Information-Based Pricing in Specialized Lending [*]

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Abstract

We study how competition between asymmetrically informed banks, one specialized and one nonspecialized, affects loan prices. Both banks possess "general" signals regarding the borrower's quality, which they use to screen loans. The specialized bank also has access to a "specialized" signal on which it bases its loan pricing. This private information–based pricing makes the specialized bank bid more aggressively, mitigating the informational rent effect that gives it monopolistic power. Our findings explain why loans from specialized lenders feature lower interest rates and better ex post performance. Supporting empirical evidence emphasizes the role of specialized information in shaping credit market outcomes.

JEL Classification: G21, L13, L52, O33, O36

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Private credit spreads, crucial for assessing credit conditions, relate closely to financial stability. They reflect not only macroeconomic conditions and borrower quality, but are also shaped by competition among informed lenders (e.g., Broecker, 1990; Hauswald and Marquez, 2003). Ultimately, banks operate in a complex informational environment, relying on various sources including financial statements, proprietary data, and qualitative insights gained through relationship lending and industry expertise. This multidimensional information directly determines default risk premia, leading to variations in loan rates and raising questions about their impact on the competitiveness of the credit market. As advances in information technologies reshape the way banks operate, this issue becomes increasingly pertinent.

We study the emergence of private information–based pricing in equilibrium amid competition among asymmetrically informed banks. Borrower quality depends on two fundamental states. Both nonspecialized and specialized lenders observe private signals about one state, but the specialized lender is "more" informed, as it observes an additional private signal about the other state. This multidimensional information directly shapes the lenders' pricing strategies. Specialized lenders leverage their superior information to improve risk assessments, leading to differentiated loan pricing that reflects borrower quality and the competitive dynamics in the credit market.

Building on the finding in Blickle, Parlatore, and Saunders (2024) that banks specialize in certain industries, we motivate our mechanism of information-based pricing with a simple empirical exercise. Using regulatory loan-level data from the Y14-Q Schedule H database maintained by the Fed, for each year, we compute the difference between the average interest rate of loans granted by specialized banks in their industry of specialization and those of their loans in other industries. Figure 1 shows that specialized lenders consistently charge around 40 basis points less for loans in their specialized industry and that, equally important, they are less likely to encounter nonperforming loans in their industry of specialization.

The empirical regularity in Figure 1, robust to more stringent econometric specifications and alternative SNC data (Section 3.4), suggests that specialized lenders can identify better

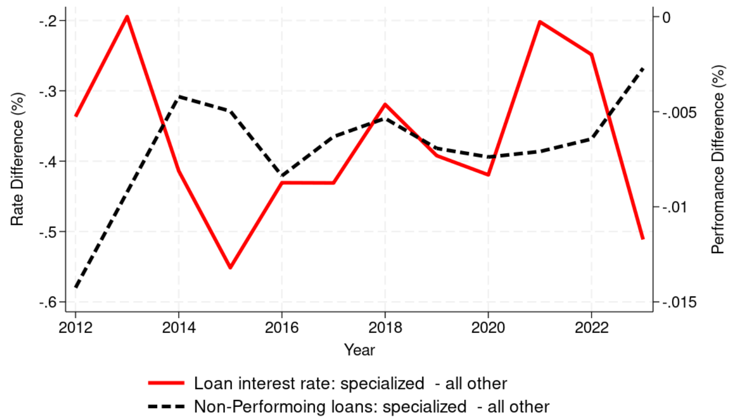

Figure 1: **Differences in interest rates and loan performance between specialized and nonspecialized lenders.** We define specialized lenders as those with more than 4% overinvestment in an industry, where overinvestment is measured as the deviation from a diversified portfolio $\frac{LoanAmount_{b,i,t}}{\sum_s LoanAmount_{b,i,t}} - \frac{LoanAmount_{i,t}}{\sum_i LoanAmount_{i,t}}$ for bank b in industry i at time t. The red solid line (left-hand side scale) plots the average difference between loan annual interest rates in the bank's specialized industry and those outside of its specialized industry. The dashed black line (right-hand side scale) plots the average annual differences in the fraction of nonperforming loans when comparing loans in a bank's specialized industry against its other loans. For a more in-depth discussion of measures of bank specialization, see Blickle, Parlatore, and Saunders (2024).

borrowers and "undercut" nonspecialized competitors. The existing information-based models, e.g., Broecker (1990) and Hauswald and Marquez (2003), however, fail to deliver this empirical regularity. As Section 3.2 shows, a stark information rent effect dominates in these canonical settings, where loans from a stronger lender (with a more precise signal) tend to have higher interest rates, contrary to Figure 1.

In our model, presented in Section 1, specialized and nonspecialized banks have a "general" signal about loan quality (e.g., from analyzing the borrower's financial statements). Moreover, the specialized lender also has access to an additional signal from "specialized" information about the borrower (e.g., from their personal interactions with loan officers). While the general signal is binary and decisive in that each lender considers making an offer only upon receiving a positive general signal, the specialized signal—which differentiates our paper from the existing literature—is continuous and guides the fine-tuned interest rate offering of the specialized bank. When the specialized signal is sufficiently low, the specialized lender rejects the borrower, as we observe in practice.

We focus on a multiplicative structure (similar to O-ring theory in Kremer, 1993) where project success requires two distinct fundamental states, one "general" and one "specialized," to be favorable;[1] the two types of signals mentioned above inform the lenders regarding these two states. Section 2 characterizes in closed form the competitive credit market equilibrium, where the specialized bank's interest rate schedule is *decreasing* in its specialized signal. In contrast, the nonspecialized bank, conditional on competing, fully randomizes its rate offers, just as in Broecker (1990). Combining these two, the specialized bank can undercut its nonspecialized opponent when receiving a good specialized signal. Hence, by incorporating a specialized signal, our model delivers the key result of private information–based pricing.[2]

In Section 2, we derive a unique credit market equilibrium that can fall into two distinct categories depending on the competitiveness of the banking industry. In the first category, the winner's curse pushes the nonspecialized "weak" bank to earn zero profits. We therefore call them *zero-weak* equilibria, where the nonspecialized bank randomly withdraws upon a positive general signal, consequently yielding more monopoly power to its specialized opponent. In the second category, termed *positive-weak* equilibria, the nonspecialized bank earns positive profits and, therefore, always participates upon a positive general signal.

Section 3 examines the model implication on the "negative interest rate wedge," referring to the empirical regularity in Figure 1 that loans from specialized lenders tend to have lower interest rates. We emphasize that the wedge, like most empirical studies on banking, is on "winning bids" (i.e., offered rates accepted by borrowers) rather than "bids" (i.e., offered interest rates); this distinction is crucial when loan rejections are an important part of equilibrium strategies. Although the standard winner's curse effect pushes the weak lender to quote higher interest rates, it also responds by rejecting loan applications. In equilibrium,

[1] The multiplicative structure can be quite flexible as the general and specialized fundamental states can potentially overlap; see He, Huang, and Parlatore (2024) who apply the setting of overlapped states to study the role of information span in credit market competition. In the extreme, these two fundamental states coincide entirely, and our model becomes the standard setting where one single fundamental state dictates the overall quality of the project.

[2] Conceptually, this is similar to the common value auction setting in Milgrom and Weber (1982), where the informed buyer who privately observes a continuum of signal realizations bids monotonically based on its private information (see the literature review for more details).

the strong lender exerts its monopolistic power by randomly quoting the maximum interest rate (which might be accepted in equilibrium), resulting in a higher expected rate for loans granted by specialized lenders. We call this the *information rent* effect. We show that this information rent effect is so strong that, under relevant parameters calibrated to U.S. banking data, canonical models à la Broecker (1990) struggle to generate the empirical regularity of a negative interest rate wedge.

In contrast, by modeling specialized signals, we explicitly incorporate the specialized lender's "undercutting" to win creditworthy borrowers, favoring a lower expected rate for granted loans by specialized lenders. We call this the *private information–based pricing* effect, which prevails especially in the regime of positive-weak equilibria. There, the specialized bank has less monopoly power and hence makes more aggressive offers to get good borrowers.[3]

We consider extensions in Section 4. First, we endogenize the information structure by considering two ex ante symmetric banks competing in two industries. Lenders can invest in aa general information technology and also acquire costly, firm-specific specialized information to become specialized. Each lender only needs to invest once in the general information technology for two industries but has to acquire the specialized signal separately for each industry. We provide conditions for a "symmetric" specialization equilibrium, where each industry has one specialized and one nonspecialized lender, as in our baseline. Second, we generalize the information structure to show the robustness of our results. Section 5 concludes.

Literature Review

Lending market competition and common-value auctions. Our paper builds on Broecker (1990), who studies lending market competition with screening tests and symmetric lenders (i.e., with the same screening abilities). Relatedly, Hauswald and Marquez (2003) explore the competition between an inside bank that can conduct credit screenings and an outside

[3]Consistent with information-based pricing, Butler (2008) finds local investment banks charge lower fees and issue municipal bonds at lower yields than nonlocal underwriters.

bank without such access.[4] In these canonical credit market competition models, it is often assumed that private screening yields a binary signal, and lenders participate (and randomize their offered rates) only when receiving the positive signal realization. In contrast, we consider competition between asymmetrically informed lenders with multiple information sources.

Conceptually, credit market competition models are an application of common-value auctions, which typically allow for general signal distributions (other than the binary signal in the aforementioned papers).[5] In terms of modeling, our framework can be viewed as a combination of Broecker (1990) (symmetric bidders with general signals) and Milgrom and Weber (1982) (asymmetric bidders, one with a specialized signal). However, lenders are privately informed with different general signals in our model, disrupting the Blackwell ordering of information between two lenders as studied in Milgrom and Weber (1982) and Engelbrecht-Wiggans, Milgrom, and Weber (1983). In that literature, one informed bidder (with public and private information) knows strictly more than the other uninformed bidder (only public information); this structure eliminates not only the winner's curse for the informed bidder but also the possibility of equilibrium profit for the uninformed bidder. We relax both assumptions and allow for a richer set of economic outcomes, yet still obtain closed-form solutions.

Specialization in lending. Existing theories in relationship lending give little guidance in predicting the interest rate wedge in an unambiguous way. However, there is a growing literature documenting specialization in bank lending; for an early paper, see Acharya, Hasan, and Saunders (2006). More recently, Paravisini, Rappoport, and Schnabl (2023) show that Peruvian banks specialize their lending across export markets, benefiting borrowers who

[4]Asymmetric credit market competition arises naturally under the recent open banking policy proposal. He, Huang, and Zhou (2023) consider competition between asymmetric lenders with different screening abilities under open banking when borrowers control access to data, and Goldstein, Huang, and Yang (2022) highlight the endogenous response of banks' liabilities once the incumbent bank's borrower data become "open to a "challenger bank, where maturity transformation of using short-term funding to support long-term loans plays an important role.

[5]The early papers on this topic include Milgrom and Weber (1982) and Engelbrecht-Wiggans, Milgrom, and Weber (1983), and later papers such as Hausch (1987) and Kagel and Levin (1999) explore information structures where each bidder has some private information, which is the information structure adopted in Broecker (1990). And, Riordan (1993) extends the N-symmetric-lender model in Broecker (1990) to a setting with continuous private signals.

obtain credit from their specialized banks. Based on data for US stress-tested banks, Blickle, Parlatore, and Saunders (2024) document that banks specialize their portfolios in different industries in a way consistent with them having informational advantages in industries in which they specialize. Besides providing a framework that rationalizes observed patterns, we also show empirically that specialized banks have fewer nonperforming loans issued at lower rates in their portfolios than nonspecialized banks in the same industry, and that this result is not due to competition among specialized banks.[6]

Pricing of bank loans. Our work joins a number of recent papers studying the pricing of loans. Chodorow-Reich, Darmouni, Luck, and Plosser (2022) investigate the liquidity provision for small and large firms, focusing in part on the rate paid by different types of firms for access to credit lines. Much of the recent collateral-on-loan-pricing literature (Benmelech and Bergman, 2009; Cerqueiro, Ongena, and Roszbach, 2014; Luck and Santos, 2023) has attempted to resolve the puzzle of why collateralized loans often pay higher rates. Our paper highlights that observed rates are "winning bids," and arguably adds an important dimension to these discussions as bank specialization and the signals associated therewith are a dimension missing from much of this literature.

The connection to the IO literature. Our analysis of the negative interest rate wedge between asymmetrically informed lenders connects to the industrial organization (IO) literature on imperfect competition and adverse selection (Mahoney and Weyl, 2017; Crawford, Pavanini, and Schivardi, 2018). There, market power (of lenders) and adverse selection (of borrowers) are treated as distinct frictions: market power arises from the demand for differentiated products, while adverse selection follows from the effective revenue of marginal consumers decreasing as the firm raises its price.[7] Their interaction implies that firms with greater

[6]Our paper is related to the literature on the nature of information in lending. Berger and Udell (2006) study relationship and transaction lending for SME, related to information's role in lending as highlighted by Stein (2002) and Paravisini and Schoar (2016). Recently, He, Jiang, Xu, and Yin (2023) show a significant rise in IT investment for US banks, which enhanced banks' capacity to generate and transmit soft information.

[7]In the insurance market example in Mahoney and Weyl (2017), a higher insurance premium is associated with lower quality insurance buyers, and a higher service cost. In Crawford, Pavanini, and Schivardi (2018), who study the enterprise loan market, a higher interest rate may attract worse borrowers or induce riskier projects, leading to lower interest revenues.

market power should charge higher prices, but this effect is dampened by adverse selection, which lowers marginal revenue as firms raise prices. In contrast, our model takes asymmetric information as the sole primitive friction, with the winners curse faced by asymmetrically informed lenders as the only underlying force. Unlike in the IO framework, our specialized lender does not enjoy "market power," as the funding sources of specialized and nonspecialized lenders are perfectly fungible. Similarly, there is no adverse selection on the borrower side, as both types of borrowers take loans at any interest rate. While market power and adverse selection could broadly relate to unobservable borrower types, they are conceptually distinct from our setting, where the primary friction stems from asymmetric information alone.

1 The Model

In this section, we present the model and define the equilibrium accordingly.

1.1 The Economic Environment

We consider a credit market competition model with two dates, one good, and risk-neutral agents (two lenders and one borrower). There are two lenders (banks) indexed by $j \in \{A, B\}$, where Bank A (B) is the specialized (nonspecialized) lender.

Project. At $t = 0$, the firm needs to borrow one dollar to invest in a (fixed-scale) risky project that pays a random cash flow $\tilde{y}$ at $t = 1$. The cash flow realization y depends on the project's quality, denoted by $\theta \in \{0, 1\}$. For simplicity, we assume that

$$\tilde{y} = \begin{cases} 1 + \bar{r}, & \text{when } \theta = 1, \\ 0, & \text{when } \theta = 0, \end{cases} \tag{1}$$

where $\bar{r} > 0$ is exogenously given. We will later refer to $\bar{r}$ as the interest rate cap or the return of a good project. The project's quality θ is unobservable to lenders, and the prior probability of a good project is $q \equiv \mathbb{P}(\theta = 1)$.

Credit market competition. At date $t = 0$, each bank j can choose to make a take-it-or-leave-it interest rate offer $r^j \leq \bar{r}$ of a unit dollar loan to the borrower or to make no offer (i.e., exit the lending market), which we normalize as $r^j = \infty$. The borrower accepts the offer with the lowest rate if receiving multiple offers.[8]

Information technology. Banks have access to information about the borrower's project quality before choosing whether to make an offer. We assume that both lenders have access to "general" data (say financial and operating data), which they can process to produce a *general information*–based private signal g^j. We call such information "general" signals. We assume that these general signals are binary, i.e., $g^j \in \{H, L\}$; and that, conditional on the (relevant) state, general signals are independent across lenders. Besides following the traditional structure presented in Broecker (1990), this modeling of general signals also captures the coarseness with which some general information is used in practice.[9]

Additionally, we endow Bank A with another private signal s, which reflects this bank is "specialized." As our major departure from the existing literature, this additional signal is a *specialized information*–based private signal, which is collected, for example, after due diligence or face-to-face interactions with the borrower after on-site visits. The specialized signal s is continuous, and its distribution is characterized by the cumulative distribution function (CDF) $\Phi(s)$ and probability density function (PDF) $\phi(s)$. Besides providing mathematical convenience, the continuous distribution captures "specialized" signals resulting from research tailored to the particular borrower and, therefore, allows for a more granular assessment of the borrower's quality.

[8] We implicitly assume that borrowers obtain some (however small) private benefit, so it is strictly optimal to take the project even for the type $\theta = 0$. One important implication is that it is irrelevant whether borrowers privately know θ or not, as both types of borrowers always pool in equilibrium.

[9] For example, as a leading example of "general information," credit scores are binned in five ranges even though scores are computed at a much more granular level and range from 300 to 850.

1.2 The Information Structure

The information structure is characterized by the correlations between the fundamental states and the two types of signals.

General and specialized fundamental states. Following the O-ring theory of economic development (Kremer, 1993), we focus on a multiplicative structure for the state θ, so that

$$\theta \equiv \theta_g \theta_s \equiv \begin{cases} 1, & \text{when } \theta_g = \theta_s = 1, \\ 0, & \text{when either } \theta_g = 0 \text{ or } \theta_s = 0. \end{cases} \tag{2}$$

Here, $\theta_g \in \{0, 1\}$ captures the "general" state and $\theta_s \in \{0, 1\}$ the "specialized" state; they jointly determine the project's success θ, in that the project fails when *either* state fails.

We further assume that general and specialized states are independent, so that the prior probability of the state being "1" is simply $q = q_g q_s$ with $q_g \equiv \mathbb{P}(\theta_g = 1)$ and $q_s \equiv \mathbb{P}(\theta_s = 1)$. This independence, together with the independence of the noise across signals, implies complete independence between the generalized and specialized signals (for Bank A). (This assumption is only for convenience as we discuss in Section 1.3.)

The distribution of the signals conditional on the state reflects the information technology. We assume that conditional on the state, the signal realizations are independent across borrowers. It is straightforward to allow for correlated signals conditional on the state (see He, Huang, and Parlatore, 2024). For binary general signals, we assume

$$\mathbb{P}\left(g^j = H \,|\theta_g = 1\right) = \alpha_u \in [0, 1]\,,\ \mathbb{P}\left(g^j = L \,|\theta_g = 0\right) = \alpha_d \in [0, 1]\,, \text{for } j \in \{A, B\}\,. \tag{3}$$

Here, $(1 - \alpha_u)$ and $(1 - \alpha_d)$ capture the probabilities of Type I and Type II errors, respectively.[10] The bad-news signal structure in He, Huang, and Zhou (2023) corresponds to $\alpha_u = 1$ and a symmetric signal structure has $\alpha_u = \alpha_d = \alpha \in (0.5, 1]$, as in Hauswald and Marquez

[10]Here, the information technology is not indexed by lender j—that is to say, lenders have the same technology to process general information that comes from "general" sources like financial statements. This assumption can be easily relaxed in our model.

(2003) and He, Jiang, and Xu (2024). Our equilibrium characterization focuses on the latter case, although our solution is robust to any $\{\alpha_u, \alpha_d\}$ structure.

For the continuous specialized signal, without loss of generality, we directly work with the posterior of the specialized state being good $\theta_s = 1$; that is,

$$s = \Pr[\theta_s = 1|\mathcal{F}_s] \in [0, 1], \tag{4}$$

where $\mathcal{F}_s$ is Bank A's information set regarding the specialized state. Note $\int_0^1 s\phi\,(s)\,ds \equiv q_s$ in order to satisfy prior consistency, where $\phi(s)$ denotes the PDF of s.

General signals being decisive. Throughout, we assume that the general signal is "decisive" and serves as "prescreening" for lending. That is to say, Bank B rejects the borrower upon $g^B = L$; Bank A rejects the borrower upon $g^A = L$ while upon $g^A = H$ it makes a pricing decision based on its specialized signal s. (However, as shown shortly, a sufficiently low specialized signal s can also induce Bank A's rejection even if $g^A = H$.) We impose the following parameter restrictions to ensure the prescreening general signal is decisive.

Assumption 1. ***(Decisive General Signals)***

i) Bank A rejects the borrower upon $g^A = L$, regardless of the specialized signal s:

$$q_g\,(1-\alpha_u)\,\overline{r} < (1-q_g)\,\alpha_d; \tag{5}$$

ii) Bank B is willing to participate (i.e., $r^B < \infty$) if its general signal $g^B = H$:

$$q_g\alpha_u q_s\overline{r} > q_g\alpha_u\,(1-q_s) + (1-q_g)\,(1-\alpha_d)\,. \tag{6}$$

These two conditions are about the loan NPV to a bank when the bank is the monopolistic lender. They shed light on the bank's incentive to participate in competition. Under condition (5), the loan has a negative NPV to Bank A upon $g^A = L$, even for the most favorable specialized signal $s = 1$. This condition implies that Bank B with a prior belief $q_s < 1$ (about

θ_s) also rejects the loan upon receiving $g^B = L$. Condition (6) states that upon $g^B = H$, Bank B is willing to lend at $\bar{r}$ if it were the monopolist lender. This implies that Bank B will participate in equilibrium; otherwise, in the conjectured equilibrium with Bank A being the monopolist lender, Bank B would have an incentive to enter (and undercut).

1.3 Discussions of Model Assumptions

Multidimensional information structure and its general applications. Our setting with multiple states admits many other interpretations besides general and specialized states. For instance, our model is equivalent to the following generalized setting:

$$\theta = \overbrace{\prod_{n=1}^{\hat{N}} \theta_n}^{\theta_g} \cdot \overbrace{\prod_{n=\hat{N}+1}^{N} \theta_n}^{\theta_s}, \tag{7}$$

with independent binomial states (or characteristics) $\theta_n \in \{0, 1\}$ where $n \in \{1, 2, ..., N\}$. One can always "relabel" to fit the specific application; in a companion paper, He, Huang, and Parlatore (2024) interpret θ_g and θ_s as the "hard" and "soft" fundamental states, respectively.

Multiplicative structure for project success. As explained in Section 4.2, the multiplicative structure in (2) or (7) makes the general signal more likely to be decisive, which is useful for tractability. But tractability does not rely on the multiplicative structure per se, and the key economics of private information–based pricing are robust to relaxing it.

Independence between general and specialized states. For ease of exposition we assume that θ_g and θ_s are independent; Section 4.2 shows that this independence can be relaxed while maintaining tractability. In a companion paper exploring the "span of information," He, Huang, and Parlatore (2024) allow for the two "hard" and "soft" fundamental states to overlap in (7), so that the general signals and the specialized signal for Bank A are correlated. For more details, see Section 4.2.

Principal and supplementary signals. The equilibrium loan-making rule of the specialized bank is practically relevant. Essentially, the specialized bank has two signals: the general one is "principal" and it determines whether to lend; the other, specialized one is "supplementary" and it helps its loan pricing.[11] As shown in Section 3, this is in sharp contrast to the existing canonical literature where lenders make loan offers *randomly* conditional on the most favorable realization of their (binary) signals. By decoupling the lender's *ex post* loan assessment from its *ex ante* technology strength, our setting helps deliver the empirical regularity of lower granted loan rates by specialized banks, as shown in Figure 1.

Endogenous information structure. In our main analysis, we take the lenders' information technologies—Bank A being the specialized lender—as given. Section 4.1 endogenizes this "asymmetric" information technology in a "symmetric" setting with two firms, a and b, where Bank A (B) endogenously becomes specialized by acquiring both "general" and "specialized" signals of the firm a (b), while nonspecialized Bank B (A) only acquires the "general" signal of the firm a (b). There, the key difference between these two signals is that a lender j only needs to invest once—say installing IT equipment—to get two general signals, one for each firm, while specialized signals need to be collected individually for each firm.

