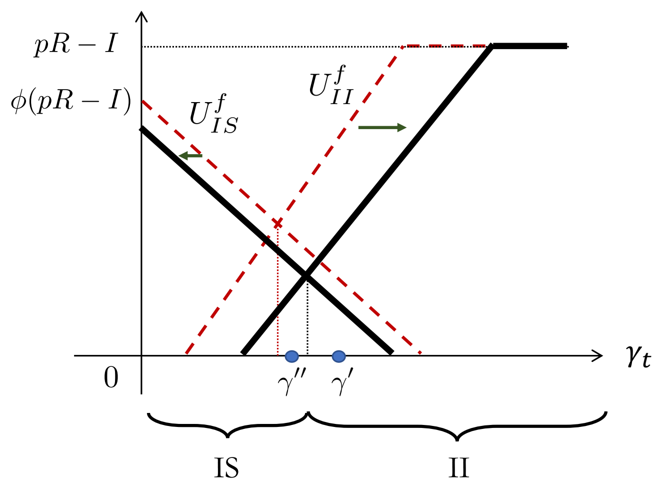


Figure 6: Effect of an aggregate shock on financial contracts when $\underline{\gamma_{II}} \leq \gamma^c$

insensitive region narrows.

In this case, whether the aggregate shock induces an informational regime change depends on the level of expertise. When investors have a low level of expertise (for example, $\gamma'$ in Figure 6), the firms with collateral $\tilde{\phi} = \eta\phi$ choose information-insensitive contracts. However, when investors acquire a high level of expertise (for example, $\gamma''$), the shock induces the firms with collateral $\tilde{\phi} = \eta\phi$ to choose information-sensitive rather than information-insensitive contracts.[7]

Figure 7 shows how the economy fluctuates in response to aggregate shocks as a solid blue line. To simplify the explanation, we assume that the aggregate shock $1 - \eta$ is sufficiently small such that firms with collateral $\tilde{\phi} = \eta$ offer information-insensitive contracts in the equilibrium path. After the shock is realized in period 50, the fraction of good assets decreases from $\phi$ to $\eta\phi$ and then moves back to the original level, $\phi$, because of idiosyncratic mean-reverting shocks (upper-left panel). When the increase in opaque collateral and the corresponding credit boom continues for a sufficiently long period, investors have acquired

[7]When $\underline{\gamma_{II}} \leq \gamma^c$, both the information-sensitive and information-insensitive regions narrow and the region of no financing widens, if the aggregate shock $1 - \eta$ is sufficiently large. 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. In these situations, the aggregate shock can prevent firms with collateral $\tilde{\phi} = \eta\phi$ from obtaining funds. However, as 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.