Nonzero loan recovery when default. We follow the literature (Broecker, 1990; He, Huang, and Zhou, 2023) and assume a zero recovery for defaulted loans—that is, $\tilde{y} = 0$ when $\theta = 0$ in (1). Appendix A.4 derives the equilibrium in closed form when loan recovery is nonzero, i.e., $\tilde{y} = \delta \in (0, 1)$ when $\theta = 0$. A nonzero recovery matters when we calibrate information technology parameters to match empirical moments in Section 3.2.

[11] Alternatively, the principal signal represents the result of a credit screening test, while the supplementary signal serves the role of internal ratings (of borrowers who are qualified for credit). This ranking portrays the key role played by hard information for large banks when dealing with new borrowers. Indeed, as documented on page 1677 of Crawford, Pavanini, and Schivardi (2018), large Italian banks list the factors they consider when assessing any new loan applicant's creditworthiness, in the following order of importance: i) hard information from the central bank (financial statement data); ii) hard information from Credit Register; iii) statistical-quantitative methods; iv) qualitative information (i.e., bank-specific soft information codifiable as data); v) availability of guarantees; and vi) first-hand information (i.e., branch-specific soft information).

1.4 Credit Market Equilibrium Definition

We now formally define the credit market equilibrium with specialized lending. Before doing so, we define the banks' strategies and their associated profits.

Bank strategies. Under Assumption 1, each lender makes a potential offer only upon receiving a positive general signal H in any credit market equilibrium. Define the space of interest rate offers by $\mathcal{R} \equiv [0, \overline{r}] \cup \{\infty\}$. Here, $\overline{r}$ is the exogenous interest rate cap (project return) imposed in Section 1.1 and ∞ captures the strategy of not making an offer.

As we will show soon, there exists an endogenous lower bound $\underline{r} > 0$, so that the endogenous support of equilibrium interest rates is $[\underline{r}, \overline{r}]$, which is a subinterval of $[0, \overline{r}]$. With a slight abuse of terminology, we refer to that subinterval as the "support" of the interest rate distribution, even though loan rejection ($r = \infty$) could also occur along the equilibrium path.

Denote Bank A's pure strategy by $r^A(s) : [0, 1] \to \mathcal{R}$; from Bank B's perspective, it induces a distribution of Bank A's offers denoted by $F^A(r) \equiv \Pr\left(r^A \leq r\right)$ according to the underlying distribution of the specialized signal. We take as given that Bank A uses a pure strategy, though later we formally prove this result in Proposition 1. On the other hand, Bank B randomizes conditional on $g^B = H$, in which case we denote by $F^B(r) \equiv \Pr\left(r^B \leq r\right)$ the cumulative distribution of its offers. Since the domain of offers includes rejection $r = \infty$, it is possible that $F^j(\overline{r}) = \mathbb{P}(r^j < \infty | g^j = H) \leq 1$ for $j \in \{A, B\}$.

The borrower chooses the lower interest rate offered (if there is any). For example, conditional on $g^A = g^B = H$, if Bank B quotes r^B, then its winning probability $\left(1 - F^A(r^B)\right)$ equals the probability that Bank A with a specialized signal s offers a rate higher than r^B—note, this includes the event of Bank A with $g^A = H$ rejecting the borrower ($r^A(s) = \infty$), presumably due to an unfavorable specialized signal. Upon ties $r^A = r^B < \infty$, the borrower randomly chooses the lender with probability one-half, although the details of the tie-breaking rule do not matter as ties are zero-measure events in equilibrium. When $r^A = r^B = \infty$, no bank wins the competition as both reject the borrower.

Definition 1. (Credit market equilibrium) A competitive equilibrium in the credit market (with decisive general signals) consists of the following:

1. A lender j rejects the borrower or $r^j = \infty$ upon $g^j = L$ for $j \in \{A, B\}$; upon $g^j = H$,

   i) Bank A offers $r^A(s) : [0,1] \to \mathcal{R}$ to maximize its expected lending profits given $g^A = H$ and s, which induces a distribution function $F^A(r) : \mathcal{R} \to [0,1]$;

   ii) Bank B offers $r^B \in \mathcal{R}$ to maximize its expected lending profits given $g^B = H$, which induces a distribution function $F^B(r) : \mathcal{R} \to [0,1]$;

2. The borrower who receives at least one offer (i.e., $\min\{r^A, r^B\} < \infty$) chooses the lower one.

Lemma 1 establishes that the equilibrium strategies in our setting are well-behaved, as established in the literature (Engelbrecht-Wiggans, Milgrom, and Weber, 1983; Broecker, 1990). The key steps of the proof are standard, though we make certain adjustments due to the presence of both discrete and continuous signals.

Lemma 1. *(**Equilibrium Structure**) In any equilibrium, there exists an endogenous lower bound $\underline{r} > 0$, so that the two distributions $F^j(\cdot)$, $j \in \{A, B\}$ share a common support $[\underline{r}, \overline{r}]$ (besides ∞ as rejection). Over $[\underline{r}, \overline{r})$ both distributions are smooth with well-defined density functions, i.e., no gaps and atomless. At most one lender can have a mass point at $\overline{r}$.*

Bank profits and optimal strategies. Denote by $g^A g^B \in \{HH, HL, LH, LL\}$ the event of two general signal realizations, where HL represents Bank A's (B's) general signal being H (L). Denote by $p_{g^A g^B}$ the joint probability of any collection of realizations of general signals; e.g., $p_{HH} \equiv \mathbb{P}\left(g^A = H, g^B = H\right) = q_g \alpha_u^2 + (1 - q_g)(1 - \alpha_d)^2$. Similarly, denote by $\mu_{g^A g^B} \equiv \mathbb{P}\left(\theta_g = 1 \middle| g^A, g^B\right)$ the posterior probability of the general state being one conditional on $g^A g^B$; for instance,

$$\mu_{HH} = \frac{q_g \alpha_u^2}{q_g \alpha_u^2 + (1 - q_g)(1 - \alpha_d)^2}.$$

Since $\{\theta_g, \theta_s\}$ are independent, the posterior of project success given $\{HH, s\}$ is

$$\mathbb{P}\left(\theta = 1 \middle| g^A = H, g^B = H, s\right) = \mu_{HH} \cdot s. \tag{8}$$

If Bank A receives $g^A = H$ and s, its profit $\pi^A(r\,|s)$ by quoting $r \in [\underline{r}, \overline{r})$ equals

$$\pi^A(r\,|s) \equiv \underbrace{p_{HH}}_{g^A=g^B=H} \underbrace{\left[1 - F^B(r)\right]}_{A \text{ wins}} [\mu_{HH} s(1+r) - 1] + \underbrace{p_{HL}}_{g^A=H, g^B=L} [\mu_{HL} s(1+r) - 1]. \tag{9}$$

Bank A can also choose to exit by quoting $r = \infty$, in which case $\pi^A(\infty\,|s) = 0$. We denote Bank A's optimal interest rate offer by $r^A(s) \equiv \arg\max_{r \in \mathcal{R}} \pi^A(r\,|s)$.

To understand (9), recall that A cannot observe g^B when making an offer. With probability p_{HH}, both banks receive favorable general signals, and A quoting r wins with probability $\left(1 - F^B(r)\right)$; whereas with probability p_{HL}, it faces no competition as B with $g^B = L$ withdraws itself. Standard winner's curse logic implies that B's participation in the loan market affects A's perceived borrower quality (regarding the general fundamental state) captured by μ_{HH} or μ_{HL}. Importantly, since B randomizes its pricing upon $g^B = H$, from A's perspective winning the competition against B is not informative about borrower quality.

This last observation is in sharp contrast with the problem of nonspecialized Bank B, which understands that the outcome of competition against its specialized opponent is informative about θ_s. More specifically, besides the possibility of the opponent's unfavorable general signal, when Bank B quotes r, it also knows that winning the competition implies $r^A(s) > r$. Hence, its expected lending profit when quoting r is therefore

$$\pi^B(r) \equiv \underbrace{p_{HH}}_{g^A=g^B=H} \underbrace{\left[1 - F^A(r)\right]}_{B \text{ wins}} \mathbb{E}\left[\mu_{HH}\theta_s(1+r) - 1 \middle| r \le r^A(s)\right] + \underbrace{p_{LH}}_{g^A=L, g^B=H} [\mu_{LH} q_s (1+r) - 1]. \tag{10}$$

Bank B's optimal strategy $F^B(\cdot)$ maximizes its expected payoff $\max_{F^B(\cdot)} \int_{\mathcal{R}} \pi^B(r)\, dF^B(r)$. As is standard in equilibria in mixed strategies, the profit-maximizing Bank B is indifferent between any offer r in its support.

An important equilibrium property, verified in Section 2.1, is that $r^A(s)$ is decreasing in s, so that Bank A competes more aggressively once it knows the borrower is of better quality.[12] The flip side of the "cherry picking" by the specialized lender A is the "winner's curse" suffered by the nonspecialized lender B, which infers an unfavorable specialized signal (of A) when it wins.

2 Credit Market Equilibrium Characterization

To characterize the equilibrium, Section 2.1 first takes the equilibrium profits π^B as given and solves for the other equilibrium objects, and then it solves for the equilibrium π^B. Section 2.2 completes the construction of the credit market equilibrium.

2.1 Solving for the Pricing Strategies of the Lenders

Solving for $r^A(s)$ as a function of π^B. We start by showing that Bank A's equilibrium strategy $r^A(s)$ (upon receiving $g^A = H$) is decreasing and characterized by two thresholds, x and $\hat{s}$ (they may coincide). Specifically, Bank A offers $r^A = \infty$ if $s < \hat{s}$, offers $r^A = \overline{r}$ if $\hat{s} \leq s \leq x$, and otherwise sets $r^A(s) \in [\underline{r}, \overline{r})$, which is strictly decreasing.

To see this, suppose that $r^A(s)$ is decreasing, which we verify later. Then, conditional on $g^A = H$, when B quotes $r = r^A(s)$, it wins the borrower only when A's specialized signal is below s. Bank B, therefore, updates its beliefs about the borrower's quality accordingly—its posterior for the specialized state is $\int_0^s t\phi(t)\,dt$. On the other hand, conditional on $g^A = L$, B wins the borrower for sure. Plugging $r^B = r^A(s)$ in B's lending profits in Eq. (10), we have the following indifference condition of B:

$$\pi^B = \underbrace{\left[p_{HH}\mu_{HH}\int_0^s t\phi(t)\,dt + p_{LH}\mu_{LH}q_s\right]\left(1 + r^A(s)\right)}_{B\text{'s expected lending revenue}} - \underbrace{\left(p_{HH}\Phi(s) + p_{LH}\right)}_{B\text{'s expected lending cost}}. \tag{11}$$

[12] This result is reminiscent of Milgrom and Weber (1982). Intuitively, the private specialized signal of Bank A s is only informative about θ_s and does not provide any insight on the strategy of Bank B (whose signal on θ_g is independent of θ_s in our main analysis). However, $r^{A\prime}(s) < 0$ holds under the weaker assumption that independent signals are conditional on project success, as shown in Section 4.2.

Because Eq. (11) holds for any $r^A(s) \in [\underline{r}, \overline{r})$, therefore

$$r^A(s) = \frac{\pi^B + p_{HH}\Phi(s) + p_{LH}}{p_{HH}\mu_{HH}\int_0^s t\phi(t)\,dt + p_{LH}\mu_{LH}q_s} - 1, \quad \text{for} \quad s \in [\hat{s}, 1]. \tag{12}$$

The lower bound interest rate $\underline{r}$ can be solved from evaluating $r^A(s)$ at $s = 1$:

$$\underline{r} = r^A(1) = \frac{\pi^B + p_{HH} + p_{LH}}{(p_{HH}\mu_{HH} + p_{LH}\mu_{LH})q_s} - 1. \tag{13}$$

Intuitively, Bank B guarantees winning by quoting $\underline{r}$, so its lending probability is $p_{HH}+p_{LH}$ in the numerator, and the share of good borrowers is $(p_{HH}\mu_{HH}+p_{LH}\mu_{LH})q_s$ in the denominator (recall $\int_0^1 t\phi(t)dt = q_s$).

Proposition 1 below shows that Bank A's strategy $r^A(s)$ is decreasing in equilibrium. Define its inverse function (correspondence) of $r^A(s)$ to be

$$s^A(r) \equiv \begin{cases} r^{A(-1)}(r), & \text{when } r \in [\underline{r}, \overline{r}), \\ [x, \hat{s}), & \text{when } r = \overline{r}, \\ [0, x), & \text{when } r = \infty. \end{cases} \tag{14}$$

The two relevant cutoffs for Bank A's strategy can be rewritten as $\hat{s} = \sup s^A(\overline{r})$, i.e., the highest signal that Bank A quotes $\overline{r}$; and $x = \sup s^A(\infty)$, i.e., the highest signal under which Bank A rejects the borrower.

Solving for $F^B(\cdot)$ as a function of π^B. Recall Bank B is indifferent among all rates on the support; we pin down B's equilibrium strategy so that $r^A(\cdot)$ in (12) is A's optimal strategy. To achieve this goal, define the total effective borrowers (who can repay) of Bank A and B when offering interest rate r as $Q^A(r; s)$ and $Q^B(r)$ respectively, which are given by

$$Q^A(r; s) = p_{HH}\mu_{HH}s\left[1 - F^B(r)\right] + p_{HL}\mu_{HL}s, \tag{15}$$

$$Q^B(r) = p_{HH}\mu_{HH}\int_0^{s^A(r)} t\phi(t)\,dt + p_{LH}\mu_{LH}q_s. \tag{16}$$

Q^A and Q^B differ in that A observes s while B only knows that it gets borrower types with $s < s^A(r)$ (if $g^A = H$) or q_s (if $g^A = L$), hence $Q^A(r; s)$ depends on the signal s.

Then, as Bank A cuts the interest rate r marginally, it loses $Q^A(r; s)dr$ from existing borrowers who repay but gains $Q^{A\prime}(r; s)dr$ more effective borrowers, where $Q^{A\prime}(r; s) \equiv \frac{dQ^A(r;s)}{dr}$. Therefore, Bank A's first-order condition (FOC) can be written as

$$\underbrace{Q^{A\prime}(r; s) \cdot \left(1 + r - \frac{1}{\mu_{HH} s}\right)}_{\text{MB on marginal borrower type}} = \underbrace{-Q^A(r; s)}_{\text{MC on existing borrower types}}. \tag{17}$$

The term inside the parentheses on the left-hand side in (17) concerns the marginal borrower with quality $\mu_{HH} s$. Given imperfect screening, to serve each good borrower who repays $1+r$ for sure, Bank A needs to incur a total lending cost $\frac{1}{\mu_{HH} s}$ due to lemons.

Similarly, for Bank B, any rate r on support balances the change in its borrowers against the gain from existing borrowers. Combining (11), and the definition of Q^B in (16), we can rewrite (11) as a function of r:

$$\pi^B(r) = \underbrace{Q^B(r)(1 + r)}_{B\text{'s expected lending revenue}} - \underbrace{\left(p_{HH} \Phi\left(s^A(r)\right) + p_{LH}\right)}_{B\text{'s expected lending cost}}. \tag{18}$$

Then, one can derive Bank B's FOC in maximizing (18) to be

$$\underbrace{Q^{B\prime}(r) \cdot \left(1 + r - \frac{1}{\mu_{HH} s^A(r)}\right)}_{\text{MB on marginal borrower type}} = \underbrace{-Q^B(r)}_{\text{MC on existing borrower types}}. \tag{19}$$

The two FOCs in (17) and (19) take a similar form. In fact, evaluating (17) at the equilibrium borrower type $s = s^A(r)$ and combining it with (19), we arrive at the following:

$$\frac{Q^{A\prime}\left(r; s^A(r)\right)}{Q^A\left(r; s^A(r)\right)} = \frac{Q^{B\prime}(r)}{Q^B(r)} \Leftrightarrow \frac{d}{dr}\left[\frac{Q^A(r; s)}{Q^B(r)}\right]\Bigg|_{s=s^A(r)} = 0. \tag{20}$$

Eq. (20) is surprisingly clean but admits simple intuition. At any interest rate r, both

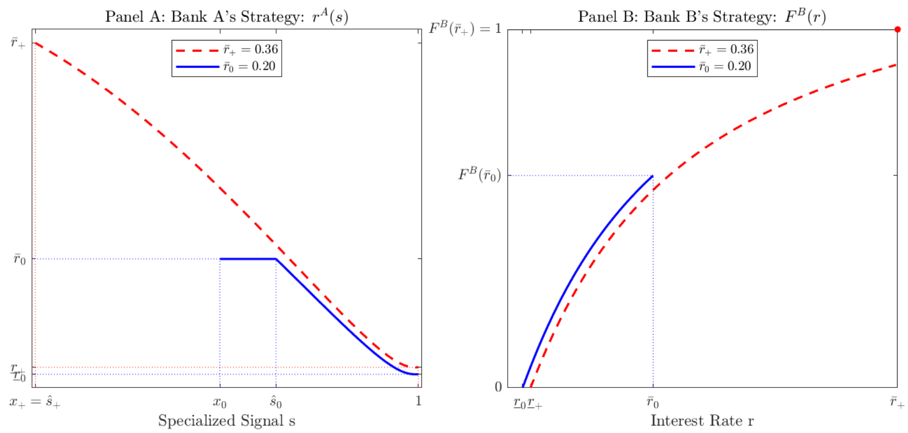

Figure 2: **Equilibrium strategies $r^A(s)$ for Bank A (left) and $F^B(r)$ for Bank B (right).** In both panels, strategies under $\bar{r}_+$ (i.e., positive-weak equilibrium) are depicted in red dashed lines while strategies with $\bar{r}_0$ (i.e., zero-weak equilibrium) are depicted in blue solid lines. In the zero-weak equilibrium, Bank A (but not Bank B) has a point mass at $\bar{r}_0$ while in the positive-weak equilibrium, Bank B (but not Bank A) has a point mass at $\bar{r}_+$. Parameters: $q_g = 0.75$, $q_s = 0.95$, $\alpha_u = \alpha_d = \alpha = 0.85$, and $\tau = 1$, where τ captures the signal-to-noise ratio of Bank A's specialized information technology as $s = \mathbb{E}[\theta_s|\theta_s + \epsilon]$ and $\epsilon \sim \mathcal{N}(0, 1/\tau)$.

lenders are competing for the same marginal borrower. As each lender balances this marginal borrower's payoff with the payoff gain from existing customers, in equilibrium, their existing effective customers should change proportionally.

Factoring out s in $Q^A(r;s)$ in (20), we obtain the following ordinary differential equation:

$$\frac{d}{dr}\left\{\frac{p_{HH}\mu_{HH}\left[1-F^B(r)\right]+p_{HL}\mu_{HL}}{p_{HH}\mu_{HH}\int_0^{s^A(r)} t\phi(t)\,dt + p_{LH}\mu_{LH}q_s}\right\} = 0, \tag{21}$$

which implies that the function inside the curly brackets is a constant independent of r. What is more, given that general signals are symmetric across lenders, i.e., $p_{HL}\mu_{HL} = p_{LH}\mu_{LH}$, $1 - F^B(r)$ is proportional to $\frac{\int_0^{s^A(r)} t\phi(t)dt}{q_s}$. Using the boundary condition $F^B(\underline{r}) = 0$ where $s^A(\underline{r}) = 1$, we solve for $F^b(r)$ in the interior strategy space,

$$1 - F^B(r) = \frac{\int_0^{s^A(r)} t\phi(t)\,dt}{q_s}, \text{ for } r \in (\underline{r}, \overline{r}). \tag{22}$$

Bank B's strategy on $\overline{r}$ depends on whether it is profitable in equilibrium: it either places a mass of $1 - F^B(\overline{r}^-) = \frac{1}{q_s}\int_0^{\hat{s}} t\phi(t)\,dt > 0$ there if $\pi^B > 0$, or withdraws $(r = \infty)$ if $\pi^B = 0$.

Illustration of lenders' pricing strategies. Before we solve for the equilibrium π^B, Figure 2 illustrates the lender strategies. Panel A (left) depicts Bank A's pricing strategy $r^A(s)$, which is decreasing, while the right panel plots Bank B's CDF of its rates $F^B(r)$. We also plot the two signal cutoffs—$\hat{s}$, at which A's strategy hits $\overline{r}$, and x, at which A exits.

We highlight a key difference between the two types of equilibria: one with $\pi^B = 0$, which we call the *zero-weak* equilibrium as the weak bank makes no profits; and the other with $\pi^B > 0$, which we call the *positive-weak* equilibrium as the weak bank makes positive profits. In Figure 2, the case of $\pi^B > 0$ is indicated by the subscript "+" and the case of $\pi^B = 0$ by the subscript "0"; the exogenous parameter that drives different π^B is $\overline{r}$, which we denote respectively by $\overline{r}_+$ and $\overline{r}_0$ with $\overline{r}_+ > \overline{r}_0$. As expected, the greater the borrower surplus $\overline{r}$, the higher the lender B's profit. As shown, in a zero-weak equilibrium A has a point mass at $\overline{r}_0$ (corresponding to $s \in (x_0, \hat{s}_0)$) but B does not, while in a positive-weak equilibrium the opposite holds. This reflects the fierce competition at the interest rate cap, which echoes the last point in Lemma 1 (otherwise, lenders will undercut each other at this point).

Solving for the equilibrium profit of Bank B. Lastly, depending on whether the equilibrium is zero-weak or positive-weak, π_B can be determined as either $\pi^B = 0$ or the break even condition of Bank A upon $s = \hat{s}$ (in positive-weak equilibrium).

Intuitively, the sign of π^B depends on which lender reaches zero profit first when quoting $\overline{r}$ as s decreases. We define s_A^{be} as the specialized signal at which Bank A quotes $\overline{r}$ and breaks even (hence the superscript "*be*"), and it corresponds to $\hat{s}$ in the conjectured positive-weak equilibrium. Similarly, we define s_B^{be} as the signal at which Bank B quotes $\overline{r}$ and breaks even, which corresponds to $\hat{s}$ in the conjectured zero-weak equilibrium. The expressions of s_A^{be} and s_B^{be} are provided in Appendix A.1. Lemma 2 shows that the relative ranking between s_A^{be} and s_B^{be} determines π^B and $\hat{s}$.

Lemma 2. *Given s_A^{be} defined in (29) in Appendix A.1, the equilibrium Bank B profit is*

$$\pi^B = \max\left\{\left[p_{HH}\mu_{HH}\int_0^{s_A^{be}} t\phi\left(t\right)dt + p_{LH}\mu_{LH}q_s\right](1+\overline{r}) - \left(p_{HH}\Phi\left(s_A^{be}\right) + p_{LH}\right), 0\right\}.$$

When $s_B^{be} < s_A^{be}$ we are in the positive-weak equilibrium in which the weak Bank B makes a positive profit, and $x = \hat{s} = s_A^{be}$. Otherwise, when $s_B^{be} \geq s_A^{be}$ we are in the zero-weak equilibrium where Bank B earns zero profits, with $x < \hat{s} = s_B^{be}$.

2.2 Credit Market Equilibrium

Credit market equilibrium characterization. The next proposition provides a full analytical characterization of the credit market equilibrium with specialized lending. Appendix A.4 generalizes the equilibrium characterization for the case of nonzero recovery.

Proposition 1. ***(Credit Market Equilibrium)*** *In the unique equilibrium, Bank A follows a pure strategy as in Definition 1. In this equilibrium, lenders reject the borrower upon a low general signal realization $h^j = L$ for $j \in \{A, B\}$. Otherwise (i.e., when $h^j = H$), their strategies are characterized as follows, with the equilibrium π^B given in Lemma 2.*

1. *Bank A with a specialized signal s offers*

$$r^A(s) = \begin{cases} \min\left\{\frac{\pi^B + p_{HH}\Phi(s) + p_{LH}}{p_{HH}\mu_{HH}\int_0^s t\phi(t)dt + p_{LH}\mu_{LH}q_s} - 1, \overline{r}\right\} & \text{for} \quad s \in [x, 1], \\ \infty, & \text{for} \quad s \in [0, x). \end{cases} \tag{23}$$

   The equation pins down $\underline{r} = r^A(1)$. If $s \in (\hat{s}, 1]$, where $\hat{s} = \sup s^A(\overline{r})$, $r^A(\cdot)$ is strictly decreasing and we can define its inverse function $s^A(\cdot) = r^{A(-1)}(\cdot)$ as in (14).

2. *Bank B makes an offer with cumulative probability given by*

$$F^B(r) = \begin{cases} 1 - \frac{\int_0^{s^A(r)} t\phi(t)dt}{q_s} & \text{for} \quad r \in [\underline{r}, \overline{r}), \\ 1 - \mathbf{1}_{\{\pi^B = 0\}} \cdot \frac{\int_0^{\hat{s}} t\phi(t)dt}{q_s} & \text{for} \quad r = \overline{r}, \end{cases} \tag{24}$$

   where $\mathbf{1}_{\{X\}} = 1$ is the indicator function that takes value one if X holds. When $\pi^B = 0$, $F^B(\overline{r}) = F^B(\overline{r}^-)$ is the probability that Bank B makes the offer (and with probability

$\frac{1}{q_s}\int_0^{\hat{s}} t\phi(t)\,dt$ it withdraws by quoting $r^B = \infty$); when $\pi^B > 0$, $F^B(\bar{r}) = 1$ and there is a mass of $\frac{1}{q_s}\int_0^{\hat{s}} t\phi(t)\,dt$ at $\bar{r}$.

The proof of Proposition 1 mainly covers three theoretical issues. First, we show that the specialized lender always adopts a pure strategy in any equilibrium; that is, the pure strategy $r^A(s)$—which is implicitly taken as given in Definition 1—is a result rather than an assumption. Second, we prove that the FOC conditions used in the equilibrium construction detailed in Section 2.1 are sufficient to ensure global optimality. Third, somewhat surprisingly, thanks to the endogenous adjustment of π^B and $\underline{r}$, monotonicity holds without the need to "iron" à la Myerson (1981) in the interior range for equilibrium interest rates.[13] In fact, consistent with point 3 in Lemma 1, Bank A's quotes never bunch at some endogenous threshold—except at the exogenous rate cap $\bar{r}$ when the zero-weak equilibrium ensues.

Remark. *(Binary specialized signal) The key equilibrium properties do not rely on Bank A's specialized signal being continuous. In Appendix A.3, we reformulate the model with a binary specialized signal, $s \in \{H, L\}$. Upon a positive general signal $g^j = H$ where $j \in \{A, B\}$, a lender offers a randomized interest rate from the common support $[\underline{r}, \bar{r}] \cup \{\infty\}$; and Bank A additionally uses its specialized signal for pricing. More specifically, there exists a threshold $\hat{r} \in (\underline{r}, \bar{r})$ such that, conditional on $g^A = H$, Bank A randomizes its interest rates over the lower subinterval $[\underline{r}, \hat{r}]$ when receiving the favorable specialized signal $s = H$ and over the upper subinterval $[\hat{r}, \bar{r}] \cup \{\infty\}$ when $s = L$.*

Properties of the credit market equilibrium. Figure 3 illustrates the main properties of the credit market equilibrium with specialized lenders. For exposition purposes, we assume that Bank A's specialized signal s is obtained from observing $\theta_s + \epsilon$, so that

$$s = \mathbb{E}[\theta_s | \theta_s + \epsilon], \tag{25}$$

[13] This result follows from lending competition, not the choice of posterior of θ_s being the specialized signal. Of course, monotonicity per se requires the specialized signal to be monotone in the posterior of θ_s.

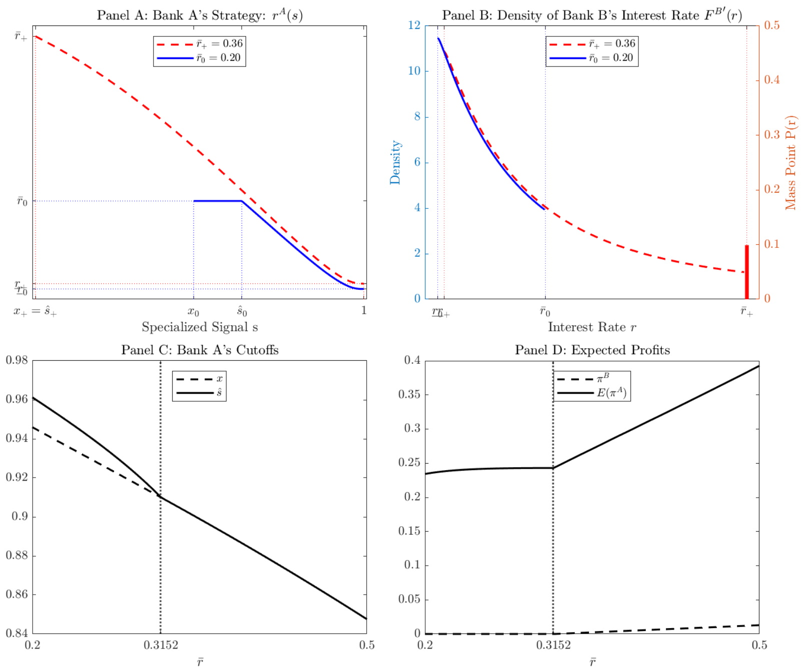

Figure 3: **Equilibrium strategies and profits.** In the top two panels, we plot equilibrium strategies for both lenders. Panel A depicts $r^A(s)$ as a function of s and Panel B plots $F^{B'}(r)$ as a function r; strategies with $\bar{r}_+$ are depicted by red dashed lines while strategies with $\bar{r}_0$ are depicted by blue solid lines. Panel C depicts Bank A's thresholds $\hat{s} = \sup s^A(\bar{r})$ and $x = \sup s^A(\infty)$, and Panel D depicts the expected profits for two lenders. Parameters: $q_g = 0.75$, $q_s = 0.95$, $\alpha_u = \alpha_d = \alpha = 0.85$, and $\tau = 1$, where τ captures the signal-to-noise ratio of Bank A's specialized information technology as $s = \mathbb{E}[\theta_s|\theta_s + \epsilon]$ and $\epsilon \sim \mathcal{N}(0, 1/\tau)$.

where $\epsilon \sim \mathcal{N}(0, 1/\tau)$ and the precision parameter τ captures the signal-to-noise ratio of Bank A's specialized information technology.

The two top panels in Figure 3 plot both lenders' pricing strategies conditional on making an offer. Panel A is the same as that in Figure 2 for convenience while Panel B plots the density $F^{B'}(r)$. Formally, we refer to Bank A's strategy of $r^A(s)$ decreasing in s as "private information–based pricing." When A's private assessment of borrower quality is sufficiently low ($s < x$), it rejects the borrower. Panel C further plots the two specialized signal cutoffs for Bank A, i.e., $\hat{s}$ at which it starts quoting $\bar{r}$ and x at which it starts rejecting the borrower.

Finally, Panel D plots the expected profits—$\mathbb{E}(\pi^A)$ and π^B—for the two lenders, against the exogenous interest rate cap $\bar{r}$. Recall that $\bar{r}$ can also be interpreted as the return of a good project, capturing the surplus to be realized from a loan. Thus, a higher total surplus gives rise to less fierce competition, and as a result, both lenders—including the weak lender

B—make positive expected profits upon a favorable general signal H. Put differently, the model features a positive-(zero-) weak equilibrium when $\overline{r}$ is relatively high (low).

The equilibrium behaviors at the upper interest rate $\overline{r}$ illustrate the competitive force in a sharp way. In the positive-weak equilibrium (high $\overline{r}$'s), the nonspecialized Bank B has a point mass on this rate, enjoying some "local monopoly power" as it is the only lender when Bank A rejects the borrower upon $s < \hat{s} = x$. In contrast, in the zero-weak equilibrium (low $\overline{r}$'s), the nonspecialized Bank B withdraws while the specialized Bank A places a point mass at $\overline{r}$ (when $s \in (x, \hat{s})$, as shown in Panel C) and is the monopolistic lender there. It is possible to have positive-weak equilibria because when the project's surplus (captured by $\overline{r}$) is sufficiently large, the nonspecialized lender B is still profitable by quoting $\overline{r}$ despite the winner's curse. We highlight that the weak lender's profits come from its conditionally independent private signal, which could also arise in canonical models, say Broecker (1990). The weak lender's "local monopoly power," however, is a unique feature of our model; it arises from Bank A's informed decision to withdraw given sufficiently low realizations of s.[14]

3 Specialized Lending: Interest Rate Wedge

As suggested by Figure 1, the loans on the balance sheets of specialized lenders tend to have higher quality and lower interest rates. That specialized lenders with informational advantages extend higher quality loans is a robust prediction of any information-based environment, including ours as well as canonical ones à la Broecker (1990) and Marquez (2002). In what follows, we focus on the implications of the model for interest rates.

We define the "interest rate wedge" as the difference between the rates of loans made by specialized and nonspecialized lenders. In Section 3.1 we first stress the difference between bids and winning bids, which explains why canonical models struggle to generate this empirical regularity (Section 3.2). Then, in Section 3.3, we show how our private information–based pricing mechanism helps generate the negative interest rate wedge observed in practice, for

[14] This point will be elaborated on later in footnote 20 in Section 3.3.

which we offer detailed evidence based on Y-14 supervisory data in Section 3.4.

3.1 Interest Rate Wedge: Bids vs. Winning Bids

An economist observes bank loans granted that borrowers accept. Put differently, the loans we use to calculate loan interest rates are already on the books of the lender that won the bidding competition for the loan. In our setting, when Bank A makes a loan offer ($r^A < \infty$), it is accepted by the borrower if $r^A < r^B \leq \infty$—that is, either if there is no offer from Bank B (e.g., when $g^B = L$ so $r^B = \infty$) or Bank A's rate is below that offered by Bank B. Therefore, the theoretical counterpart of negative rate differentials in Figure 1 is:

$$\Delta r \equiv \underbrace{\mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right]}_{\text{interest rate of } A\text{'s granted loan}} - \underbrace{\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]}_{\text{interest rate of } B\text{'s granted loan}} < 0, \tag{26}$$

where $\{r^i < r^j \leq \infty\}$ denotes the event that Bank i wins the loan (over Bank j).[15]

We call Δr in (26) the *interest rate wedge*. There is a crucial difference between the wedge calculated from "bids," i.e., banks' offered interest rates, and the one calculated from "winning bids," i.e., banks' rates on their granted loans. In our model, banks can reject loan applications by quoting ∞. Therefore, the winning bid, which is a first-order statistic (i.e., the smaller one given two quotes), necessarily requires conditioning $r^i < \infty$ in (26).

Although the winner's curse pushes the less informed Bank B to bid higher (often in the form of withdrawals by quoting $r = \infty$), it also leads to higher winning bids from the more informed Bank A. For example, in He, Huang, and Zhou (2023), conditional on quoting an interior interest rate $r < \bar{r}$, both lenders follow exactly the same bidding strategy; and the stronger bank quotes the monopoly rate $\bar{r}$ with a strictly positive probability while the

[15]There is a subtle distinction between Δr and Figure 1. The former represents the wedge between loan rates of specialized and nonspecialized lenders, while the latter pertains to loan rates within the same lender but the wedge between specialized and nonspecialized industries. However, this difference is inconsequential. First, the regression analysis in Section 3.4 accounts for cross-lender differences. Second, in the extension presented in Section 4.1, where we endogenize the model's information structure, Bank A also issues nonspecialized loans to industry b (employing the same strategy as Bank B in industry a), perfectly aligning with the analysis in Figure 1.

weaker lender withdraws from the market with the same positive probability. As a result, the interest rate wedge is typically positive.

Because Bank A's monopoly rent comes from its informational advantage, we call this economic force the "information rent" effect, which leads to a positive interest rate wedge $\Delta r > 0$. In contrast, the "private information–based pricing" effect $r^{A\prime}(s) < 0$ in our model naturally favors a negative interest rate wedge $\Delta r < 0$. We next investigate these two effects in isolation by studying two classes of models separately.

3.2 Canonical Models: The Information Rent Effect

Canonical credit market competition models parameterize the information technology by the signal's precision, which captures the lenders' ability to screen out uncreditworthy borrowers. There, the natural way to capture "specialized lending" is by imposing asymmetric screening abilities on general signals (and setting a degenerate specialized fundamental state $\theta_g = 1$).

Specification in canonical models. The literature has primarily focused on the following two parameterizations for the general signals in (3). The first is the bad-news signal structure with $\alpha_d^A > \alpha_d^B$ (and $\alpha_u^A = \alpha_u^B = 1$) in He, Huang, and Zhou (2023); alternatively, Marquez (2002) and He, Jiang, and Xu (2024) adopt a symmetric signal structure in which $\alpha_u^A = \alpha_d^A > \alpha_u^B = \alpha_d^B$. In the bad-news signal structure, A makes fewer false positive mistakes than B, while in the symmetric signal structure A also makes fewer false negative mistakes. For ease of exposition, in both cases, we suppress the subscript of u or d and simply use $\alpha^A > \alpha^B$ to capture that A is better informed. We have the following proposition.

Proposition 2. ***(Counterfactual Prediction in Canonical Models.)*** *In the canonical models of bank competition with unidimensional information:*

1. *Under a bad-news signal structure, there exists a threshold $\hat{\bar{r}}$ such that $\Delta r > 0$ for $\bar{r} < \hat{\bar{r}}$;*
2. *Under a symmetric signal structure, when $\alpha^A = \alpha$ and $\alpha^B \uparrow \alpha$, we have $\Delta r > 0$ if either i) $\bar{r} \le \frac{1}{q} - 1$ or ii) $q \ge 1 - \alpha + \alpha^2$ holds.*

In canonical models, only quantity decisions (i.e., whether to lend or not) are based on the signal realizations, while pricing decisions (offered interest rates) are randomized. Since Bank A's private signal is more precise, the weak lender B is more concerned about the winner's curse, that is, picking up a "lemon" that was rejected by the competitor lender. As a result, B randomly withdraws even after receiving a favorable signal $g^B = H$, effectively making Bank A a monopolist. This corresponds to the *information rent* effect in Section 3.1 when both lenders participate, driving the specialized Bank A to have higher expected winning bids (that is, rates on granted loans) than Bank B. This force favors a positive interest wedge.

The above discussion applies only to the event in which both lenders participate (HH). However, we also need to take into account the possibility that one lender receives a negative general signal L and withdraws, in which case "bids" matter. Because by definition a bank's "bids" are higher than its "winning bids," a negative interest rate wedge may arise if Bank B's expected rates on granted loans receive relatively more weighting on its "bids" (the event of HL) than those of Bank A. This relative weighting, together with the difference in bids and winning bids, is the counterforce that the assumptions in Proposition 2 aim to limit.

The first part of Proposition 2 concerns the bad-news signal structure. The lower the rate cap $\overline{r}$, the more severe the winner's curse in competition (HH), and therefore the weaker lender is more likely to reject loan applications. This intensifies the effect of the information rent. Meanwhile, as shown in Lemma A.7 in Appendix A.5, the difference between "bids" and "winning bids" also narrows for a lower $\overline{r}$, weakening the counterforce discussed above. Both forces explain the first part of Proposition 2 that $\Delta r > 0$ when $\overline{r}$ sits below a threshold; we will show shortly that this threshold is significantly higher than the usury rate cap in the U.S. under empirically relevant parameters calibrated to the U.S. banking industry.

The second part of Proposition 2 concerns the symmetric signal structure. We are unable to formally prove the general case; instead, we analyze only the limiting case of $\alpha^B \uparrow \alpha^A$. Our calibrated precision parameters below are extremely close to each other ($\alpha^A = 0.984$ and $\alpha^B = 0.977$), confirming that this limit is empirically relevant. Moreover, the information rent effect is presumably minimized in this limiting case; indeed, as shown in Figure 4, within the range of calibrated parameters, the information rent effect intensifies as the technology gap $\alpha^A - \alpha^B > 0$ widens. Finally, regarding the two sufficient conditions, the first about $\bar{r}$ is similar to that in the bad-news structure, while the second implies that Bank A has a higher relative weighting on "bids" than Bank B and so the counterforce is restrained.[16]

Calibrations and numerical examples. We now show that the canonical model delivers the counterfactual prediction of $\Delta r > 0$ under empirically relevant primitives that are calibrated to U.S. banking data. The key steps of our calibration are given below, while a more detailed description is available in Appendix A.6.

We set $\bar{r}$ to be 36%, the rate cap imposed by most U.S. usury laws. There are three other key parameters in canonical models: two signal precision parameters α^A and α^B, and the loan quality prior q. We calibrate these parameters on the basis of three empirical moments. First, using Y14Q.H1 data for stress-tested banks, we calculate the nonperforming loan (NPL) rates of specialized and nonspecialized banks in our sample. This gives an NPL rate of 3% for specialized and 4% for nonspecialized banks, as reported in Table B.1 in Appendix B. The third empirical moment is the loan approval rate in U.S. banks, which is reported in Chart 11 of DeSpain and Pandolfo (2024). To be consistent with the data of Y14Q.H1 covering large banks tested for stress, we take the loan approval rate of about 50% for large banks during the 2017–2024 period.

We then calculate the model-implied moments based on canonical models, which allow us to back out the three primitive parameters of interest. For example, the overall loan approval rate is 50%, which is presumably averaged between both types of banks; but since there are no data on loan applications to specialized versus nonspecialized lenders, we match the overall loan approval rate in our model which is is given by $\frac{1}{2}\mathbb{P}(g^A = H) + \frac{1}{2}\mathbb{P}(g^B = H)F^B(\bar{r})$. For

[16] As explained in Appendix A.5, the condition $q \geq 1 - \alpha + \alpha^2$ ensures a sufficiently high prior so that the more informed Bank A has a higher overall lending probability than Bank B (see (63)). But with $\alpha^B \uparrow \alpha^A = \alpha$, in HH Bank A has a slightly lower lending probability $\frac{\alpha^B}{2\alpha^A} p_{HH}$ as shown in (61) because $\frac{\alpha^B}{2\alpha^A} < \frac{1}{2}$. Combining both, we know that Bank A's loan rates place relatively less weight on its "winning bids" (HH) and more weight on its "bids" (HL) than Bank B.

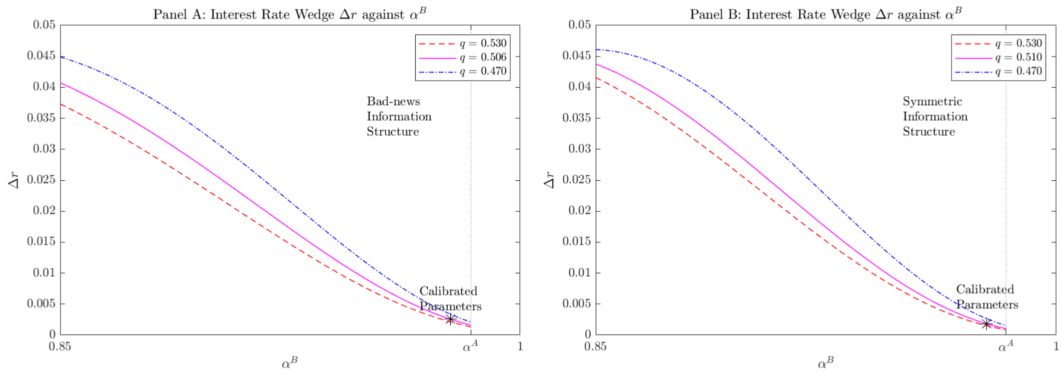

Figure 4: **Interest rate wedge under canonical models.** We plot the interest rate wedge $\Delta r = \mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right] - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]$ with calibrated parameters. We fix $\bar{r} = 0.36$ at the usury rate and calibrate α^A, α^B, and q based on empirical moments ($NPL^A = 3\%$ and $NPL^B = 4\%$, and loan approval rate 50%). We highlight the calibrated parameters in each panel with marker "$*$". Panel A depicts Δr as a function of α^B while varying q under the bad-news signal structure, with calibrated parameters $\alpha^A = 0.984$, $\alpha^B = 0.977$, $q = 0.506$. Panel B depicts Δr as a function of α^B while varying q under the symmetric signal structure, with calibrated parameters $\alpha^A = 0.984$, $\alpha^B = 0.977$, and $q = 0.510$.

the bad-news signal structure, the calibrated parameters are $\alpha^A = 0.984$, $\alpha^B = 0.977$, and $q = 0.506$, which imply $\Delta r = 0.26\%$. For the symmetric signal structure, we have $\alpha^A = 0.984$, $\alpha^B = 0.977$, and $q = 0.510$, under which $\Delta r = 0.17\%$.

Figure 4 plots the implied interest rate wedge (which is always positive) using these baseline parameters together with comparative statics in α^B and q. Panel A concerns the bad-news signal structure, and the calibrated parameters are denoted by the "$*$" marker in the figure. Recall that Proposition 2 states that $\Delta r > 0$ holds as long as the interest rate cap $\bar{r}$ is not too high. We then ask: How high would the interest rate cap need to be for Δr to turn negative? Based on the calibrated parameters, the answer is 393%—a value significantly higher than the current U.S. usury rate of 36%.[17]

Panel B in Figure 4 considers the symmetric signal structure; one can verify that Condition 1 in Part 2 of Proposition 2 holds under the calibrated parameters. Note that the two calibrated precision parameters are extremely close to each other in Panel B of Figure 4, so the limit of Proposition 2 is empirically relevant. Presumably, the information rent effect is stronger when the technology gap $\alpha^A - \alpha^B > 0$ is larger, which is confirmed in Panel B of

[17]For more details, see "Calibration" in Appendix A.6 on Page 66.

Figure 4 as well as in all our numerical exercises.

Why do we always have a positive interest rate wedge in canonical models for parameters that are close to the calibrated ones? As discussed right after Proposition 2, the counterforce manifests itself in the event of disagreement (LH or HL so one lender exits, and hence "bids" rather than "winning bids" prevail). But our calibrated precision parameters α's are close to one. This implies highly correlated screening outcomes across banks with rare instances of disagreement, rendering the counteracting force quantitatively negligible.

Calibration with nonzero recovery rate. So far, we have assumed that defaulted loans have no recovery, while in practice they typically have nonzero liquidation value. As mentioned in Section 1.3, Appendix A.4 provides a full characterization of equilibrium with nonzero recovery $\delta \in (0, 1)$ for models with specialized lending as well as that for the canonical settings. We set $\delta = 0.6$ which is approximately the average recovery rate in the Y-14 data (across all types of collateral), and then recalibrate our three parameters in the canonical models; the implied interest rate wedge, though smaller, is still positive.[18]

Two important conceptual points are worth mentioning. First, if δ's are heterogeneous in the data, then borrowers with lower δ's are more likely to be rejected, implying that 0.6 is an overestimate of δ due to selection. Second, for a higher δ, the interest rate wedge is expected to be smaller as the equilibrium rates are lower. However, lower rate levels do not necessarily imply a negative interest rate wedge; at the extreme of $\delta = 1$ the model converges to perfect Bertrand competition, leading to a zero interest rate wedge.

Combining Proposition 2, Figure 4, and the results for the nonzero recovery case, we conclude that canonical models generate counterfactual implications about the interest rate wedge. We show that our model with a specialized signal naturally delivers this result.

[18]For the bad-news (symmetric) signal structure, to match the observed moments, i.e., NPL ratios of 3% and 4% for specialized and nonspecialized lenders, and average approval rate of 0.5, the calibrated parameters are $q = 0.4967$ (0.5006), $\alpha^A = 0.9846$ (0.9843), $\alpha^B = 0.9788$ (0.9790). The resulting interest rate wedge is $\Delta r = 5 \times 10^{-4}$ (4×10^{-5}).

3.3 Our Model: The Private Information–Based Pricing Effect

As illustrated by Figure 2 Panel A, the "private information–based pricing" effect pushes Bank A with a more favorable specialized signal to offer a lower rate, which naturally gives rise to a negative interest rate wedge.