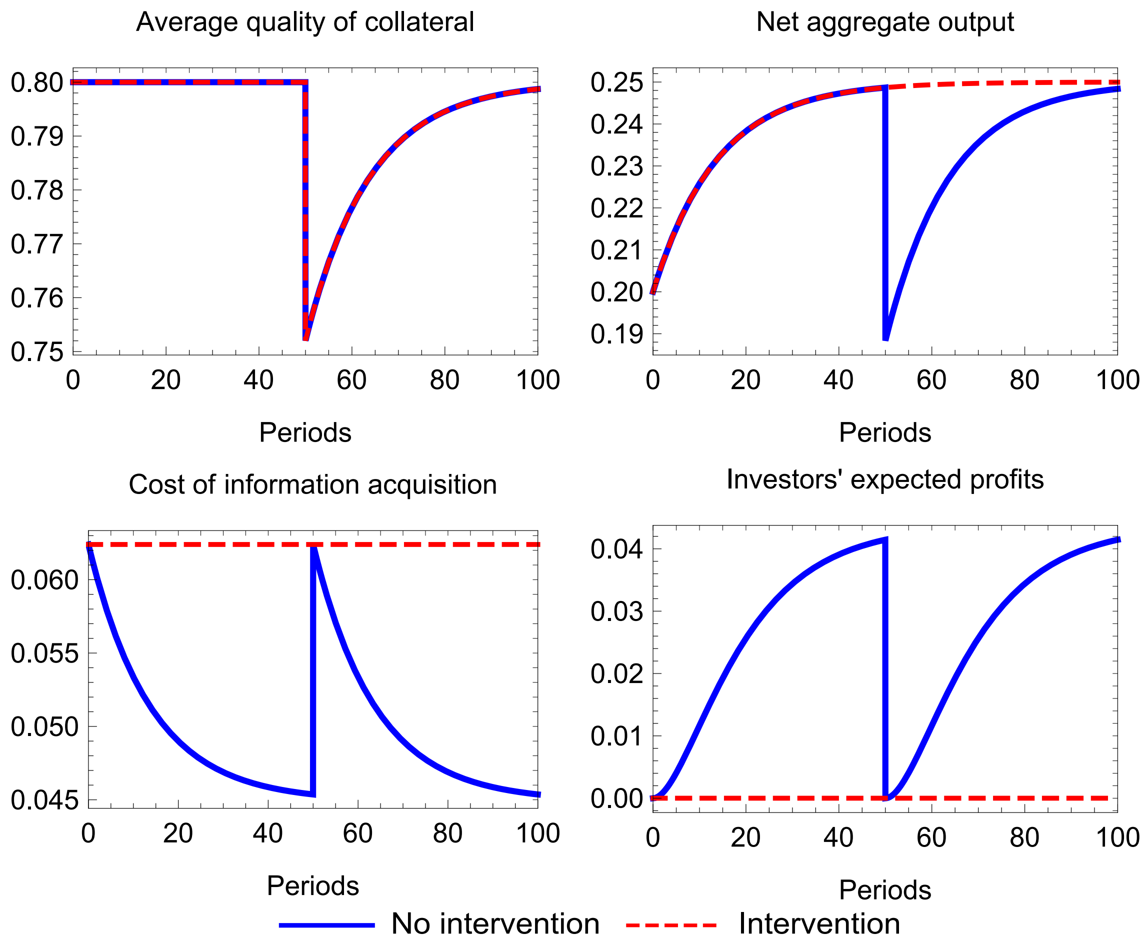


Figure 7: The boom and bust

*Notes:* The horizontal axis represents periods from $t = 0$ to $t = 100$. We assume that $\eta = 0.94$ and aggregate shocks hit in periods $t = 50$. In the case of no intervention, the cost of expertise acquisition $\psi(\gamma_{max} - \gamma_t) = \frac{1}{2d}(\gamma_{max} - \gamma_t)^2$ is small such that $d = 0.0035$. In the case of intervention, the cost of expertise acquisition is large such that $\gamma_t^* = \gamma_{max}$ for any period.

a high level of expertise (lower-left panel) and thus, 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 the net aggregate output must drop sharply (upper-right panel). The disappearance of opaque collateral discourages investors from acquiring expertise and reduces their profits (lower-right panel). Then, the economy begins to recover and the net aggregate output and investors' expected profits grow again.

**Proposition 4** *Suppose that Assumptions 1–3 hold. Assume that* $4(pR-I) > (1-p)C$ *and that a negative aggregate shock* $1-\eta$ *hits unexpectedly, where*

$$\eta\phi \geq \phi^c \equiv 2 - \sqrt{1 + \frac{(1-p)C}{(1-p)C + pR - I}}. \tag{23}$$

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

**Proof.** See Appendix A. ■

As a comparison with the equilibrium path without any government intervention, the dotted red line in Figure 7 shows the effect of government intervention in expertise acquisition on financial stability. We consider that the government increases the cost of expertise acquisition $\psi(\gamma_{max} - \gamma_t)$ for any $\gamma_t$ so that investors do not acquire expertise; that is, $\gamma_t^* = \gamma_{max}$. Despite the aggregate shock, the firms can issue information-insensitive debt without fear of information acquisition. Then, the net aggregate output grows steadily. Therefore, the government can stabilize the economy by preventing investors from acquiring expertise and maintaining symmetric ignorance.

We identify the growth in expertise as a source of financial fragility. In Gorton and Ordoñez (2014), the level of expertise is exogenously given, and thus, the possibility that an aggregate shock causes a decline in output is independent of a fraction of opaque collateral. By contrast, our model predicts that the possibility that the shock generates a drop in output rises as a fraction of opaque collateral increases, because it 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 the one without growth in expertise.

## 5 Conclusion

This study analyzes expertise acquisition incentives in a model of debt funding markets in which expertise enables the production of information about the underlying collateral at a low cost. We show that in equilibrium, investors acquire expertise not to produce information but to extract rents from firms. 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 the prevalence of opaque assets with growth in the financial sector and the financial crisis.

In this study, we focused on the effect of financial expertise on funding liquidity. However, financial expertise can influence market liquidity as well because the quality of assets traded in markets is also heterogenous. This implies that the growth in financial expertise can change liquidity management by financial institutions. Analyzing the interplay between expertise acquisition and liquidity management is an important area for future research.

## Appendix A Proof of Proposition 4

**Proof.** Proposition 1 suggests that the information-insensitive region is $\gamma_t \geq \max\{\underline{\gamma_{II}}, \gamma^c\}$. If $4(pR - I) > (1-p)C$, then for any $\phi$,

$$\gamma^c - \underline{\gamma_{II}} = \frac{1-\phi}{2-\phi}\left[pR - I - (1-\phi)\phi(1-p)C\right] > 0. \tag{24}$$

$\gamma^c$ given by (19) is decreasing in $\phi$ for $\phi \in [\phi^c, 1]$ because the total differentiation of (19) with respect to $\gamma^c$ and $\phi$ yields

$$\frac{d\gamma^c}{d\phi} = \frac{(1-p)C + pR - I}{(2-\phi)^2} \left\{ \phi^2 - 4\phi + 3 - \frac{(1-p)C}{(1-p)C + pR - I} \right\} < 0. \tag{25}$$

Thus, we have $\max\{\underline{\gamma_{II}}, \gamma^c\} = \gamma^c < \hat{\gamma}^c = \max\{\underline{\hat{\gamma}_{II}}, \hat{\gamma}^c\}$, where

$$\underline{\hat{\gamma}_{II}} \equiv (1 - \eta\phi) \left[ (1-p)\eta\phi C - pR + I \right], \tag{26}$$

$$\hat{\gamma}^c \equiv \frac{1 - \eta\phi}{2 - \eta\phi} \left[ (1-p)\eta\phi C - (1 - \eta\phi)(pR - I) \right], \tag{27}$$

implying that the aggregate shock that reduces the belief $\tilde{\phi} = \phi$ to $\tilde{\phi} = \eta\phi$ makes the information-insensitive region narrower.

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

Since $\gamma_t^*$ given by (22), where $f_t(\phi) = 1 - \lambda^t$, is nonincreasing in time $t$, if $\lim_{t\to\infty} \gamma_t^* < \max\{\underline{\hat{\gamma}_{II}}, \hat{\gamma}^c\}$, 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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