What is more, the early discussion regarding "bids versus winning bids" in Section 3.1 suggests that whether Bank B rejects (quoting $r^B = \infty$) or not plays a role; that is, $\Delta r > 0$ is more likely to occur if B rejects more often (so A enjoys a higher information rent).[19] Hence, the private information–based pricing effect is more likely to prevail in a positive-weak equilibrium in which B never rejects after receiving a high signal. In that equilibrium, B even enjoys some "local monopoly power" as the only lender (when A withdraws after $s < x$) having a point mass at $\overline{r}$. We stress that the endogenous point mass on $\overline{r}$ placed by a weaker lender is a distinct feature of our setting compared to canonical settings à la Broecker (1990), which arises because a bank with greater ex ante technology strength in our model can have a worse ex post loan assessment.[20] As a result, when Bank B never withdraws after receiving $g^B = H$, the better informed Bank A undercuts to win higher-quality borrowers while leaving those lemons to Bank B (who then makes loans with higher winning bids).

Comparative statics on interest rate wedge. Figure 5 plots the comparative statics of Δr with respect to model parameters, with regions of zero-weak and positive-weak equilibria highlighted. Just as in the calibration exercise for canonical models in Section 3.2, we now choose our parameters α, q_g and q_s (given in the caption of Figure 5) to fit three empirical moments (NPL ratios in specialized and nonspecialized lenders, which are 3% and 4% re-

[19]This intuition is consistent with the discussion right after Proposition 2, where we explain an opposite result: Even in canonical models, the monopoly power of Bank B in the event of LH favors a negative interest rate wedge. (But this force is quantitatively small in canonical models under calibrated parameters.)

[20]In canonical models à la Broecker (1990), although the weak bank may earn some positive profits given a high borrower surplus (say, large q and $\overline{r}$), it never has a point mass at $\overline{r}$ to enjoy "local" monopoly power. To see the intuition, note that because in canonical settings information is used to determine participation only, the strong lender never withdraws upon H; and since only one lender can have a point mass at $\overline{r}$ (a result that is similar to Lemma 1 for canonical models), it must be the strong lender that possesses such a point mass.

spectively, and a loan approval rate 50%).[21] Implicitly, we fix $\bar{r} = 36\%$ and $\tau = 1$, but our results are robust to these choices.

As shown in Figure 5 (marked with $*$ in all panels), our model generates a negative interest rate wedge under the calibrated parameters. We intentionally consider a wide parameter range to illustrate the workings of our model when credit market competition transitions between the zero-weak equilibrium and the positive-weak one.

The top two panels A and B concern information technology parameters α (precision of general signals) and τ (precision of the specialized signal). The intuition of Panel B is clear: A higher specialized signal precision τ benefits lender A and the economy is more likely to be in the zero-weak equilibrium. Note that Δr is discontinuous when π^B becomes zero, since Bank B reallocates a probability mass of $1 - F^B(\bar{r}^-) > 0$ from $\bar{r}$ to ∞ (see also Panel B in Figure 3). Interestingly, when the precision of general signals increases (Panel A), it first helps nonspecialized Bank B in that the economy switches from zero-weak to positive-weak; but eventually, when $\alpha \to 1$ so that the general signal is public information, the equilibrium converges to a zero-weak one because Bank B essentially becomes (effectively) uninformed.

Though not highly visible, Δr in Panel B remains negative even in the region of zero-weak equilibria. This is consistent with Proposition A.2 in Appendix A.7, in that we show that we do not need a positive-weak equilibrium to generate a negative interest rate wedge. This result highlights the robustness of our mechanism of private information–based pricing.

Panel C conducts another comparative statics analysis that captures the relative importance of general versus specialized information. More specifically, consider varying $1/q_g$ but fixing the project success probability q, which implies $q_s = q/q_g$. The companion paper by He, Huang, and Parlatore (2024) explains that this comparative statics exercise corresponds to the scenario in which general signals increase their span so that they cover more fundamental states critical to the success of the funded project.[22] Interestingly, this exercise delivers a

[21] We need to adapt the formula for model-implied moments to the model with specialized signal. For instance, since Bank A upon $g^A = H$ will also reject loan applications for sufficiently low signal realizations, the model-implied loan approval rate becomes $\frac{1}{2}\mathbb{P}(g^A = H)(1 - \Phi(x)) + \frac{1}{2}\mathbb{P}(g^B = H)F^B(\bar{r})$.

[22] As explained in Section 1.3 where we introduce multidimensional fundamental states, He, Huang, and

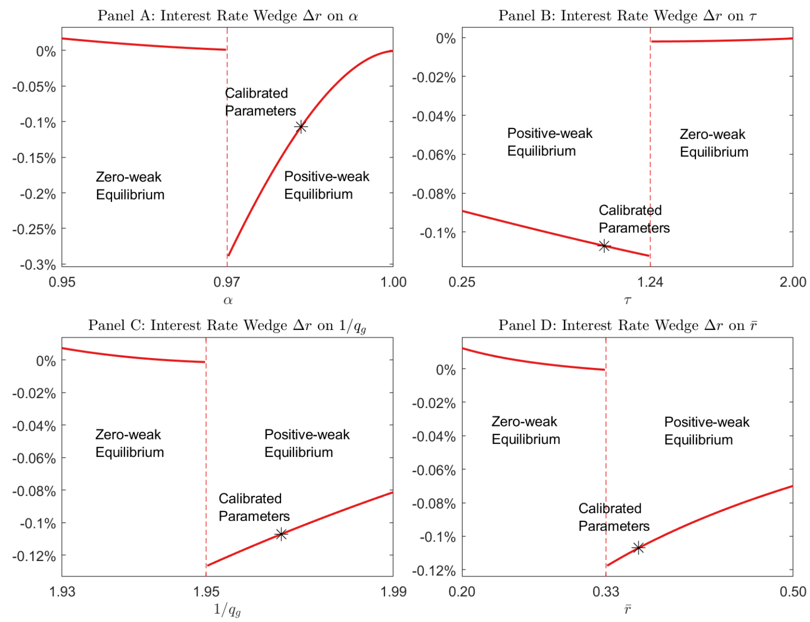

Figure 5: **Interest rate wedge.** Panels A through Panel D depict $\Delta r = \mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right] - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]$ as a function of α, τ, $1/q_g$ and $\bar{r}$. In Panel C, we vary $1/q_g$ but fix the project success probability q, i.e., we set $q_s = q/q_g$. The positive-weak equilibrium arises when τ lies below a certain value and $1/q_g$ and $\bar{r}$ exceed a certain value. Baseline calibrated parameters: $\bar{r} = 0.36$, $q_g = 0.508$, $q_s = 0.990$, $\tau = 1$ and $\alpha_u = \alpha_d = \alpha = 0.986$. Note τ captures the signal-to-noise ratio of Bank A's specialized information technology as $s = \mathbb{E}\left[\theta_s | \theta_s + \epsilon\right]$ and $\epsilon \sim \mathcal{N}(0, 1/\tau)$.

new economic force that is distinct from signal precisions in Panels A and B. Intuitively, now Bank B, equipped with general information technology that covers more fundamental states, becomes relatively stronger (rather than weaker when α and/or τ increase), so the credit market equilibrium is more likely to be in the positive-weak region (and delivers a negative interest rate wedge). Finally, the comparative statics of $\bar{r}$ in Panel D is intuitive: When the total surplus increases, the credit market equilibrium moves from the zero-weak region to the positive-weak region.

As a robustness check, we also calibrate our model with specialized lending for a positive

Parlatore (2024) interpret $\theta_g \equiv \prod_{n=1}^{\hat{N}} \theta_n$ ($\theta_s \equiv \prod_{n=\hat{N}+1}^{N} \theta_n$) as the borrower's "hard" ("soft") fundamental state, and model the expansion of the span of "hard" information by an increase in $\hat{N}$ (so θ_g covers more fundamental states). In the short-run, this expansion of $\hat{N}$ does not alter the span of the soft signal so that θ_g and θ_s overlap (as both have their own $\hat{N}$'s), but in the long-run the coverage of θ_s also shrinks so that θ_g and θ_s do not overlap. Panel C corresponds to the long-run scenario. For the short-run scenario, the expansion of $\hat{N}$ induces a correlation between θ_g and θ_s, which makes the analysis a bit involved but still tractable. For more details, see He, Huang, and Parlatore (2024).

recovery $\delta = 0.6$ (for a full characterization of equilibrium, see Appendix A.4). The newly calibrated parameters are $\alpha = 0.9870$, $q_g = 0.5012$, $q_s = 0.9897$, and consistent with the main prediction of our paper, the resulting interest rate wedge is negative (-1×10^{-4}).

3.4 Lower Rates and Better Performance: Empirical Evidence

The two main testable predictions of our model relate to differences in loan pricing and performance between specialized and nonspecialized banks. We have provided supporting evidence for these predictions, based on raw differences, in Figure 1. In this section, we conduct a more rigorous empirical analysis of these two testable hypotheses.

Our empirical study uses the supervisory data collected by the Federal Reserve System (Y14Q-H.1) which covers all C&I loans (over one million USD) to which a stress-tested bank has committed between 2012 and 2023. In Appendix B, we provide more details on the data, variable construction, and regression specifications.

Throughout we consider both two-digit and four-digit NAICS codes for industry specifications. In our model a bank is either specialized in an industry or not, while in the data bank specialization can take a continuum of values as measured by "excess specialization" in Blickle, Parlatore, and Saunders (2024). To incorporate their measure into our framework, we identify whether a bank specializes in a particular industry by assigning a binary specialization flag. This flag is set to 1 if "excess specialization" for bank b in industry s, defined in Blickle, Parlatore, and Saunders (2024), exceeds a certain threshold. For instance, when working with industries defined using two-digit NAICS codes, we set the threshold to be 4%, so a bank b is specialized in industry s if it invests 4% more of its C&I lending relative to the overall share of industry s in all C&I lending, i.e.,

$$\frac{LoanAmount_{b,s,t}}{\sum_s LoanAmount_{b,s,t}} - \frac{LoanAmount_{s,t}}{\sum_s LoanAmount_{s,t}} \geq 4\%.$$

Under this threshold, the average bank specializes in 2.8 industries; the average overinvestment is 8.9% for specialized banks, while only 0.2% for nonspecialized ones. Our results are

Table 1: **Interest Rate and Loan Performance**

Panel A: Specialization defined at the 2-Digit NAICS Level

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Nonperforming Loans	
Specialized Bank	-0.076***	-0.150***	-0.082***	-0.008***	-0.005***	-0.005***
	[0.006]	[0.007]	[0.007]	[0.001]	[0.001]	[0.001]
Log Loan Amount	-0.156***	-0.170***	-0.178***	-0.000	-0.000*	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.044	0.047
N	353,544	353,537	351,776	353,544	353,537	351,776

Panel B: Specialization defined at the 4-Digit NAICS Level

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Nonperforming Loans	
Specialized Bank	-0.090***	-0.249***	-0.188***	-0.012***	-0.006***	-0.007***
	[0.008]	[0.008]	[0.009]	[0.001]	[0.001]	[0.001]
Log Loan Amount	-0.156***	-0.169***	-0.178***	-0.000	-0.000*	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.38	0.4	0.03	0.044	0.048
N	353,544	353,537	351,776	353,544	353,537	351,776

Note: In Columns (1)–(3), we regress the loan rate paid by a firm on the fixed effects specified at the bottom of the table and a dummy denoting whether the firm is borrowing from a bank that is specialized in the industry in which said firm operates. In Columns (4)–(6), we use the same specifications as in previous columns, but use whether the loan in question ever becomes nonperforming at any date it is in our sample after its origination. A loan becomes nonperforming if it is ever in arrears, has not been paid down at maturity, or defaults outright. In Panel A, we define specialization using two-digit NAICS industries. We define a bank as specialized if it is overinvested by 4% or more in an industry, relative to what would be expected from diversification. In Panel B, we define specialization at the four-digit NAICS level. We define a bank as specialized if it is overinvested by 1% or more in an industry, relative to what would be expected from diversification. Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

robust to using 3% or 5% as a threshold (not reported for brevity).

Baseline results. We consider the following specification that relates our variable of interest y_{libst}, either the loan rate or performance, for a bank b's loan l to borrower i in industry s in quarter-year t, to a dummy $Specialized_{bst}$ that denotes whether bank b in question is specialized in industry s at time t:

$$y_{libst} = \beta_0 + \beta_1 \cdot Specialized_{bst} + \beta_2 \cdot Size_{lt} + \xi_{bt} + \sigma_{st} + \phi_{lt}^{\text{rating-category}} + \omega_{lt}^{\text{loan-purpose}} + \epsilon_{libst}. \quad (27)$$

The inclusion of controls and fixed effects in (27) deserves further discussion. First, loans are of fixed size and have the same purpose in our model; hence, we control for the loan's size and purpose to ensure that these characteristics do not drive our findings. Second, although firm-fixed effects are typically used in the literature to control for borrower-specific factors, it is inappropriate to include them in our setting. This is because whether firms sort into specialized and nonspecialized banks is a key feature of the mechanism that our model highlights; ideally, we should saturate our regression with as many observable borrower characteristics as possible, such as leverage and EBIT/Assets. However, as more than 50% of the firms in our sample are private firms, we do not have financial data for many of them.

To address this issue, in our regression (27) we include the time-varying rating category dummy of each loan based on the bank's internal risk rating to absorb borrower-specific time-varying factors. But extra care must be taken. Our model is conditional on firm characteristics that are *observable* to both lenders; however, banks' internal loan risk ratings potentially reflect private information (though the extent of private information is limited, as it must be defensible to Federal Reserve examiners). We mitigate this issue by classifying the loans as *high-risk*, *mid-risk*, and *safe* based on their internal rating. As shown in Appendix Table B.3 Panel B, for a subsample of firms for which we do have balance sheet characteristics (e.g., leverage and EBIT/Assets), the three internal risk categories indeed correspond to generally accepted metrics of firm riskiness. In sum, by categorizing these risks into broad buckets, we take advantage of the information they convey on borrower quality while curbing the unique bank-specific knowledge about borrowers reflected by them.

Consecutively introducing bank-year and industry-year fixed effects, columns (1)–(3) of Panel A in Table 1 show a negative relation between banks being specialized and loan rates in their industry of specialization. This is the empirical counterpart to the negative interest rate wedge we studied above in this section. In terms of magnitude, the identified negative wedge (8∼15 bps) is smaller than the raw difference of about 40 bps shown in Figure 1, presumably due to better controls in our richer specification in (27). Interestingly, the magnitude identified in Table 1 matches squarely with the predicted interest rate wedge under calibrated parameters shown in Figure 5 (about 10 bps). Finally, there is a significantly negative correlation between specialization and nonperformance reported in columns (4)–(6) in Table 1.[23] In our model, specialization is driven by the banks' informational advantage, and loans granted by specialized lenders are of higher quality and therefore less likely to turn nonperforming later.

So far, we have defined an industry using two-digit NAICS codes, which yields 23 distinct industries. Turning to four-digit NAICS codes, we have a far greater degree of granularity with 310 industries, and specialization at the four-digit level is much narrower. Accordingly, we define a bank as specialized if it is 1% overinvested relative to what would be assumed under full diversification. To put this threshold into perspective, it is equivalent to having levels of overinvestment equivalent to being in the top 20% of overinvestment by Y-14 lenders at any given time in any industry. Panel B of Table 1 confirms that all model predictions continue to hold in four-digit NAICS codes. The effects are somewhat larger at the four-digit level compared to those at the two-digit level, perhaps because of stronger specialization with narrower industry specifications.

Robustness tests. In Appendix B we offer a battery of robustness tests to confirm that our results hold under various specifications. First, Appendix B.3 considers alternative bor-

[23]Nonperforming loans are those that fall into arrears, are not paid down by the end of their maturity, default or require renegotiation due to covenant violation issues.

rower risk measures. Panel A of Table B.3 demonstrates that our findings hold when using dummies for a bank's detailed 1–10 risk assessment instead of three broad categories. Panel B shows that our results are robust to controlling for risk measures based on observable firm characteristics, such as EBIT/Assets and leverage, using data from a subset of firms (approximately half) that report these metrics in the Y-14 dataset. Second, Appendix Table B.4 shows that our coefficients remain qualitatively unchanged after removing the COVID-19 period (2020–2021).

Multiple specialized lenders in an industry. For simplicity, our model considers only one specialized lender (and another nonspecialized lender). However, this assumption excludes an empirically relevant mechanism in which *multiple* specialized banks in the same industry compete for the same borrower. To ensure that our results are not driven by potential competition among multiple specialized banks, Table 2 expands Table 1 with an additional control for a bank operating in an industry with multiple specialized lenders. We define the loan market as having multiple specialized lenders as a dummy that takes the value of one if two or more banks specialize in a given industry and add this dummy "Multiple Specialized Lenders" and its interaction with "Specialized Bank" to our baseline regression. Under this alternative mechanism, the specialized lender charges lower rates only because it faces fiercer competition from other specialized lenders, and therefore, the significantly negative effect on "Specialized Bank" in Table 1 would be fully absorbed by the interaction term in Table 2.

Panel A of Table 2 reports the results at the two-digit NAICS level. In columns (1)–(3) of Table 2 we still observe a negative coefficient on "Specialized Bank," consistent with our model predictions. We also observe a negative coefficient for the dummy "Multiple Specialized Lenders," potentially because industries with more specialized lenders have better quality borrowers.[24] But the coefficients of the interaction term are either positive or insignificant across all three specifications (Columns (1)-(3)), inconsistent with the alternative mechanism of competition among specialized lenders. This result establishes that the bank's

[24] This hypothesis is further supported by the negative coefficients for "Multiple Specialized Lenders," in columns (4)–(6), where the dependent variable is nonperforming dummy.

Table 2: **Interest Rate and Loan Performance: Controlling for Lending Market Competition among Specialized Banks**

Panel A: Specialization defined at the 2-Digit NAICS Level

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rates			Nonperforming Loans	
Specialized Bank	-0.454***	-0.179***	-0.112***	-0.019***	-0.007	-0.007
	[0.037]	[0.036]	[0.038]	[0.005]	[0.005]	[0.005]
Log Loan Amount	-0.157***	-0.171*	-0.178**	-0.000	-0.001*	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Multiple Specialized Lenders	-0.149***	-0.125***		-0.012***	-0.011***	
	[0.008]	[0.007]		[0.001]	[0.001]	
Spec. Bank × Multiple Specialized Lenders	0.407***	0.047	0.032	0.012**	0.004	0.002
	[0.037]	[0.037]	[0.039]	[0.005]	[0.005]	[0.005]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.044	0.047
N	353,544	353,537	351,776	353,544	353,537	351,776

Panel B: Specialization defined at the 4-Digit NAICS Level

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rates			Nonperforming Loans	
Specialized Bank	0.141***	-0.214***	-0.195***	-0.028***	-0.012***	-0.019***
	[0.020]	[0.019]	[0.020]	[0.002]	[0.003]	[0.003]
Log Loan Amount	-0.154***	-0.168***	-0.175***	-0.000	-0.000*	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Multiple Specialized Lenders	-0.327***	-0.253***		0.003***	0.002*	
	[0.006]	[0.006]		[0.001]	[0.001]	
Spec. Bank × Multiple Specialized Lenders	-0.041*	0.150***	0.144***	0.017***	0.006**	0.014***
	[0.022]	[0.021]	[0.022]	[0.003]	[0.003]	[0.003]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.045	0.048
N	353,544	353,537	351,776	353,544	353,537	351,776

Note: In Columns (1)–(3), we regress the loan rate paid by a given firm on the fixed effects specified at the bottom of the table and a dummy denoting whether said firm is borrowing from a bank that is specialized in the industry where the firm operates. We interact our variable of interest with a dummy that takes the value of 1 if the industry in question is one where more than one specialized lender operates. In Columns (4)–(6), we use the same specifications as in previous columns, but with a "nonperforming" indicator as the dependent variable. A loan becomes nonperforming if it is ever in arrears, has not been paid down at maturity, or defaults outright. In Panel A, we define specialization using two-digit NAICS industries. We define a bank as specialized if it is overinvested by 4% or more in an industry, relative to what would be expected from diversification. In Panel B, we define specialization at the four-digit NAICS level. We define a bank as specialized if it is overinvested by 1% or more in an industry, relative to what would be expected from diversification. Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

specialization—as opposed to competition among specialized lenders—is the driving force behind how the specialized bank sets its rates.

In Panel B, we use the same specifications as in Panel A, but we define industry specialization at the four-digit NAICS-code level. Although the number of specialized lenders in four-digit industries is somewhat less stable (i.e., the degree of specialization can vary a little more from one quarter to another, as discussed in B), the coefficients on our interaction terms are still significantly positive (except Column (1) without any fixed effects, which is negative at 10% level), supporting the mechanism proposed by our model.

Finally, recall that we have defined "Multiple Specialized Lenders" as a dummy that captures an industry with more than one specialized lender. As explained in Appendix B.5, our results are robust to using the exact number of specialized lenders in an industry as an alternative definition of "Multiple Specialized Lenders" (Table B.6).

Empirical results using SNC data and Dealscan data. For our last effort to show the robustness of our empirical findings, we confirm that the interest rate wedge is negative even outside the Y-14 data. Collected by the Federal Reserve, the OCC, and the FDIC, SNC (Syndicated National Credit Registry) data contain information on syndicated loans that are valued over 20 million USD and held by two or more U.S. banks. Compared to the 40 stress-tested banks represented in the Y-14 data, the SNC data cover 218 lenders that originate at least one syndicated loan in the U.S. between 1993 and 2018.[25] Hence, one can use it to test whether our predictions hold for a sample that includes smaller lenders.

Unfortunately, the SNC data have several serious limitations (which we discuss in detail in Appendix B.6). One key limitation, which is crucial to our study, is that the SNC data do not contain information on loan interest rates. To overcome these issues, we follow the steps detailed in Appendix B.6 to merge SNC data with Dealscan following a methodology first laid out in Cohen, Friedrichs, Gupta, Hayes, Lee, Marsh, Mislang, Shaton, and Sicilian (2018).

[25] In 2018 the thresholds of "20 million USD and being held by two or more U.S. banks" were raised to "100 million USD and three supervised U.S. banks." We cut our data in 2018 to avoid sample construction issues. Our results are unaffected if we keep years after 2018.

The merged sample does not represent the universe of loans, and these SNC tests serve as indicative additions to our main analyses. Nevertheless, Appendix Table B.7 confirms our key theoretical predictions: the specialization of the lead arranging bank in a syndicated loan is related to lower rates and better ex post loan performance.

4 Extensions

This section provides two important model extensions. We first endogenize the bank specialization structure that we have assumed so far—that is, Bank A has both general and specialized signals while Bank B has only a general signal. We then show that our theoretical results are robust to a generalized information structure.

4.1 Information Acquisition and Endogenous Specialization

By studying the lender's information acquisition problem, we derive conditions under which the baseline model's information structure is an equilibrium outcome.

Setting and information acquisition technologies. We extend the baseline model by introducing another borrower firm, b, alongside the original borrower, a. Two technologies, "general" and "specialized," generate signals. The "general" information technology costs $\kappa_g > 0$ and allows a lender j to process standardized data (e.g., credit reports, income statements) to produce private independent general signals $g_i^j \in \{H, L\}$ on the general fundamental θ_g for each firm $i \in \{a, b\}$. This reflects general information collected via standardized and transferable data, such as credit reports and income statements; so once the IT equipment, software, and APIs are installed, credit analysis is easy to implement in multiple firms. The "specialized" information technology requires a lender to collect firm-specific data individually. Lender j specializes in firm i by investing $\kappa_s > 0$ to obtain a private specialized signal s_i^j, distributed according to the CDF $\Phi(s)$ and the PDF $\phi(s)$ for $s \in [0, 1]$. Acquiring specialized information on both firms, incurs a cost $2\kappa_s$.

We are interested in the equilibrium in which Bank A only specializes in firm a, Bank B only specializes in firm b and both lenders acquire the general information technology. Note that the baseline model analyzed in Section 2 is the subgame for either firm following the equilibrium information acquisition strategies.

Incentive compatibility conditions. Banks simultaneously choose their information acquisition, which we assume is observable when entering the credit market competition game. Since a lender's deviation from the proposed equilibrium information acquisition will lead to a different information structure in the credit market competition, we need to derive equilibrium lending profits in all possible subgames following a deviation.

Bank A can deviate in three ways: i) it can choose not to acquire the general signal, ii) it can choose not to acquire the specialized signal about firm a, or iii) it can choose to acquire a specialized signal about firm b. Bank A's incentive to deviate in any of these directions depends on the information acquisition cost. The lower the cost of acquiring the general signal (κ_g), the greater incentives Bank A has to acquire the general signal and not deviate in direction i). For deviations along the direction of the specialized signal, the cost of acquiring the specialized signal (κ_s) has to be low enough to make it worth acquiring the specialized signal for firm a (thereby having an informational advantage over Bank B in this firm), but high enough so that it is not worth acquiring a specialized signal for firm b to stop being the least informed lender. This intuition is formally stated in Appendix A.8, where we also characterize the deviation payoffs.

An equilibrium with lending specialization emerges as long as κ_g is sufficiently low so that both lenders want to acquire general signals, and κ_s lies in some intermediate range so that the benefits of acquiring a specialized signal to become the more informed lender (e.g., getting s_a^A for Bank A, which is part of the equilibrium strategy in the baseline) are greater than the benefits of acquiring a specialized signal to stop being the less informed lender (e.g., getting s_b^A for Bank A, which deviates from our equilibrium in the baseline). These requirements are confirmed in Appendix Figure A.1, which shows the range of information acquisition costs κ_g

and κ_s for our conjectured credit market competition equilibrium with a specialized lender.

4.2 General Information Structure

Our modeling has two features that drive the tractability of our model—that is, under these two weaker assumptions, the solution technique in Section 2 can be readily applied. We discuss these two assumptions below, while relegating the detailed characterization of the model with a general information structure to Appendix A.9.

Decisive general signal. Assumption 1 is motivated by the observation that in many practical scenarios, the decisive general signal is used as a prescreening signal for loan approval, while the specialized signal collected by the specialized bank tailors interest rate terms (see Section 1.3). The multiplicative setting that we adopt in (2), where the "general" state is crucial for project success, makes such lending strategies more likely to arise in equilibrium, although, in principle, a signal can be decisive without the multiplicative structure.

Independence conditional on project success. In our model, conditional on project success, all signals—including the specialized one of lender A and the two general ones of both lenders—are independent of each other. Formally,

$$\tilde{g}^A \perp\!\!\!\perp \tilde{g}^B \perp\!\!\!\perp \tilde{s} \mid \theta = 1 \; . \tag{28}$$

Because lenders only get paid from the good-type borrower, the effects of specialized and general signals on equilibrium strategies are separable if signals are independent conditional on project success. Satisfying (28), our setting in Section 1.3 in which general and specialized states are independent imposes a stronger notion of independence than needed, which is (28). Consider the following example studied by He, Huang, and Parlatore (2024) with $\theta = \theta_1\theta_2\theta_3$, $\theta_g = \theta_1\theta_2$, and $\theta_s = \theta_2\theta_3$. This information structure generalizes (7) in Section 1.3 while satisfying (28);[26] we provide a closed-form characterization of the equilibrium in Appendix

[26] When $\theta = 1$, $\{\theta_n\}$ for $n \in \{1, ..., N\}$ take the value of one. Unconditionally, however, the pair-wise correlations of $\{g^A, g^B, s\}$ are all positive, because the general and specialized states, θ_g and θ_s, are correlated.

A.9 under this weaker assumption. Since our general information structure allows the general and specialized signals to be correlated, it can be used to study credit market applications such as data sharing and credit registries that induce correlated lender signals.

5 Concluding Remarks

This paper extends the classic credit market competition framework (à la Broecker, 1990) to explore the interplay between multidimensional information and equilibrium loan pricing. We focus on how these informational asymmetries shape the equilibrium strategies of specialized and nonspecialized lenders, thereby shedding light on the nuanced role of information in credit market outcomes. Beyond our theoretical analysis, we empirically explore the relationship between bank specialization and realized rates for large, stress-tested U.S. banks and link it to our theoretical findings.

We show that specialized lending can explain the robust empirical pattern of a negative interest rate wedge. In a companion paper with a similar credit market competition setting, He, Huang, and Parlatore (2024) distinguish between the quality (signal precision) and breadth (information span) of information, a distinction that is crucial to understanding the changing landscape in the credit market due to technological advances related to data gathering and processing that lead to the hardening of soft information.

From a modeling perspective, including a continuously distributed signal in a credit market equilibrium enables us to examine private information–based pricing, an important and pertinent aspect in the banking sector. Furthermore, by incorporating both specialized and general signals—which potentially reflect many more underlying states—among asymmetric lenders, our paper markedly advances the common-value auction literature involving such asymmetrically informed lenders in which each lender possesses private information (in contrast to Milgrom and Weber (1982) where one bidder knows strictly more than the other). We fully characterize the equilibrium in closed form and anticipate broader applications based on our framework and solution methodology.

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A Technical Appendices

A.1 Credit Competition Equilibrium

Proof of Lemma 1

Proof. Note that the property of no gaps implies common support $[\underline{r}, \overline{r}]$. This is because, if a bank's interest rate offering has a larger lower bound or a smaller upper bound interest rate than its competitor's, this is one example of gaps in the first bank's support.

To show that the distributions have no gap, suppose that, say, the support of Bank B's interest rate offering F^B has a gap $(r_1, r_2) \subset [\underline{r}, \overline{r}]$.Then F^A should have no weight in this interval either, as any $r^A(s) \in (r_1, r_2)$ will lead to the same demand for Bank A and so a higher r will be more profitable. It follows that at least one lender, whose competitor's interest rate offering does not have a mass point at r_1 (it is impossible that both distributions have a mass point at r_1), has a profitable deviation by revising r_1 to $r \in (r_1, r_2)$. Contradiction.

Regarding point mass, suppose that one distribution, say F^B has a mass point at $\tilde{r} \in [\underline{r}, \overline{r})$. Then Bank A would not quote any $r^A(s) \in [\tilde{r}, \tilde{r}+\epsilon]$ and it would strictly prefer quoting $r^A = \tilde{r} - \epsilon$ instead. In other words, the support of F^A must have a gap in the interval $[\tilde{r}, \tilde{r}+\epsilon]$. This contradicts the property of no gaps which we have shown. Finally, it is impossible that both distributions have a mass point at $\overline{r}$.

□

Proof of Lemma 2 We explicitly define s^A_{be} and s^B_{be} below. Bank A that receives s^A_{be} breaks even when quoting $\overline{r}$,

$$0 = \pi^A \left(\overline{r} \middle| s^{be}_A, \hat{s} = s^{be}_A\right) = p_{HH} \frac{\int_0^{s^{be}_A} t\phi(t)\, dt}{q_s} \cdot \left[\mu_{HH} s^{be}_A (1+\overline{r}) - 1\right] + p_{HL}\left[\mu_{HL} s^{be}_A (1+\overline{r}) - 1\right]. \quad (29)$$

Similarly Bank B quotes $\overline{r}$ and breaks even under define s^{be}_B:

$$0 = \pi^B \left(r = \overline{r}; s = s^{be}_B\right) = p_{HH}\left[\mu_{HH}\left(\int_0^{s^{be}_B} t\phi(t)dt\right)(1+\overline{r}) - \Phi\left(s^{be}_B\right)\right] + p_{LH}\left[\mu_{LH} q_s (1+\overline{r}) - 1\right]. \quad (30)$$

Before we delve into the details of proof we first explain its logic. Note that s^{be}_B is the highest specialized signal under which Bank A's offer hits $\overline{r}$, given $\pi^B = 0$. Moreover, recall that s^{be}_A is the level of the specialized signal under which Bank A just breaks even when quoting $\overline{r}$. If $s^{be}_B < s^{be}_A$, then we know s hits s^{be}_A (i.e., Bank A hits zero profit) first when s goes down from the top, implying that Bank A will lose money upon $s = s^{be}_B < s^{be}_A$ and $\hat{s} = s^{be}_B$ must be off-equilibrium for Bank A. Therefore in equilibrium $\pi^B > 0$ and Bank A withdraws itself upon $s < x = \hat{s} = s^{be}_A$. If on the other hand $s^{be}_B \geq s^{be}_A$, we are in the alternative scenario where $\hat{s} = s^{be}_B$ and $\pi^B = 0$; Bank A who is making a positive profit at s^{be}_B will keep quoting $\overline{r}$ for $s < s^{be}_B$, until $s < x$ upon which it exits.

Proof. First, we argue that equilibrium $\hat{s} \equiv \arg\sup_s \left\{s : r^A(s) \geq \overline{r}\right\}$ either equals s^{be}_A or s^{be}_B. To see this, if $\pi^B = 0$, we have $\hat{s} = s^{be}_B$ by construction. If $\pi^B > 0$, $F^B(r)$ has a point mass at $\overline{r}$ because Bank B always makes an offer upon H, i.e., $F^B(\overline{r}) = 1$, and $F^B(\overline{r}^-) = 1 - \frac{\int_0^{s^A(r)=\hat{s}} t\phi(t)dt}{q_s} < 1$ ($\hat{s} > 0$ because Bank A must reject the borrower when $s \to 0$). It follows that $F^A(r)$ is open at $\overline{r}$, so $\hat{s} = x$ and $\pi^A\left(r^A(\hat{s})\,|\hat{s}\right) = 0$, which is exactly the definition of s^{be}_A. In addition, Eq. (29) gives a unique solution of s^{be}_A inside $(0,1)$, because $\pi^A\left(\overline{r}\middle|s^{be}_A\right)$ is strictly increasing in s^{be}_A, with $\pi^A\left(\overline{r}\middle|s^{be}_A = 0\right) < 0$ and $\pi^A\left(\overline{r}\middle|s^{be}_A = 1\right) = p_{HH}\left[\mu_{HH}(1+\overline{r}) - 1\right] + p_{HL}\left[\mu_{HL}(1+\overline{r}) - 1\right] > 0$—the latter is implied by Bank A's willingness to make an offer given $g^A = H$. Therefore, $\hat{s} = s^{be}_A$ when $\pi^B > 0$.

We check the property of Eq. (30) and its solution s^{be}_B. Let $\hat{\pi}^B(s^{be}_B) \equiv \pi^B\left(\overline{r}\middle|s = s^{be}_B\right)$ and we have

$$\hat{\pi}^{B\prime}\left(s^{be}_B\right) = p_{HH}\left[\mu_{HH} s^{be}_B (1+\overline{r}) - 1\right]\phi\left(s^{be}_B\right),$$

so $\pi^B\left(\overline{r}\middle|s = s^{be}_B\right)$ is strictly decreasing in s^{be}_B when $s^{be}_B \in [0, \frac{1}{\mu_{HH}(1+\overline{r})})$ and strictly increasing in s^{be}_B when $s^{be}_B \in [\frac{1}{\mu_{HH}(1+\overline{r})}, 1]$. At the endpoints $s^{be}_B = 0$ and 1, $\pi^B\left(\overline{r}\middle|s^{be}_B = 1\right) = p_{\cdot H}\left[\mu_{\cdot H} q_s (1+\overline{r}) - 1\right] > 0$ according to Assumption 1, but the sign of $\pi^B\left(\overline{r}\middle|s^{be}_B = 0\right) = p_{LH}[\mu_{LH} q_s (1+\overline{r}) - 1]$ is ambiguous.

When $\pi^B\left(\bar{r}\left|s_B^{be}=0\right.\right)<0$, there is at most one solution s_B^{be} inside $(0,1)$. On the other hand, when $\pi^B\left(\bar{r}\left|s_B^{be}=0\right.\right)>0$, there are at most two solutions of s_B^{be} inside $(0,1)$, s_{B1}^{be} and s_{B2}^{be}, with $\mu_{HH}s_{B1}^{be}(1+\bar{r})-1<0$ and $\mu_{HH}s_{B2}^{be}(1+\bar{r})-1>0$. We argue that only the larger solution s_{B2}^{be} is a candidate for equilibrium $\hat{s}$. To see this, we first show that $s_A^{be}>s_{B1}^{be}$: otherwise, if $s_A^{be}<s_{B1}^{be}$, then

$$\mu_{HL}s_A^{be}(1+\bar{r})-1\underbrace{<}_{\mu_{HL}<\mu_{HH}}\mu_{HH}s_A^{be}(1+\bar{r})-1\underbrace{<}_{s_A^{be}<s_{B1}^{be}}\mu_{HH}s_{B1}^{be}(1+\bar{r})-1<0,$$

which leads to the contradictory implication that $\pi^A\left(\bar{r}\left|s_A^{be}\right.\right)=p_{HH}\frac{\int_0^{s_A^{be}}t\phi(t)dt}{q_s}\cdot\left[\mu_{HH}s_A^{be}(1+\bar{r})-1\right]+p_{HL}\left[\mu_{HL}s_A^{be}(1+\bar{r})-1\right]<0$ (by construction $\pi^A\left(\bar{r}\left|s_A^{be}\right.\right)=0$.) Hence, $s_A^{be}>s_{B1}^{be}$. Then if equilibrium $\hat{s}=s_{B1}^{be}$, Bank A makes negative profits upon $\hat{s}=s_{B1}^{be}$, because $\pi^A(\bar{r}\,|s)$ decreases in s and $\pi^A\left(r^A(\hat{s})=\bar{r}\left|\hat{s}=s_{B1}^{be}\right.\right)<\pi^A\left(\bar{r}\left|s=s_A^{be}\right.\right)=0$. Therefore, in the case of $\pi^B\left(\bar{r}\left|s_B^{be}=0\right.\right)>0$ and there are at most two solutions of s_B^{be} inside $(0,1)$, only the larger one is relevant. For the following analysis, we restrict s_B^{be} to be this largest solution $s_B^{be}\equiv\sup\{s_B^{be}\in(0,1)|\pi^B\left(\bar{r}\left|s_B^{be}\right.\right)=0\}$. If there is no solution of s_B^{be}, we define $s_B^{be}=0$ and the lemma implies that equilibrium $\hat{s}=s_A^{be}$.

Now we show that equilibrium $\hat{s}=\max\{s_A^{be},s_B^{be}\}$ and the comparison between s_A^{be} and s_B^{be} determines whether the equilibrium is positive-weak or zero-weak. To see this, in the first case of $s_B^{be}<s_A^{be}$, suppose $\hat{s}=s_B^{be}$. Then Bank A's equilibrium profit upon $\hat{s}$, $\pi^A\left(r^A(\hat{s})=\bar{r}\left|\hat{s}=s_B^{be}\right.\right)$, is negative because $\pi^A(\bar{r}\,|s)$ increases in s and $\pi^A\left(r^A(\hat{s})=\bar{r}\left|s=\hat{s}=s_B^{be}\right.\right)<\pi^A\left(\bar{r}\left|s=s_A^{be}\right.\right)=0$; this is a contradiction. Hence, when $s_B^{be}<s_A^{be}$, $\hat{s}=s_A^{be}$. Because $\pi^B(r=\bar{r};s)=0$ is strictly increasing in $s\in(s_B^{be},1)$ as discussed above, Bank B's equilibrium profit $\pi^B\left(r=\bar{r};s=\hat{s}=s_A^{be}\right)>\pi^B\left(r=\bar{r};s=s_B^{be}\right)=0$, i.e., the equilibrium is positive weak.

In the other case of $s_A^{be}<s_B^{be}$, suppose $\hat{s}=s_A^{be}$ and then Bank B's equilibrium profit (at $\bar{r}$) is $\pi^B\left(r=\bar{r};s=\hat{s}=s_A^{be}\right)$. From the discussion about Eq. (30) above, when Eq. (30) has one solution in $(0,1)$, $\pi^B(r=\bar{r};s)$ is negative for $s\in(0,s_B^{be})$, which applies to $s_A^{be}<s_B^{be}$; when Eq. (30) has two solutions in $(0,1)$, $\pi^B(r=\bar{r};s)$ is negative for $s\in(s_{B1}^{be},s_{B2}^{be})$, which applies to $s_{B1}^{be}<s_A^{be}<s_{B2}^{be}$. (Recall we took $s_B^{be}=s_{B2}^{be}$.) Hence, Bank B's equilibrium profit $\pi^B\left(r=\bar{r};s=\hat{s}=s_A^{be}\right)<0$, which is a contradiction. Therefore, when $s_A^{be}<s_B^{be}$, $\hat{s}=s_B^{be}$ and the equilibrium is zero-weak by construction. In addition,

$$\begin{aligned}0=&\frac{p_{HH}\int_0^{s_A^{be}}t\phi(t)\,dt}{q_s}\left[\mu_{HH}s_A^{be}(1+\bar{r})-1\right]+p_{HL}\left[\mu_{HL}s_A^{be}(1+\bar{r})-1\right]\\=&\frac{p_{HH}\int_0^{s_B^{be}}t\phi(t)\,dt}{q_s}\left[\mu_{HH}x(1+\bar{r})-1\right]+p_{HL}\left[\mu_{HL}x(1+\bar{r})-1\right]\\>&\frac{p_{HH}\int_0^{s_A^{be}}t\phi(t)\,dt}{q_s}\left[\mu_{HH}x(1+\bar{r})-1\right]+p_{HL}\left[\mu_{HL}x(1+\bar{r})-1\right].\end{aligned}$$

The first equality is the definition of s_A^{be}, $\pi^A\left(\bar{r}\left|s_A^{be}\right.\right)=0$, the second equality is Bank A's equilibrium break-even condition $\pi^A(\bar{r}|x)=0$ where winning probability in competition is $1-F^B(\bar{r}^-)=\frac{\int_0^{\hat{s}}t\phi(t)dt}{q_s}=\frac{\int_0^{s_B^{be}}t\phi(t)dt}{q_s}$, and the last inequality uses $s_B^{be}>s_A^{be}$ in this case. This means $x<s_A^{be}(<s_B^{be}=\hat{s})$, and the distribution of Bank A's quote has a point mass at $\bar{r}$.

$\square$

A.2 Proof of Proposition 1

Proof. Since the derivations of equilibrium strategies are largely included in the main text, we provide only the missing details toward the end of this proof. This part proves that Bank A's equilibrium interest rate quoting strategy as a function of specialized signal $r^A(s)$ is always decreasing; this implies that the FOC that helps us derive Bank A's strategy also ensures the global optimality.

Write Bank A's value $\Pi^A(r,s)$ as a function of its interest rate quote and specialized signal, in the event of $g^A = H$ and s. (We use π to denote the equilibrium profit but Π for any strategy.) Recall that Bank A solves the following problem:

$$\max_r \Pi^A(r,s) = \underbrace{p_{HH}}_{g^A=H,g^B=H} \underbrace{\left[1-F^B(r)\right]}_{A \text{ wins}} \left[\mu_{HH}s(1+r)-1\right] + \underbrace{p_{HL}}_{g^A=H,g^B=L} \left[\mu_{HL}s(1+r)-1\right] \quad (31)$$

with the following FOC:

$$0 = \underbrace{p_{HH}\left[-\frac{dF^B(r)}{dr}\right]}_{\text{lost customer}} \left[\underbrace{\mu_{HH}s(1+r)-1}_{\text{customer return}}\right] + \underbrace{p_{HH}\left[1-F^B(r)\right]}_{\text{customer}} \underbrace{\mu_{HH}s}_{\text{MB of customer}} + p_{HL}\mu_{HL}s. \quad (32)$$

One useful observation is that on the support, it must hold that $\mu_{HH}s(1+r)-1>0$; otherwise, $\mu_{HL}s(1+r)-1<\mu_{HH}s(1+r)-1\le 0$, implying that Bank A's profit is negative (so it will exit).

Lemma A.1. *Consider s_1, s_2 in the interior domain with corresponding interest rate quote r_1 and r_2. The marginal value of quoting r_2 for type $s=s_1$ is*

$$\Pi_r^A(r_2,s_1) = \frac{s_2-s_1}{\mu_{HH}s_2(1+r_2)-1}\left\{p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}+p_{HL}\mu_{HL}\right\}$$

and its sign depends on the sign of s_2-s_1.

Proof. Evaluating the FOC (32) of type s_1 but quoting r_2:

$$\Pi_r^A(r_2,s_1) = p_{HH}\left[-\frac{dF^B(r_2)}{dr}\right]\left[\mu_{HH}s_1(1+r_2)-1\right] + p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}s_1 + p_{HL}\mu_{HL}s_1. \quad (33)$$

FOC at type s_2 yields

$$\Pi_r^A(r_2,s_2) = p_{HH}\left[-\frac{dF^B(r_2)}{dr}\right]\left[\mu_{HH}s_2(1+r_2)-1\right] + p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}s_2 + p_{HL}\mu_{HL}s_2 = 0,$$

or

$$\frac{dF^B(r_2)}{dr} = \frac{p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}s_2 + p_{HL}\mu_{HL}s_2}{p_{HH}\left[\mu_{HH}s_2(1+r_2)-1\right]}. \quad (34)$$

Plugging in this term to (33), $\Pi_r^A(r_2, s_1)$ becomes

$$
\begin{aligned}
&-\frac{\mu_{HH}s_1(1+r_2)-1}{\mu_{HH}s_2(1+r_2)-1}\left\{p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}s_2+p_{HL}\mu_{HL}s_2\right\}+p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}s_1+p_{HL}\mu_{HL}s_1\\
&=\left[s_1-\frac{\mu_{HH}s_1(1+r_2)-1}{\mu_{HH}s_2(1+r_2)-1}\cdot s_2\right]\left\{p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}+p_{HL}\mu_{HL}\right\}\\
&=(s_2-s_1)\cdot\frac{p_{HH}\left[1-F^B(r_2)\right]\mu_{HH}+p_{HL}\mu_{HL}}{\mu_{HH}s_2(1+r_2)-1},
\end{aligned}
$$

which is the claimed marginal benefit of quoting r_2 for type s_1. Its sign depends on s_2-s_1 because the denominator is positive as we noted right after Eq. (32). □

Lemma A.1 has three implications. First, as long as $r^A(\cdot)$ is (strictly) increasing in some segment, then Bank A would like to deviate in this segment. To see this, suppose that $r_1 > r_2$ when $s_1 > s_2$ for s_1, s_2 arbitrarily close. Because Lemma 1 has shown that Bank A's strategy is smooth, r_2 is arbitrarily close to r_1. Then $\Pi_r^A(r_2, s_1) < 0$, implying that the value is convex and the Bank A at s_1 (who in equilibrium is supposed to quote r_1) would like to deviate further.

Second, the monotonicity implied by Lemma A.1 helps us show that Bank A uses a pure strategy. To see this, for any $\hat{s} \geq s_1 > s_2$ that induce interior quotes $r_1, r_2 \in [\underline{r}, \overline{r})$, however close, in equilibrium we must have $\sup r^A(s_1) < \inf r^A(s_2)$ by monotonicity. Combining this with Part 3 of Lemma 1, i.e., the induced distribution $F^A(\cdot)$ is atomless except for at $\overline{r}$ and has no gaps, we know that Bank A must adopt a pure strategy in the interior of $[\underline{r}, \overline{r})$, or for $s \leq \hat{s}$. Finally, on $s < \hat{s}$ Bank A can quote either $\overline{r}$ or ∞ which generically gives different values; this then rules out randomization.

Third, if $r^A(\cdot)$ is decreasing globally over $\mathcal{S}$, then the FOC is sufficient to ensure global optimality. Consider a type s_1 who would like to deviate to $\check{r} > r_1$; then

$$\Pi^A(\check{r}, s_1) - \Pi^A(r_1, s_1) = \int_{r_1}^{\check{r}} V_r^A(r, s_1)\, dr.$$

Given the monotonicity of $r(s)$, we can find the corresponding type $s(r)$ for $r \in [r_1, \check{r}]$. From Lemma A.1 we know that

$$\Pi_r^A(r, s_1) = (s(r) - s_1)\frac{p_{HH}\left[1-F^B(r)\right]\mu_{HH}+p_{HL}\mu_{HL}}{\mu_{HH}s(r)(1+r)-1},$$

which is negative given $s(r) < s_1$. Therefore the deviation gain is negative. Similarly, we can show a negative deviation gain for any $\check{r} < r_1$.

Next, we show that $r^A(\cdot)$ is single-peaked over the space of $[0, 1]$.

Lemma A.2. *Given any exogenous $\pi^B \geq 0$, $r^A(\cdot)$ single-peaked over $[0, 1]$ with a maximum point.*

Proof. When $r \in [\underline{r}, \overline{r})$, the derivative of $r^A(s)$ in Eq. (12) with respect to s is

$$\frac{dr^A(s)}{ds} = \frac{p_{HH}\phi(s)\left(\overbrace{p_{HH}\mu_{HH}\left[\int_0^s t\phi(t)\,dt - s\Phi(s)\right]}^{M_1(s)<0,\text{ and }M_1'(s)<0} + \overbrace{p_{LH}\mu_{LH}q_s - \left(\pi^B + p_{LH}\right)\mu_{HH}s}^{M_2(s)?0,\text{ but }M_2'(s)<0}\right)}{\left(p_{HH}\mu_{HH}\int_0^s t\phi(t)\,dt + p_{LH}\mu_{LH}q_s\right)^2}.$$

As $\int_0^s t\phi(t)\,dt < s\Phi(s)$, the first term in the bracket $M_1(s) < 0$, and

$$M_1'(s) = -p_{HH}\mu_{HH}\Phi(s) < 0.$$

For $M_2(s) = p_{LH}\mu_{LH}q_s - \left(\pi^B + p_{LH}\right)\mu_{HH}s$, it has an ambiguous sign, but is decreasing in s. This implies that $M_1(s) + M_2(s)$ decreases with s. It is easy to verify that $M_1(0) + M_2(0) > 0$ and $M_1(1) + M_2(1) < 0$. Therefore $r^A(s)$ first increases and then decreases, i.e. single-peaked. □

Suppose that the peak point is $\tilde{s}$; then Bank A should simply charge $r(s) = \tilde{r}$ for $s < \tilde{s}$ for better profit. This is the standard "ironing" technique and we therefore define the following ironed strategy formally (here, we also take care of the capping $r \leq \overline{r}$):

$$r^A_{ironed}(s) \equiv \sup_{t\in[s,1]} \min\left(r^A(t), \overline{r}\right).$$

By definition $r^A_{ironed}(s)$ is monotonely decreasing.

We now argue that in equilibrium, π^B and $\underline{r}$ adjust so that $r^A(\cdot)$ is always monotonely decreasing over $[x, 1]$. (Since we define $r^A(s) = \infty$ for $s < x$, monotonicity over the entire signal space $[0, 1]$ immediately follows.) There are two subcases to consider.

1. Suppose that $\tilde{r} = \overline{r}$. In this case, $r^A(s)$ in Eq. (12) used in Lemma A.1 and A.2 does not apply to $s < \tilde{s}$ because the equation is defined only over the left-closed-right-open interval $[\underline{r}, \overline{r})$. Instead, $r^A(s)$ in this region is determined by Bank A's optimality condition: as r^A does not affect the competition from Bank B (which equals $F^B(\overline{r}^-)$), Bank A simply sets the maximum possible rate $r^A(r) = \overline{r}$ unless it becomes unprofitable (for $s < x$). (This is our zero-weak equilibrium with $\pi^B = 0$, and there is no "ironing" in this case.)

2. Suppose that $\tilde{r} < \overline{r}$; then bank A quotes $\tilde{r}$ for all $s < \hat{s}$. But this is not an equilibrium—Bank A now leaves a gap in the interval $[\tilde{r}, \overline{r}]$, contradicting with Lemma 1 (there, we rule out gaps in equilibrium). Intuitively, Bank A is too aggressive, and Bank B always would like to raise its quotes inside $[\tilde{r}, \overline{r}]$ to $\overline{r}$. In equilibrium, π^B and $\underline{r}$ adjust upward, so that the peak point $\tilde{s}$ coincides with $\overline{r}$, resulting in no "ironing" in this case either. (This is our positive-weak equilibrium with $\pi^B > 0$.)

□

A.3 Binary Specialized Signal

We reformulate Bank A's specialized signal as binary, $s \in \{H, L\}$, with distribution

$$\mathbb{P}(s = H \,|\theta_s = 1) = \mathbb{P}(s = L \,|\theta_s = 0) = \beta \in (0.5, 1]. \tag{35}$$

Consistent with the baseline, we impose the following parameter restrictions to ensure the pre-screening general signal to be decisive. Bank A's condition is adapted for the binary distribution of s and Bank B' condition remains the same.

Assumption 2. ***(Decisive general signals)*** *i) Bank A rejects the borrower upon an L general signal and is willing to participate upon an H general signal, regardless of its specialized signal s:*

$$q_g(1-\alpha_u)q_s\beta \cdot \overline{r} < (1-q_g)\alpha_d, \tag{36}$$

$$q_g\alpha_u q_s(1-\beta) \cdot \overline{r} > q_g\alpha_u(1-q_s)\beta + (1-q_g)(1-\alpha_d) \tag{37}$$

ii) Bank B is willing to participate (i.e., $r^B < \infty$) if its general signal $g^B = H$:

$$q_g \alpha_u q_s \overline{r} > q_g \alpha_u (1 - q_s) + (1 - q_g)(1 - \alpha_d); \tag{38}$$

We briefly explain Bank A's conditions, which are new. The conditions are about the loan NPV to a bank when the bank is the monopolistic lender, which sheds light on the bank's incentive to participate in competition. Under condition (36), the loan has a negative NPV to Bank A upon $g^A = L$ and the favorable specialized signal $s = H$. Under condition (37), the loan has a positive NPV to Bank A upon $g^A = H$ and the unfavorable specialized signal $s = L$. Hence, Bank A participates if and only if $g^A = H$.

Since Bank A's additional specialized signal s is binary, we add "+" and "-" after superscript "A" to denote Bank A's strategy associated with $s = H$ and $s = L$ respectively. We denote by $F^{A+}(r)$ Bank A's cumulative distribution of its offers upon $g^A = H$ and $s = H$, and by $F^{A-}(r)$ its cumulative distribution of its offers upon $g^A = H$ and $s = L$. Moreover, let $F^A(r) \equiv \mathbb{P}(s = H)F^{A+}(r) + \mathbb{P}(s = L)F^{A-}(r)$ denote Bank A's cumulative distribution of its offers upon $g^A = H$. Similarly, $F^B(r) \equiv \Pr\left(r^B \leq r\right)$ represents Bank B's cumulative distribution of offers upon $g^B = H$.

Definition 2. (Credit market equilibrium) A competitive equilibrium in the credit market (with decisive general signals) consists of the following:

1. A lender j rejects the borrower or $r^j = \infty$ upon $g^j = L$ for $j \in \{A, B\}$; upon $g^j = H$,
   (a) Bank A offers $r^{A+} : [0,1] \to \mathcal{R}$ ($r^{A-} : [0,1] \to \mathcal{R}$) to maximize its expected lending profits given $g^A = H$ and $s = H$ ($s = L$), which induces a distribution function $F^{A+}(r) : \mathcal{R} \to [0,1]$ ($F^{A-}(r) : \mathcal{R} \to [0,1]$);
   (b) Bank B offers $r^B \in \mathcal{R}$ to maximize its expected lending profits given $g^B = H$, which induces a distribution function $F^B(r) : \mathcal{R} \to [0,1]$;
2. The borrower who receives at least one offer (i.e., $\min\{r^A, r^B\} < \infty$) chooses the lower one.

The following lemma shows that lenders' strategies upon $g^j = H$ in our setting are still well-behaved as established in the literature (Broecker, 1990).

Lemma A.3. ***(Equilibrium Structure)*** *In any equilibrium, there exists an endogenous lower bound $\underline{r} > 0$, so that the two distributions $F^j(\cdot)$, $j \in \{A, B\}$ share a common support $[\underline{r}, \overline{r}]$ (besides ∞ as rejection). Over $[\underline{r}, \overline{r})$ both distributions are smooth with well-defined density functions, i.e., no gap and atomless. At most one lender can have a mass point at $\overline{r}$.*

The following result is consistent with the property of information-based pricing—monotone decreasing $r^A(s)$—in the baseline model.

Proposition A.1. ***(Banks' equilibrium pricing)*** *There exists $\hat{r} \in [\underline{r}, \overline{r}]$ so that the support of Bank A's offers, conditional on $g^A = H$ and $s = H$, is $[\underline{r}, \hat{r}]$, and the support of its offers, conditional on $g^A = H$ and $s = L$, is $[\hat{r}, \overline{r}] \cup \{\infty\}$.*

Proof. Let $\mathcal{R}^{A+}$ and $\mathcal{R}^{A-}$ denote the support of Bank A's interest rate offerings besides ∞ as rejection, conditional on $g^A = H$ and $s = H$, and $g^A = H$ and $s = L$, respectively. Lemma A.3 implies that the union of the supports of Bank A's interest rate offerings (besides ∞) is $\mathcal{R}^{A+} \bigcup \mathcal{R}^{A-} = [\underline{r}, \overline{r}]$. We now argue that the closure of two supports can only overlap by one point, i.e., $\mathcal{R}^{A+} \bigcap \mathcal{R}^{A-} = \{\hat{r}\}$ can only be a singleton.

Suppose, counterfactually, that there exist two points, r_1 and r_2, so that $\{r_1, r_2\} \in [\underline{r}, \overline{r}]$ lie in both supports $\mathcal{R}^{A+}$ and $\mathcal{R}^{A-}$. Without loss of generality suppose that $r_1 < r_2$. Our goal is to show that if Bank A is indifferent between these two points for $s = L$, then it must be strictly better off by quoting r_1 when $s = H$. This contradicts with the equilibrium requirement that Bank A is indifferent between these two interest rate quotes both when $s = H$ and $s = L$.

Recall that $p_{g^A g^B} \equiv \mathbb{P}(g^A, g^B)$ and $\mu_{g^A g^B} \equiv \mathbb{P}(\theta_g = 1|g^A, g^B)$ are respectively the joint probability of signal realizations and the posterior belief of the general state being one conditional on $g^A g^B$. Introduce $\mu_+ \equiv \mathbb{P}(\theta_s = 1|s = H)$ and $\mu_- \equiv \mathbb{P}(\theta_s = 1|s = L)$ to denote the posterior belief of the specialized state being one conditional on $s = H$ and $s = L$ respectively. For Bank A who receives $g^A = H$ and s, its profit $\pi^A(r|s)$ by quoting $r \in [\underline{r}, \overline{r})$ equals

$$\pi^A(r|s) \equiv \underbrace{p_{HH}}_{g^A=g^B=H} \underbrace{\left[1 - F^B(r)\right]}_{A \text{ wins}} \left[\mu_{HH}\mu_s(1+r) - 1\right] + \underbrace{p_{HL}}_{g^A=H, g^B=L} \left[\mu_{HL}\mu_s(1+r) - 1\right]. \tag{39}$$

When Bank A receives $g^A = H$ and $s = L$, it is indifferent between quoting r_1 and r_2,

$$\begin{aligned}\pi^A(r_1|s=L) = \pi^A(r_2|s=L) \Leftrightarrow & p_{HH}\left[1 - F^B(r_1)\right]\left[\mu_{HH}\mu_s(1+r_1) - 1\right] + p_{HL}\left[\mu_{HL}\mu_s(1+r_1) - 1\right] \\ = & p_{HH}\left[1 - F^B(r_2)\right]\left[\mu_{HH}\mu_s(1+r_2) - 1\right] + p_{HL}\left[\mu_{HL}\mu_s(1+r_2) - 1\right].\end{aligned}$$

Rearrange this term,

$$\begin{aligned}&\underbrace{\mu_-\left\{\left[p_{HH}\left(1 - F^B(r_1)\right)\mu_{HH} + p_{HL}\mu_{HL}\right](1+r_1) - \left[p_{HH}\left(1 - F^B(r_2)\right)\mu_{HH} + p_{HL}\mu_{HL}\right](1+r_2)\right\}}_{\Delta \text{ lending revenues}} \\ =&\underbrace{p_{HH}\left[1 - F^B(r_1)\right] - p_{HH}\left[1 - F^B(r_2)\right]}_{-\Delta \text{ lending costs}},\end{aligned} \tag{40}$$

which says that Bank A's difference in revenue when quoting these two rates is exactly offset by the difference in its lending costs. Note the right-hand-side of Eq. (40) is positive because we have assumed $r_1 < r_2$ and so $F^B(r_1) < F^B(r_2)$, so the left-hand-side is positive as well. Since $\mu_- > 0$, this means that the curly bracketed term on the left-hand-side is positive.

Now using $\mu+ > \mu_- > 0$ and Eq. (40), we have

$$\begin{aligned}&\mu_+\left\{\left[p_{HH}\left(1 - F^B(r_1)\right)\mu_{HH} + p_{HL}\mu_{HL}\right](1+r_1) - \left[p_{HH}\left(1 - F^B(r_2)\right)\mu_{HH} + p_{HL}\mu_{HL}\right](1+r_2)\right\} \\ >& p_{HH}\left[1 - F^B(r_1)\right] - p_{HH}\left[1 - F^B(r_2)\right].\end{aligned}$$

This implies that given $g^A = H$ and $s = H$, Bank A strictly prefers the lower rate r_1 than r_2, i.e.,

$$\pi^A(r_1|s=H) > \pi^A(r_2|s=H),$$

a contradiction.

We have proven that the supports of Bank A's interest rate offering overlap in only one point, $\mathcal{R}^{A+} \bigcap \mathcal{R}^{A-} = \{\hat{r}\}$; in other words, the supports are two sub-intervals of $[\underline{r}, \overline{r}]$. Suppose Bank A randomizes over the lower sub-interval $[\underline{r}, \hat{r}]$ when $s = L$ and randomizes over the higher sub-interval when $s = H$. This means, upon $s = L$, Bank A is indifferent between $\hat{r}$ and a smaller $r' \in [\underline{r}, \hat{r})$. From the previous argument, if Bank A is indifferent between two rates when $s = L$, it strictly prefers the *lower* rate when $s = H$. This means that Bank A strictly prefers $r' < \hat{r}$ to $\hat{r}$. However, this contradicts with $\hat{r}$ being an optimal rate for Bank A when $s = H$, as $\hat{r} \in \mathcal{R}^+$.

We hence conclude that in equilibrium, Bank A has two connected subintervals and it quotes lower rate when its specialized signal is favorable:

$$\mathcal{R}^{A+} = [\underline{r}, \hat{r}], \quad \mathcal{R}^{A-} = [\hat{r}, \overline{r}]. \tag{41}$$

Last, Bank A must make positive profits and so always makes an offer when $s = H$. Evaluating its profits at $r = \hat{r}$ both when $s = H$ and $s = L$, we have

$$\pi^A(\hat{r}|s = H) > \pi^A(\hat{r}|s = L) \geq 0,$$

where the competition from Bank B is a constant regardless of s, but Bank A's posterior belief is strictly better when $s = H$. This shows, upon $g^A = H$, Bank A may randomly withdraw (i.e., $r = \infty$) only when $s = L$. □

Now we solve for the credit competition equilibrium. We first take Bank B's equilibrium profits π^B as given and solve for the other equilibrium objects. We then solve for π^B by examining whether Bank B or Bank A upon L breaks even.

Solving for $F^{A+}(r)$ and $F^{A-}(r)$. We use Bank B's indifference condition to solve for Bank A's equilibrium strategies, $F^{A+}(r)$ and $F^{A-}(r)$. Let $p_+ \equiv \mathbb{P}(s = H)$ and $p_- \equiv \mathbb{P}(s = L)$ denote the probability that the specialized signal is H and L, respectively. According to Proposition A.1, the support of Bank A's interest rate besides ∞ is $[\underline{r}, \hat{r}]$ upon $s = H$ and is $[\hat{r}, \overline{r}]$ upon $s = L$. This means, when Bank B quotes an interest rate $r \in [\hat{r}, \overline{r})$ and faces competition from Bank A, it loses when Bank A's specialized signal realizes as $s = H$, and may win only when $s = L$ and Bank A quotes $r^A > r$. Hence, Bank B's expected lending profit when quoting $r \in [\hat{r}, \overline{r})$ is

$$\pi^B = \underbrace{p_{HH} p_- \left[1 - F^{A-}(r)\right] \left[\mu_{HH} \mu_- (1 + r) - 1\right]}_{\text{competition } (g^A = H)\text{: } s=L} + \underbrace{p_{LH} \left[\mu_{LH} q_s (1 + r) - 1\right]}_{\text{no competition } (g^A = L)}, \quad r \in [\hat{r}, \overline{r}). \tag{42}$$

Bank B faces competition if Bank A receives a favorable general signal $g^A = H$. In competition, Bank B could only win when $s = L$ (with probability p_-) and $r^A > r$ (with probability $1 - F^{A-}(r)$); moreover, Bank B updates its belief regarding the borrower's specialized fundamental to μ_-, recognizing that it can only win when $s = L$. From Eq. (42), we solve for

$$F^{A-}(r) = 1 - \frac{\pi^B - p_{LH} \left[\mu_{LH} q_s (1 + r) - 1\right]}{p_{HH} p_- \left[\mu_{HH} \mu_- (1 + r) - 1\right]}. \tag{43}$$

Similarly, when Bank B quotes an interest rate $r \in [\underline{r}, \hat{r})$ and faces competition from Bank A, it wins when Bank A's specialized signal realizes as $s = H$ and Bank A quotes $r^A > r$, and always wins when $s = L$. Hence, Bank B's expected lending profit when quoting $r \in [\underline{r}, \hat{r})$ is

$$\pi^B = \underbrace{p_{HH} p_+ \left[1 - F^{A+}(r)\right] \left[\mu_{HH} \mu_+ (1 + r) - 1\right]}_{\text{competition } (g^A = H)\text{: } s=H} + \underbrace{p_{HH} p_- \left[\mu_{HH} \mu_- (1 + r) - 1\right]}_{\text{competition } (g^A = H)\text{: } s=L} + \underbrace{p_{LH} \left[\mu_{LH} q_s (1 + r) - 1\right]}_{\text{no competition } (g^A = L)}. \tag{44}$$

From the indifference condition of Bank B, we solve for

$$F^{A+}(r) = 1 - \frac{\pi^B - p_{LH} \left[\mu_{LH} q_s (1 + r) - 1\right] - p_{HH} p_- \left[\mu_{HH} \mu_- (1 + r) - 1\right]}{p_{HH} p_+ \left[\mu_{HH} \mu_+ (1 + r) - 1\right]}. \tag{45}$$

We can solve for $\underline{r}$ from $F^{A+}(\underline{r}) = 0$,

$$\underline{r} = \frac{\pi^B + p_{LH} + p_{HH}}{(p_{HH}\mu_{HH} + p_{LH}\mu_{LH})\, q_s} - 1. \tag{46}$$

From Lemma A.3, the distribution of Bank A's interest rate offering has no interior mass. This implies that $F^{A+}(\hat{r}) = 1$, and then we can solve for $\hat{r}$ from Eq. (45),

$$\hat{r} = \frac{\pi^B + p_{LH} + p_{HH}p_-}{p_{LH}\mu_{LH}q_s + p_{HH}p_-\mu_{HH}\mu_-} - 1. \tag{47}$$

Solving for $F^B(r)$. We use Bank A's indifference condition to solve for the CDF of Bank B's equilibrium interest rate offering, $F^B(r)$. For Bank A who receives $g^A = H$ and s, its profit $\pi^A(r\,|s)$ by quoting $r \in [\underline{r}, \overline{r})$ equals

$$\pi^A(r\,|s) \equiv \underbrace{p_{HH}}_{g^A=g^B=H} \underbrace{\left[1 - F^B(r)\right]}_{A \text{ wins}} [\mu_{HH}\mu_s(1+r) - 1] + \underbrace{p_{HL}}_{g^A=H, g^B=L} [\mu_{HL}\mu_s(1+r) - 1], \tag{48}$$

where $\mu_s \in \{\mu_+, \mu_-\}$, depending on the realization of s. Bank A's profits when $s = H$ can be determined by evaluating at $r = \underline{r}$, and its profits when $s = L$ can be determined by evaluating at $r = \hat{r}$,

$$\pi^A(r|s = H) \equiv \pi^A(\underline{r}|s = H), \quad \pi^A(r|s = L) \equiv \pi^A(\hat{r}|s = H).$$

Then Bank B's equilibrium strategy is

$$F^B(r) = \begin{cases} 1 - \frac{\pi^A(r|s=H) - p_{HL}[\mu_{HL}\mu_+(1+r)-1]}{p_{HH}[\mu_{HH}\mu_+(1+r)-1]}, & r \in [\underline{r}, \hat{r}], \\ 1 - \frac{\pi^A(r|s=L) - p_{HL}[\mu_{HL}\mu_-(1+r)-1]}{p_{HH}[\mu_{HH}\mu_-(1+r)-1]}, & r \in [\hat{r}, \overline{r}), \end{cases} \tag{49}$$

where we have used the result of Bank A's information-based pricing in Proposition A.1.

Solving for the equilibrium profit of Bank B. The value of Bank B's equilibrium profit depends on whether Bank B, or Bank A when $s = L$, breaks even in competition.

We evaluate Bank A's profits when $s = L$ and it quotes $r = \overline{r}$. If $\mu_{HL}\mu_-(1+\overline{r}) - 1 > 0$, Bank A earns a positive profit even if it never wins Bank B in competition; evaluating Eq. (48) at $r = \overline{r}$,

$$\pi^A(\overline{r}\,|s = L) \geq p_{HL}[\mu_{HL}\mu_-(1+\overline{r}) - 1] > 0.$$

In this case, $\pi^B = 0$. Otherwise, if $\mu_{HL}\mu_-(1+\overline{r}) - 1 \leq 0$, then Bank A earns a negative profit when $g^A = H$ and $s = L$, unless Bank B's strategy $F^B(r)$ has a mass at $\overline{r}$—meaning $\pi^B > 0$ and $\pi^A(r|s = L) = 0$. Since π^A is a function of π^B, we can solve for π^B from $\pi^A(r|s = L) = 0$ in this case.

A.4 Equilibrium Characterization for Non-Zero Recovery

A.4.1 Specialized lending

In this part, we change our baseline model by assuming that a lender recovers $\delta \in (0, 1)$ from a borrower who defaults. The analysis below shows that non-zero recovery rate is isomorphic to our baseline with zero recovery rate where the lending cost per loan is changed from 1 to $1 - \delta$.

We focus on the primitive conditions under which the general signal is decisive for screening. Specifically, Bank A rejects the borrower upon $g^A = L$, regardless of its specialized signal realization,

$$p_{L\cdot}\left[\mu_{L\cdot}\left(1+\overline{r}\right)+\left(1-\mu_{L\cdot}\right)\delta-1\right], \Leftrightarrow q_g\left(1-\alpha_u\right)\overline{r}<\left(1-q_g\right)\alpha_d\left(1-\delta\right);$$

in addition, Bank B is only willing to participate when it receives a favorable general signal H,

$$p_{\cdot H}\left[\mu_{\cdot H}\left(1+\overline{r}\right)+\left(1-\mu_{\cdot H}\right)\delta-1\right]>0 \Leftrightarrow q_g\alpha_u q_s\overline{r}>\left[q_g\left(1-q_s\right)\alpha_u+\left(1-q_g\right)\left(1-\alpha_d\right)\right]\left(1-\delta\right).$$

Intuitively, compared with our baseline conditions in Assumption 1, the above conditions change the loss of bad projects from 1 to $1-\delta$.

Lenders choose interest rate strategies to maximize their profits, which are

$$\begin{aligned}\pi^A\left(r\,|s\right) &\equiv p_{HH}\left[1-F^B\left(r\right)\right]\left[\mu_{HH}s\left(1+r\right)+\left(1-\mu_{HH}s\right)\delta-1\right]+p_{HL}\left[\mu_{HL}s\left(1+r\right)+\left(1-\mu_{HL}s\right)\delta-1\right]\\ &= p_{HH}\left[1-F^B\left(r\right)\right]\left[\mu_{HH}s\left(1+r-\delta\right)-\left(1-\delta\right)\right]+p_{HL}\left[\mu_{HL}s\left(1+r-\delta\right)-\left(1-\delta\right)\right] \quad (50)\\ \pi^B\left(r\right) &\equiv p_{HH}\left[1-F^A\left(r\right)\right]\mathbb{E}\left[\mu_{HH}\theta_s\left(1+r-\delta\right)-\left(1-\delta\right)\middle|\, r\le r^A\left(s\right)\right]+p_{LH}\left[\mu_{LH}q_s\left(1+r-\delta\right)-\left(1-\delta\right)\right]\\ &= p_{HH}\int_0^{s^A(r)}t\phi\left(t\right)dt\left[\mu_{HH}s\left(1-\delta+r\right)-\left(1-\delta\right)\right]+p_{LH}\left[\mu_{LH}q_s\left(1-\delta+r\right)-\left(1-\delta\right)\right]. \quad (51)\end{aligned}$$

The lenders' problems could be nested in our baseline model after replacing lending cost from 1 to $1-\delta$, so the previous derivation of the equilibrium applies here. We first derive equilibrium strategies as a function of π^B and then characterize π^B in closed form. Bank A's equilibrium strategy $r^A(s)$ over $[\underline{r},\overline{r})$ makes Bank B indifferent, and Bank A may offer $\overline{r}$ or ∞ upon worse specialized signals:

$$r^A\left(s\right)=\begin{cases}\min\left\{\frac{\pi^B+\left(p_{HH}\Phi(s)+p_{LH}\right)\left(1-\delta\right)}{p_{HH}\mu_{HH}\int_0^{s^A(r)}t\phi(t)dt+p_{LH}\mu_{LH}q_s}-\left(1-\delta\right),\overline{r}\right\}, & \text{for } s\in\left[x,1\right],\\ \infty, & \text{for } s\in\left[0,x\right),\end{cases}$$

where x satisfies $\pi^A(\overline{r}|x)=0$ and $\pi^A(r|s)$ is given in Eq. (50). The two lenders' optimality conditions help us pin down Bank B's strategy,

$$F^B\left(r\right)=\begin{cases}1-\frac{\int_0^{s^A(r)}t\phi(t)dt}{q_s}, & \text{for } r\in\left[\underline{r},\overline{r}\right),\\ 1-\mathbf{1}_{\pi^B=0}\cdot\frac{\int_0^{s^A(r)}t\phi(t)dt}{q_s}, & \text{for } r=\overline{r}.\end{cases}$$

Note that Bank A's strategy $r^A(s)$, which makes Bank B indifferent, adjusts for the positive recovery rate δ that affects Bank B's profit. On the other hand, the functional form of $F^B(r)$ is the same as in the baseline and $F^B(r)$ is only affected via the endogenous $r^A(s)$. This is because the key ODE that pins down $F^B(r)$ involves the quality of lenders' existing borrowers but is irrelevant of borrower payoffs.

Last, Bank B's equilibrium profit is

$$\pi^B=\max\left\{\left[p_{HH}\mu_{HH}\int_0^{s_A^{be}}t\phi\left(t\right)dt+p_{LH}\mu_{LH}q_s\right]\left(1-\delta+\overline{r}\right)-\left(p_{HH}\Phi\left(s_A^{be}\right)+p_{LH}\right)\left(1-\delta\right),0\right\},$$

where s_A^{be} satisfies

$$0 = \pi^A \left(\bar{r} \middle| s_A^{be} \right) = p_{HH} \frac{\int_0^{s_A^{be}} t\phi\left(t\right)dt}{q_s} \cdot \left[\mu_{HH} s_A^{be} \left(1-\delta+\bar{r}\right) - \left(1-\delta\right) \right] + p_{HL} \left[\mu_{HL} s_A^{be} \left(1-\delta+\bar{r}\right) - \left(1-\delta\right) \right].$$

A.4.2 Canonical models

In this part, we formally characterize the credit competition equilibrium under canonical setting with recovery $\delta \in [0, 1)$ from default borrowers. When $\delta = 0$, the bad news signal case corresponds to He, Huang, and Zhou (2023) and the symmetric signal structure case corresponds to Broecker (1990); Hauswald and Marquez (2003); the analysis in Appendix A.5 rely on this equilibrium characterization under $\delta = 0$.

First, we characterize lender strategies $F^j(r)$ for $j \in \{A, B\}$ as functions of primitives $p_{g^A g^B}$, $\mu_{g^A g^B}$ and endogenous variables $\pi^A, \pi^B, \underline{r}$. These functions apply to both bad news and symmetric signal structure. Then we characterize $p_{g^A g^B}$, $\mu_{g^A g^B}$ and endogenous variables $\pi^A, \pi^B, \underline{r}$ for the two signal structures separately.

We focus on the primitive conditions under which a lender rejects the borrower upon $g^j = L$ for $j \in \{A, B\}$, and they are later separately characterized for both bad news signal structure and symmetric structures. Upon $g^j = H$, lenders' profits are

$$\begin{aligned}
\pi^A(r) =& p_{HH} \left[1 - F^B(r) \right] \left[\mu_{HH}(1+r) + (1-\mu_{HH})\delta - 1 \right] + p_{HL} \left[\mu_{HL}(1+r) + (1-\mu_{HL})\delta - 1 \right], \\
\pi^B(r) =& p_{HH} \left[1 - F^A(r) \right] \left[\mu_{HH}(1+r) + (1-\mu_{HH})\delta - 1 \right] + p_{LH} \left[\mu_{LH}(1+r) + (1-\mu_{LH})\delta - 1 \right].
\end{aligned}$$

Since both lenders use mixed strategies, they earn a constant profit π^j which we take as given for now. Therefore, a lender's strategy $F^j(r)$ could be solved from its competitor indifference condition over common support $[\underline{r}, \bar{r}]$:

$$F^A\left(r\right) = \begin{cases} 1 - \frac{\pi^B - p_{LH}\left[\mu_{LH}\left(r+1-\delta\right)-\left(1-\delta\right)\right]}{p_{HH}\left(\mu_{HH}\left(r+1-\delta\right)-\left(1-\delta\right)\right)}, & \text{for } r \in [\underline{r}, \bar{r}), \\ 1, & \text{for } r = \bar{r}, \end{cases} \tag{52}$$

$$F^B\left(r\right) = 1 - \frac{\pi^A - p_{HL}\left[\mu_{HL}\left(r+1-\delta\right)-\left(1-\delta\right)\right]}{p_{HH}\left(\mu_{HH}\left(r+1-\delta\right)-\left(1-\delta\right)\right)}, \quad \text{for } r \in [\underline{r}, \bar{r}]. \tag{53}$$

Since Bank A with superior information technology must make a higher profit than Bank B, we have $\pi^A > 0$ and $F^A(\bar{r}) = 1$ while whether $F^B(\bar{r}) = 1$ depends on the endogenous profit π^B.

Bad-news signal structure In the bad news signal structure, $\mathbb{P}(g^j = H|\theta = 1) = 1$ for $j \in \{A, B\}$. Under this structure, a lender always rejects a borrower upon L because it reveals the borrower to be bad type and the loan has negative NPV (recovery $\delta < 1$).

The signal probabilities $p_{g^A g^B}$ and posterior upon signals $\mu_{g^A g^B}$ in Eq. (52) and (53) are

$$\begin{aligned}
p_{HH} &= q + (1-q)\left(1-\alpha^A\right)\left(1-\alpha^B\right), \quad \mu_{HH} = \frac{q}{p_{HH}}, \\
p_{HL} &= (1-q)\left(1-\alpha^A\right)\alpha^B, \quad \mu_{HL} = 0, \\
p_{LH} &= (1-q)\,\alpha^A\left(1-\alpha^B\right), \quad \mu_{LH} = 0.
\end{aligned}$$

The remaining equilibrium variables are

$$\begin{aligned}
\pi^B &= 0, \\
\underline{r} &= \frac{(1-q)\left(1-\alpha^B\right)(1-\delta)}{q}, \\
\pi^A &= q\underline{r} - (1-q)\left(1-\alpha^A\right)(1-\delta).
\end{aligned}$$

Symmetric signal structure In the symmetric signal structure, lender j's signal correctly identifies the project quality with precision α^j, i.e., $\mathbb{P}(g^j = H|\theta = 1) = \mathbb{P}(g^j = L|\theta = 0) = \alpha^j$ for $j \in \{A, B\}$. We focus on the primitive condition under which a lender always rejects a borrower upon L. Because Bank A with a higher precision $\alpha^A > \alpha^B$ has a worse posterior upon L than Bank B, it is sufficient to require the condition for Bank B,

$$p_{\cdot L}[\mu_{\cdot L}(1-\delta+\overline{r}) + (1-\mu_{\cdot L}\delta - 1] < 0 \Leftrightarrow q(1-\alpha^B)\overline{r} < (1-q)\alpha^B(1-\delta).$$

The signal probabilities $p_{g^A g^B}$ and posteriors $\mu_{g^A g^B}$ in Eq. (52) and (53) are

$$\begin{aligned}
p_{HH} &= q\alpha^A\alpha^B + (1-q)\left(1-\alpha^A\right)\left(1-q^B\right), \quad \mu_{HH} = \frac{q\alpha^A\alpha^B}{p_{HH}}, \\
p_{HL} &= q\alpha^A\left(1-\alpha^B\right) + (1-q)\left(1-\alpha^A\right)q^B, \quad \mu_{HL} = \frac{q\alpha^A\left(1-\alpha^B\right)}{p_{HL}}, \\
p_{LH} &= q\left(1-\alpha^A\right)\alpha^B + (1-q)\,\alpha^A\left(1-q^B\right), \quad \mu_{LH} = \frac{q\left(1-\alpha^A\right)\alpha^B}{p_{LH}}.
\end{aligned}$$

The other equilibrium variables $\pi^A, \pi^B, \underline{r}$ depend on whether the equilibrium is zero weak or positive weak. When

$$p_{LH}\left[\mu_{LH}\left(\overline{r}+1-\delta\right) - (1-\delta)\right] \leq 0,$$

the equilibrium is zero weak and

$$\begin{aligned}
\pi^B &= 0, \\
\underline{r} &= \frac{(1-q)\left(1-\alpha^B\right)(1-\delta)}{q\alpha^B}, \\
\pi^A &= q\alpha^A\underline{r} - (1-q)\left(1-\alpha^A\right)(1-\delta).
\end{aligned}$$

Otherwise, the equilibrium is positive weak and

$$\begin{aligned}
F^B\left(\overline{r}\right) = 1 \Rightarrow \pi^A &= p_{HL}\left[\mu_{HL}\left(\overline{r}+1-\delta\right) - (1-\delta)\right], \\
\underline{r} &= \frac{\pi^A + (1-q)\left(1-\alpha^A\right)(1-\delta)}{q\alpha^A}, \\
\pi^B &= q\alpha^B\underline{r} - (1-q)\left(1-\alpha^B\right)(1-\delta).
\end{aligned}$$

A.5 Proof of Proposition 2

This part studies canonical models where each lender has a (general) binary signal g^j for $j \in \{A, B\}$,

$$\mathbb{P}(g^j = H|\theta = 1) = \alpha_u^j, \quad \mathbb{P}(g^j = L|\theta = 0) = \alpha_d^j.$$

$F^j(r)$ with $j \in \{A, B\}$ indicates the distribution of lender j's interest rate offering.

Lemma A.4. *For any $r \in [\underline{r}, \overline{r})$, we have*

$$\frac{F^B(r)}{F^A(r)} = \frac{\alpha_u^A}{\alpha_u^B}, \ \frac{dF^B(r)/dr}{dF^A(r)/dr} = \frac{\alpha_u^A}{\alpha_u^B}.$$

Proof. For any $r \in [\underline{r}, \overline{r})$, lenders' profit functions are

$$\pi^A = \underbrace{p_{HH}}_{g^B=H} \underbrace{\left(1 - F^B(r)\right)}_{A \text{ wins}} [\mu_{HH}(r+1) - 1] + \underbrace{p_{HL}}_{g^B=L} [\mu_{HL}(r+1) - 1], \tag{54}$$

$$\pi^B = \underbrace{p_{HH}}_{g^A=H} \underbrace{\left(1 - F^A(r)\right)}_{B \text{ wins}} [\mu_{HH}(r+1) - 1] + \underbrace{p_{LH}}_{g^A=L} [\mu_{LH}(r+1) - 1]. \tag{55}$$

These two equations imply that

$$\frac{F^B(r)}{F^A(r)} = \frac{p_{HH}[\mu_{HH}(r+1) - 1] + p_{HL}[\mu_{HL}(r+1) - 1] - \pi^A}{p_{HH}[\mu_{HH}(r+1) - 1] + p_{LH}[\mu_{LH}(r+1) - 1] - \pi^B}. \tag{56}$$

And, evaluating Eq. (54), (55) at $r = \underline{r}$ and using $F^A(\underline{r}) = F^B(\underline{r}) = 1$ gives lenders' profits:

$$\pi^A(\underline{r}) = p_{HH}[\mu_{HH}(\underline{r}+1) - 1] + p_{HL}[\mu_{HL}(\underline{r}+1) - 1],$$
$$\pi^B(\underline{r}) = p_{HH}[\mu_{HH}(\underline{r}+1) - 1] + p_{LH}[\mu_{LH}(\underline{r}+1) - 1].$$

Using these in Eq. (56), we have

$$\frac{F^B(r)}{F^A(r)} = \frac{(p_{HH}\mu_{HH} + p_{HL}\mu_{HL})(r - \underline{r})}{(p_{HH}\mu_{HH} + p_{LH}\mu_{LH})(r - \underline{r})} = \frac{\mathbb{P}\left(g^A = H, \theta = 1\right)}{\mathbb{P}(g^B = H, \theta = 1)} = \frac{\alpha_u^A}{\alpha_u^B}.$$

Here, $F^B(r) = \frac{\alpha_u^A}{\alpha_u^B} F^A(r)$ immediately implies that $\frac{dF^B(r)/dr}{dF^A(r)/dr} = \frac{\alpha_u^A}{\alpha_u^B}$. □

Proof of Proposition 2

Part 1: Bad-news signal structure. This structure corresponds to

$$\alpha_u^A = \alpha_u^B = 1, \quad 1 > \alpha_d^A > \alpha_d^B > 0;$$

i.e., lenders only make Type II mistakes. In this part, we use $\alpha^j \equiv \alpha_d^j$ as a lender's signal precision, which captures the probability that bad-type borrowers are correctly identified as L, and $\alpha^A > \alpha^B$.

Proof. From Lemma A.4, lender bidding strategies $F^A(\cdot), F^B(\cdot)$ over $[0, \overline{r}] \cup \{\infty\}$ satisfy

$$F^B(r) = \begin{cases} F^A(r), & r \in [0, \overline{r}), \\ F^A(r^-), & r = \overline{r}. \end{cases}$$

We use this result to express Δr as a function of $F^B(r)$. Specifically,

$$\begin{aligned}
\mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right] &= \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]rdF^A(r) + p_{HL}\int_{\underline{r}}^{\overline{r}} rdF^A(r)}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]dF^A(r) + p_{HL}} \\
&= \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]rdF^B(r) + p_{HH}\overline{r}\left[1-F^B(\overline{r})\right]^2 + p_{HL}\left[\overline{r} - \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr\right]}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]dF^B(r) + p_{HH}\left[1-F^B(\overline{r})\right]^2 + p_{HL}} \\
&= \overline{r} - \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr + p_{HL}\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr}{p_{HH}\left\{-\frac{\left[1-F^B(\overline{r})\right]^2}{2} + \frac{1}{2}\right\} + p_{HH}\left[1-F^B(\overline{r})\right]^2 + p_{HL}},
\end{aligned}$$

and

$$\begin{aligned}
\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right] &= \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^A(r)\right]rdF^B(r) + p_{LH}\int_{\underline{r}}^{\overline{r}} rdF^B(r)}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]dF^B(r) + p_{LH}F^B(\overline{r})} \\
&= \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]rdF^B(r) + p_{LH}\left[\overline{r}F^B(\overline{r}) - \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr\right]}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]dF^B(r) + p_{LH}F^B(\overline{r})} \\
&= \overline{r} - \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr + p_{LH}\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr}{p_{HH}\left\{\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}\right\} + p_{LH}F^B(\overline{r})}.
\end{aligned}$$

Hence,

$$\begin{aligned}
&\Delta r \equiv \mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right] - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right] \\
&= \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr + p_{LH}\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr}{p_{HH}\left\{\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}\right\} + p_{LH}F^B(\overline{r})} - \frac{p_{HH}\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr + p_{HL}\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr}{p_{HH}\left\{-\frac{\left[1-F^B(\overline{r})\right]^2}{2} + \frac{1}{2}\right\} + p_{HH}\left[1-F^B(\overline{r})\right]^2 + p_{HL}}.
\end{aligned} \tag{57}$$

Now we plug in the expressions of $F^B(r)$ to show that the canonical model leads to counterfactual predictions when $\overline{r}$ is relatively small. From He, Huang, and Zhou (2023),

$$F^B(r) = \frac{r - \underline{r}}{r - \underline{r}\left(1-\alpha^A\right)},$$

and the key terms are accordingly

$$\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr = \overline{r} - \underline{r} - \alpha^A\underline{r}\ln\left(\frac{\overline{r}}{\underline{r}} - 1 + \alpha^A\right) + \alpha^A\underline{r}\ln\alpha^A,$$

$$\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr = \frac{\underline{r}}{2}\cdot\frac{\left(\frac{\overline{r}}{\underline{r}} - 1\right)^2}{\frac{\overline{r}}{\underline{r}} - 1 + \alpha^A}.$$

Let $M(\overline{r}) \equiv \frac{\overline{r}}{\underline{r}} - \left(1-\alpha^A\right)$. Multiply Δr by both denominators in Eq. (57) (which are positive as the probability of lending), and one can show that

$$\begin{aligned}\Delta r \propto & p_{HH}\cdot\frac{\underline{r}\alpha^A}{2}\cdot\left(\frac{M-\alpha^A}{M}\right)^2\left(\frac{p_{HH}\alpha^A}{M}+p_{LH}\right)+\frac{p_{HH}}{2}\left[\int_{\underline{r}}^{\overline{r}}F^B(r)\right](p_{LH}+p_{HL})\left(\frac{\alpha^A}{M}\right)^2\\ &+p_{LH}p_{HL}\frac{\alpha^A}{M}\left[\int_{\underline{r}}^{\overline{r}}F^B(r)\right]+(p_{HL}-p_{LH})\frac{p_{HH}}{2}\cdot\underline{r}\cdot\frac{\left(M-\alpha^A\right)^2}{M}-(p_{HL}-p_{LH})\frac{p_{HH}}{2}\left[\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr\right].\end{aligned}$$

Note that only the last term $-(p_{HL}-p_{LH})\frac{p_{HH}}{2}\left[\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr\right]$ is negative. In addition, this term approaches zero as $\overline{r}\to\underline{r}=\frac{(1-q)\left(1-\alpha^B\right)}{q}$, and

$$\frac{\partial\left[\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr\right]}{\partial\overline{r}}=1-\frac{\alpha^A}{M}>0.$$

Therefore, there exists some threshold $\hat{\overline{r}}$ such that when $\overline{r}\leq\hat{\overline{r}}$, the canonical model has counterfactual prediction $\Delta r>0$. □

Part 2: Symmetric signal structure. This structure corresponds to

$$\alpha^j\equiv\alpha_u^j=\alpha_d^j\in\left(\frac{1}{2},1\right],\quad\text{for}\quad j\in\{A,B\}.$$

In this context, the specialized lender Bank A's signal is more precise, $\alpha^A>\alpha^B$.

Lemma A.5. $\mathbb{E}\left[r^A\middle|r^A<r^B\leq\infty\right]\geq\mathbb{E}\left[r^B\middle|r^B<r^A\leq\infty\right]$ *is equivalent to the following inequality*

$$\begin{aligned}&\frac{\mathbb{P}\left(g^A=H\right)\frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr+p_{HH}\int_{\underline{r}}^{\overline{r}}F^A(r)\,rdF^B(r)-p_{HH}\overline{r}\frac{\alpha^B}{2\alpha^A}\left(F^B(\overline{r})\right)^2}{p_{HH}\left[1-F^B(\overline{r})+\frac{\alpha^B}{2\alpha^A}\left(F^B(\overline{r})\right)^2\right]+p_{HL}}\\ \leq&\frac{\mathbb{P}\left(g^B=H\right)\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr+p_{HH}\int_{\underline{r}}^{\overline{r}}F^A(r)\,rdF^B(r)-p_{HH}\frac{\alpha^B}{2\alpha^A}\left(F^B(\overline{r})\right)^2\overline{r}}{p_{HH}\left[F^B(\overline{r})-\frac{\alpha^B}{2\alpha^A}\left(F^B(\overline{r})\right)^2\right]+p_{LH}F^B(\overline{r})}.\end{aligned}$$

Proof. The expected rate of a lender's loan is

$$\mathbb{E}\left[r^A\middle|r^A<r^B\leq\infty\right]\triangleq\frac{\underbrace{p_{HH}}_{\text{B gets H}}\int_{\underline{r}}^{\overline{r}}\underbrace{\left[1-F^B(r)\right]}_{\text{A wins}}rdF^A(r)+\underbrace{p_{HL}}_{\text{B gets L}}\int_{\underline{r}}^{\overline{r}}rdF^A(r)}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^B(r)\right]dF^A(r)+p_{HL}},\tag{58}$$

$$\mathbb{E}\left[r^B\middle|r^B<r^A\leq\infty\right]\triangleq\frac{\underbrace{p_{HH}}_{\text{A gets H}}\int_{\underline{r}}^{\overline{r}}\underbrace{\left[1-F^A(r)\right]}_{\text{B wins}}rdF^B(r)+\underbrace{p_{LH}}_{\text{A gets L}}\int_{\underline{r}}^{\overline{r}}rdF^B(r)}{p_{HH}\int_{\underline{r}}^{\overline{r}}\left[1-F^A(r)\right]dF^B(r)+p_{LH}F^B(\overline{r})}.\tag{59}$$

In the first step, we rewrite the equations as functions of $dF^B(r)$ and dr which are continuous at $\overline{r}$. Using integration by parts and Lemma A.4, we have

$$\int_{\underline{r}}^{\overline{r}}rdF^A(r)=rF^A(r)\Big|_{\underline{r}}^{\overline{r}}-\int_{\underline{r}}^{\overline{r}}F^A(r)\,dr=\overline{r}-\int_{\underline{r}}^{\overline{r}}F^A(r)\,dr=\overline{r}-\frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}}F^B(r)\,dr.$$

In the last step, although Lemma A.4 does not apply at $r=\overline{r}$, it is of zero measure. Similarly, the probability of Bank A winning in competition is

$$\begin{aligned}\int_{\underline{r}}^{\overline{r}}\left[1-F^{B}(r)\right]dF^{A}(r)&=\int_{\underline{r}}^{\overline{r}}dF^{A}(r)-\int_{\underline{r}}^{\overline{r}}F^{B}(r)\,dF^{A}(r)\\ \underbrace{=}_{\text{integration by parts}}&1-\left[F^{B}(\overline{r})-\int_{\underline{r}}^{\overline{r}}F^{A}(r)\,dF^{B}(r)\right]\\ \underbrace{=}_{F^{A}=\frac{\alpha^{B}}{\alpha^{A}}F^{B}}&1-F^{B}(\overline{r})+\int_{\underline{r}}^{\overline{r}}\frac{\alpha^{B}}{\alpha^{A}}F^{B}(r)\,dF^{B}(r)\\ &=1-F^{B}(\overline{r})+\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2},\end{aligned}$$

and thus the probability of Bank B winning is the residual

$$\int_{\underline{r}}^{\overline{r}}\left[1-F^{A}(r)\right]dF^{B}(r)=F^{B}(\overline{r})-\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}.$$

Similarly,

$$\begin{aligned}\int_{\underline{r}}^{\overline{r}}F^{B}(r)\,r\,dF^{A}(r)&=\int_{\underline{r}}^{\overline{r}-}F^{B}(r)\,r\,dF^{A}(r)+F^{B}(\overline{r})\,\overline{r}\left[1-F^{A}(\overline{r}^{-})\right]\\ \underbrace{=}_{F^{A}=\frac{\alpha^{B}}{\alpha^{A}}F^{B},F^{B}(\overline{r}^{-})=F^{B}(\overline{r})}&\int_{\underline{r}}^{\overline{r}}F^{A}(r)\,r\,dF^{B}(r)+F^{B}(\overline{r})\,\overline{r}\left(1-\frac{\alpha^{B}}{\alpha^{A}}F^{B}(\overline{r})\right)\end{aligned}$$

Plug these terms into Eq. (58) and (59), and we have

$$\begin{aligned}\mathbb{E}\left[r^{A}\middle|r^{A}<r^{B}\leq\infty\right]&=\frac{\mathbb{P}\left(g^{A}=H\right)\int_{\underline{r}}^{\overline{r}}r\,dF^{A}(r)-p_{HH}\int_{\underline{r}}^{\overline{r}}F^{B}(r)\,r\,dF^{A}(r)}{p_{HH}\left[1-F^{B}(\overline{r})+\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}\right]+p_{HL}}\\ &=\overline{r}-\frac{\mathbb{P}\left(g^{A}=H\right)\frac{\alpha^{B}}{\alpha^{A}}\int_{\underline{r}}^{\overline{r}}F^{B}(r)\,dr+p_{HH}\int_{\underline{r}}^{\overline{r}}F^{A}(r)\,r\,dF^{B}(r)-p_{HH}\overline{r}\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}}{p_{HH}\left[1-F^{B}(\overline{r})+\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}\right]+p_{HL}};\end{aligned}$$

for Bank B,

$$\begin{aligned}\mathbb{E}\left[r^{B}\middle|r^{B}<r^{A}\leq\infty\right]&=\frac{\mathbb{P}\left(g^{B}=H\right)\int_{\underline{r}}^{\overline{r}}r\,dF^{B}(r)-p_{HH}\int_{\underline{r}}^{\overline{r}}F^{A}(r)\,r\,dF^{B}(r)}{p_{HH}\left[F^{B}(\overline{r})-\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}\right]+p_{LH}F^{B}(\overline{r})}\\ &=\overline{r}-\frac{\mathbb{P}\left(g^{B}=H\right)\int_{\underline{r}}^{\overline{r}}F^{B}(r)\,dr+p_{HH}\int_{\underline{r}}^{\overline{r}}F^{A}(r)\,r\,dF^{B}(r)-p_{HH}\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}\overline{r}}{p_{HH}\left[F^{B}(\overline{r})-\frac{\alpha^{B}}{2\alpha^{A}}\left(F^{B}(\overline{r})\right)^{2}\right]+p_{LH}F^{B}(\overline{r})}.\end{aligned}$$

Therefore, $\mathbb{E}\left[r^{A}\middle|r^{A}<r^{B}\leq\infty\right]\geq\mathbb{E}\left[r^{B}\middle|r^{B}<r^{A}\leq\infty\right]$ is equivalent to the stated inequality. □

Lemma A.6. *In the case of $q>\frac{1}{1+\overline{r}}$, when $\alpha^{B}\uparrow\alpha^{A}$, there exists a threshold $\hat{\alpha}\left(\alpha^{A}\right)<\alpha^{A}$ so that when $\alpha^{B}>\hat{\alpha}\left(\alpha^{A}\right)$ we have $F^{B}(\overline{r})=1$.*

Proof. Let $\alpha^B = \alpha^A - \epsilon$. Bank B's profit could be pinned down by setting $r = \overline{r}^-$,

$$\begin{aligned}
\pi^B =& p_{HH}\left[1 - F^A\left(\overline{r}^-\right)\right]\left[\mu_{HH}\left(\overline{r}+1\right)-1\right] + p_{LH}\left[\mu_{LH}\left(\overline{r}+1\right)-1\right] \\
\underbrace{\geq}_{F^A(\overline{r}^-)\leq 1} & \; p_{LH}\left(\mu_{LH}\left(\overline{r}+1\right)-1\right) \\
\underbrace{=}_{\alpha^B=\alpha^A-\epsilon} & \; q\left(1-\alpha^A\right)\left(\alpha^A-\epsilon\right)\overline{r} - (1-q)\,\alpha^A\left(1-\left(\alpha^A-\epsilon\right)\right) \\
=& \left(1-\alpha^A\right)\alpha^A\left[q\overline{r}-(1-q)\right] - \epsilon\left[q\left(1-\alpha^A\right)\overline{r} + (1-q)\,\alpha^A\right].
\end{aligned}$$

Hence, when $\epsilon < \frac{(1-\alpha^A)\alpha^A[q\overline{r}-(1-q)]}{q(1-\alpha^A)\overline{r}+(1-q)\alpha^A}$, or equivalently, when

$$\alpha^B > \hat{\alpha}\left(\alpha^A\right) = \alpha^A - \frac{\left(1-\alpha^A\right)\alpha^A\left[q\overline{r}-(1-q)\right]}{q\left(1-\alpha^A\right)\overline{r}+(1-q)\,\alpha^A},$$

we have $\pi^B > 0$ and $F^B\left(\overline{r}\right) = 1$. □

Now we prove the part 2 of Proposition 2. There are two cases depending on whether $q < \frac{1}{1+\overline{r}}$, i.e., whether the project has a negative NPV at prior.

Proof. The first case of $q < \frac{1}{1+\overline{r}}$ is easier. When $\alpha^B \uparrow \alpha^A$ and $\alpha^A - \alpha^B = o\left(q - \frac{1}{1+\overline{r}}\right)$, Bank B's signal distributions and strategies approach that of Bank A except at $r = \overline{r}$ (Lemma A.4):

$$F^B\left(r\right) \uparrow F^A\left(r\right) \quad \text{for any} \quad r \in [\underline{r}, \overline{r}), \quad \text{and} \quad F^B\left(\overline{r}\right) < 1 = F^A\left(\overline{r}\right).$$

Then from the expressions of $\mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right]$ and $\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]$ in Lemma A.5,

$$\begin{aligned}
\frac{\overline{r} - \mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right]}{\overline{r} - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]} =& \frac{p_{HH}\left[F^B\left(\overline{r}\right) - \frac{1}{2}\left(F^B\left(\overline{r}\right)\right)^2\right] + p_{LH}F^B\left(\overline{r}\right)}{p_{HH}\left[1 - F^B\left(\overline{r}\right) + \frac{1}{2}\left(F^B\left(\overline{r}\right)\right)^2\right] + p_{HL}} \\
\underbrace{\leq}_{\text{RHS set } F^B(\overline{r})=1} & \; \frac{\frac{1}{2}p_{HH} + p_{LH}}{\frac{1}{2}p_{HH} + p_{HL}} = 1,
\end{aligned} \tag{60}$$

where the last inequality holds because the ratio is increasing in $F^B\left(\overline{r}\right)$. ($F^B\left(\overline{r}\right) - \frac{1}{2}\left(F^B(\overline{r})\right)^2$ in both the numerator and denominator is monotone increasing when $F^B(\overline{r}) \in (0,1]$.) Hence, $\mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right] \geq \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]$ always holds in this case.

Now consider the second case $q \geq \frac{1}{1+\overline{r}}$. When $\alpha^B \to \alpha^A$, since $\mathbb{E}\left[r^A \middle| r^A < r^B \leq \infty\right]$ decreases while $\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty\right]$ increases in $F^B\left(\overline{r}\right)$, it is sufficient to show that the equivalent inequality in Lemma A.5 holds under $F^B(\overline{r}) = 1$, i.e.,

$$\begin{aligned}
&\frac{\mathbb{P}\left(g^A = H\right) \frac{\alpha^B}{\alpha^A} \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr + p_{HH} \int_{\underline{r}}^{\overline{r}} F^A(r)\, r dF^B(r) - p_{HH}\overline{r}\frac{\alpha^B}{2\alpha^A}}{p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}} \\
\leq &\frac{\mathbb{P}\left(g^B = H\right) \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr + p_{HH} \int_{\underline{r}}^{\overline{r}} F^A(r)\, r dF^B(r) - p_{HH}\frac{\alpha^B}{2\alpha^A}\overline{r}}{p_{HH}\left(1 - \frac{\alpha^B}{2\alpha^A}\right) + p_{LH}}, \qquad (61)
\end{aligned}$$

where both the LHS and RHS are positive. When $q > \frac{1}{1+\overline{r}}$, recall that Lemma A.6 shows $F^B(\overline{r}) = 1$ as $\alpha^B \to \alpha^A$ under $q > \frac{1}{1+\overline{r}}$ and so the inequality is also necessary.

Denote by $N \triangleq \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr > 0$, and $M \triangleq \overline{r}\frac{\alpha^B}{2\alpha^A} - \int_{\underline{r}}^{\overline{r}} F^A(r)\, r dF^B(r)$. $M > 0$ because

$$\int_{\underline{r}}^{\overline{r}} F^A(r)\, r dF^B(r) < \overline{r}\int_{\underline{r}}^{\overline{r}} F^A(r)\, dF^B(r) = \overline{r}\int_{\underline{r}}^{\overline{r}} \frac{\alpha^B}{\alpha^A} F^B(r)\, dF^B(r) = \overline{r}\frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}} d\left(\frac{F^B(r)^2}{2}\right) = \overline{r}\frac{\alpha^B}{2\alpha^A}.$$

Collect terms in the key inequality (61), we have

$$\begin{aligned}
&\left\{\left[p_{HH}\left(1 - \frac{\alpha^B}{2\alpha^A}\right) + p_{LH}\right](p_{HH} + p_{HL})\frac{\alpha^B}{\alpha^A} - \left(p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}\right)(p_{HH} + p_{LH})\right\} N \\
\leq &p_{HH}\left[p_{HH}\left(1 - \frac{\alpha^B}{2\alpha^A}\right) + p_{LH} - \left(p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}\right)\right] M \qquad (62)
\end{aligned}$$

Let $\alpha^B = \alpha^A - \epsilon$ and calculate the coefficients. Note that as $\alpha^B = \alpha^A - \epsilon$, we have $p_{HL} - p_{LH} = (2q-1)\epsilon$.[27] The coefficient on the LHS of (62):

$$\begin{aligned}
&\left[p_{HH}\left(1 - \frac{\alpha^B}{2\alpha^A}\right) + p_{LH}\right](p_{HH} + p_{HL})\frac{\alpha^B}{\alpha^A} - \left(p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}\right)(p_{HH} + p_{LH}) \\
=&\left(\frac{p_{HH}}{2} + \frac{\epsilon}{2\alpha^A}p_{HH} + p_{LH}\right)(p_{HH} + p_{HL})\left(1 - \frac{\epsilon}{\alpha^A}\right) - \left(\frac{p_{HH}}{2} - \frac{\epsilon}{2\alpha^A}p_{HH} + p_{HL}\right)(p_{HH} + p_{LH}) \\
=&-\frac{p_{HH}}{2}(2q-1)\epsilon + \frac{\epsilon}{2\alpha^A}p_{HH}^2 - \frac{\epsilon}{2\alpha^A}p_{LH}p_{HH} - \frac{\epsilon}{\alpha^A}p_{LH}p_{HL}
\end{aligned}$$

The coefficient on the RHS of (62):

$$\begin{aligned}
p_{HH}\left[p_{HH}\left(1 - \frac{\alpha^B}{2\alpha^A}\right) + p_{LH} - \left(p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}\right)\right] &= \frac{\epsilon}{\alpha^A}p_{HH}^2 - p_{HH}(p_{HL} - p_{LH}) \\
&= \frac{\epsilon}{\alpha^A}p_{HH}^2 - p_{HH}(2q-1)\epsilon.
\end{aligned}$$

Plug the coefficients back into the inequality (62), so we need to show that

$$\begin{aligned}
0 \leq &\left\{\frac{\epsilon}{\alpha^A}p_{HH}^2 - p_{HH}(2q-1)\epsilon\right\} M - \left\{-\frac{p_{HH}}{2}(2q-1)\epsilon + \frac{\epsilon}{2\alpha^A}p_{HH}^2 - \frac{\epsilon}{2\alpha^A}p_{LH}p_{HH} - \frac{\epsilon}{\alpha^A}p_{LH}p_{HL}\right\} N \\
=&\left[(2q-1) - \frac{p_{HH}}{\alpha}\right]\frac{p_{HH}(N - 2M)}{2}\epsilon + \left(\frac{1}{2}p_{LH}p_{HH} + p_{LH}p_{HL}\right)\frac{N}{\alpha}\epsilon.
\end{aligned}$$

[27] We have $p_{HL} = q\alpha^A\left(1 - \alpha^B\right) + (1-q)\alpha^B\left(1 - \alpha^A\right)$ and $p_{LH} = q\left(1 - \alpha^A\right)\alpha^B + (1-q)\alpha^A\left(1 - \alpha^B\right)$ and then therefore $p_{HL} - p_{LH} = q\left(\alpha^A - \alpha^B\right) + (1-q)\left(\alpha^B - \alpha^A\right) = (2q-1)\epsilon$.

Note that

$$\begin{aligned}
N-2M &= \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr - 2\left(\overline{r}\frac{\alpha^B}{2\alpha^A} - \int_{\underline{r}}^{\overline{r}} F^A(r)\,r dF^B(r)\right) \\
&= \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr - 2\left(\overline{r}\frac{\alpha^B}{2\alpha^A} - \frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}} F^B(r)\,r dF^B(r)\right) \\
&= \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr - 2\left(\overline{r}\frac{\alpha^B}{2\alpha^A} - \frac{\alpha^B}{2\alpha^A}\overline{r} + \frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}} \frac{\left(F^B(r)\right)^2}{2}dr\right) \\
&= \int_{\underline{r}}^{\overline{r}} F^B(r)\,dr - \frac{\alpha^B}{\alpha^A}\int_{\underline{r}}^{\overline{r}}\left(F^B(r)\right)^2 dr > 0.
\end{aligned}$$

Therefore, one sufficient condition is

$$2q-1 \geq \frac{p_{HH}}{\alpha} = \frac{q\alpha^2 + (1-q)(1-\alpha)^2}{\alpha}.$$

Collecting terms, the condition above requires $q \geq 1-\alpha+\alpha^2$. Since $1-\alpha+\alpha^2$ increases in α for $\alpha \in \left(\frac{1}{2}, 1\right)$, this imposes a simple condition that prior needs to be sufficiently good and information technology α cannot be too high.

Note that the above primitive condition implies that Bank A has a higher overall lending probability,

$$\underbrace{p_{HH}\frac{\alpha^B}{2\alpha^A} + p_{HL}}_{\mathbb{P}(r^A<r^B\leq\infty)} - \left[\underbrace{p_{HH}\left(1-\frac{\alpha^B}{2\alpha^A}\right) + p_{LH}}_{\mathbb{P}(r^B<r^A\leq\infty)}\right] = \left(\alpha^A - \alpha^B\right)\left(2q-1-\frac{p_{HH}}{\alpha^A}\right). \tag{63}$$

In addition, Bank A's lending probability in event HH, which is $\frac{\alpha^B}{2\alpha^A}p_{HH}$ in Eq. (61), is slightly lower because $\frac{\alpha^B}{2\alpha^A} < \frac{1}{2}$. Combining both, this primitive condition means that Bank A's loan rates place relatively less weight on its "winning bids" (HH) and more weight on its "bids" (HL) than Bank B, which restricts the counterforce. □

The next result shows that under the bad-news signal structure, a higher $\overline{r}$ reduces the counterforces mentioned in the main text, thereby providing more insights into the primitive restrictions in Proposition 2.

Lemma A.7. *Under the bad-news signal structure, the gap between the nonspecialized Bank B's bids and its winning bids,* $\mathbb{E}\left[r^B \middle| r^B < r^A = \infty, LH\right] - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty, HH\right]$ *increases in* $\overline{r}$.

Proof. From the proof of Proposition 2 in Appendix A.5, we have the following expressions:

$$\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty, HH\right] = \overline{r} - \frac{\int_{\underline{r}}^{\overline{r}}\left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\}dr}{\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}},$$

$$\mathbb{E}\left[r^B \middle| r^B < r^A = \infty, LH\right] = \overline{r} - \frac{\int_{\underline{r}}^{\overline{r}} F^B(r)\,dr}{F^B(\overline{r})}.$$

We show the following increase in $\overline{r}$,

$$\mathbb{E}\left[r^B \middle| r^B < r^A = \infty, LH\right] - \mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty, HH\right] = \frac{\int_{\underline{r}}^{\overline{r}} \left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\} dr}{\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}} - \frac{\int_{\underline{r}}^{\overline{r}} F^B(r)\, dr}{F^B(\overline{r})}.$$

Taking derivative w.r.t. $\overline{r}$,

$$\partial \left\{ \frac{\int_{\underline{r}}^{\overline{r}} \left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\} dr}{\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}} - \frac{\int_{\underline{r}}^{\overline{r}} F^B(r)\, dr}{F^B(\overline{r})} \right\} \Big/ \partial \overline{r}$$

$$= \frac{\int_{\underline{r}}^{\overline{r}} F^B(r)\, dr \cdot \left(F^B(\overline{r})\right)' \cdot \left[\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}\right]^2 - \int_{\underline{r}}^{\overline{r}} \left\{\frac{1}{2} - \frac{\left[1-F^B(r)\right]^2}{2}\right\} dr \left[\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}\right]' \cdot F^B(\overline{r})^2}{\left[\frac{1}{2} - \frac{\left[1-F^B(\overline{r})\right]^2}{2}\right]^2 F^B(\overline{r})^2}$$

$$\propto \int_{\underline{r}}^{\overline{r}} F^B(r)\, dr \left(F^B(\overline{r})\right)' \left\{\frac{\left[2 - F^B(\overline{r})\right] F^B(\overline{r})}{2}\right\}^2 - \int_{\underline{r}}^{\overline{r}} \frac{\left[2 - F^B(\overline{r})\right] F^B(\overline{r})}{2} dr \left[1 - F^B(\overline{r})\right] \left(F^B(\overline{r})\right)' F^B(\overline{r})^2$$

$$\propto \int_{\underline{r}}^{\overline{r}} F^B(r)\, dr \cdot \frac{\left[2 - F^B(\overline{r})\right]^2}{4} - \int_{\underline{r}}^{\overline{r}} \left[F^B(r) - \frac{F^B(r)^2}{2}\right] dr \cdot \left[1 - F^B(\overline{r})\right]$$

$$= \int_{\underline{r}}^{\overline{r}} \left\{\frac{F^B(r)\, F^B(\overline{r})^2}{4} + \frac{F^B(r)^2}{2}\left[1 - F^B(\overline{r})\right]\right\} dr > 0,$$

where the first "propotional to ($\propto$)" omits the positive denominator, and the second omits $\left(F^B(\overline{r})\right)' F^B(\overline{r})^2$, which is positive because $F^B(\overline{r}) = \frac{\overline{r}-\underline{r}}{\overline{r}-\underline{r}+\underline{r}\alpha^A}$ ($\underline{r} = \frac{q}{(1-q)(1-\alpha^B)}$ is a constant in $\overline{r}$.)

Therefore, for the nonspecialized Bank B, the gap between its bids $\mathbb{E}\left[r^B \middle| r^B < r^A = \infty, LH\right]$ and winning bids $\mathbb{E}\left[r^B \middle| r^B < r^A \leq \infty, HH\right]$ widens as $\overline{r}$ increases, which could potentially lead to a negative interest rate wedge. For example, in the extreme case of $\overline{r} \to \infty$, both approach infinity but the bids have a higher order; this combined with the fact that Bank B's rate has a higher weight on its bids than Bank A (more likely to make mistakes, $p_{LH} > p_{HL}$) generates a negative interest rate wedge when $\overline{r} \to \infty$.

□

A.6 Calibration

In this section we explain the details of the empirical moments we use to calibrate parameters $\left\{q, \alpha^A, \alpha^B\right\}$, for both bad news and symmetric signal structures. We fix $\overline{r} = 0.36$.

The first two empirical moments that we aim to match are the NPL rates of specialized and non-specialized (stress-tested) banks in our Y14Q.H1 data for stress-tests banks (see Section B for more details). The two NPL rates are 3% (specialized) and 4% (non-specialized) as reported in Table B.1.

The third moment is the average loan approval rate for large U.S. banks (Chart 11 in DeSpain and Pandolfo (2024); we take large banks to be consistent with Y14Q.H1 data which is for large stress test banks). Note this moment is average across banks and loan applications; but since we do not observe the proportions of loans applications that specialized and non-specialized lenders receive, we follow the theory with one specialized bank and one non-specialized bank to assign a weight of half for each bank.

Bad-news information structure. Using results in Appendix A.4.2 and A.5, one can calculate the three model-implied moments under a bad-news information structure to be

$$3\% = \mathbb{P}\left(\theta = 0 \middle| r^A < r^B < \infty\right) = \frac{1}{\frac{q}{1-q}\frac{\frac{1}{2}+\frac{\left[1-F^B(\overline{r})\right]^2}{2}}{(1-\alpha^A)(1-\alpha^B)\left\{\frac{1}{2}+\frac{\left[1-F^B(\overline{r})\right]^2}{2}\right\}+(1-\alpha^A)\alpha^B}+1},$$

$$4\% = \mathbb{P}\left(\theta = 0 \middle| r^B < r^A < \infty\right) = \frac{1}{\frac{q}{1-q}\frac{\frac{1}{2}-\frac{\left[1-F^B(\overline{r})\right]^2}{2}}{(1-\alpha^A)(1-\alpha^B)\left\{\frac{1}{2}-\frac{\left[1-F^B(\overline{r})\right]^2}{2}\right\}+\alpha^A(1-\alpha^B)F^B(\overline{r})}+1},$$

$$0.5 = \frac{1}{2}\mathbb{P}(g^A = H) + \frac{1}{2}\mathbb{P}(g^B = H)F^B(\overline{r}) = \frac{q + (1-q)(1-\alpha^A)}{2} + \frac{[q + (1-q)(1-\alpha^B)]F^B(\overline{r})}{2},$$

where $F^B(\overline{r}) = \frac{\frac{\overline{r}}{\underline{r}}-1}{\frac{\overline{r}}{\underline{r}}-1+\alpha^A}$ and $\underline{r} = \frac{(1-q)(1-\alpha^B)}{q}$. The resulting calibrated parameters are $\alpha^A = 0.984$, $\alpha^B = 0.977$, and $q = 0.506$, under which $\Delta r = 0.26\%$.

Symmetric information structure. Using results in Appendix A.4.2 and A.5, one can calculate the three model-implied moments under a symmetric information structure to be

$$3\% = \mathbb{P}\left(\theta = 0 \middle| r^A < r^B < \infty\right) = \frac{1}{\frac{q}{1-q}\frac{\alpha^A\alpha^B\left[1-F^B(\overline{r})+\frac{\alpha^B}{2\alpha^A}(F^B(\overline{r}))^2\right]+\alpha^A(1-\alpha^B)}{(1-\alpha^A)(1-\alpha^B)\left[1-F^B(\overline{r})+\frac{\alpha^B}{2\alpha^A}(F^B(\overline{r}))^2\right]+(1-\alpha^A)\alpha^B}+1},$$

$$4\% = \mathbb{P}\left(\theta = 0 \middle| r^B < r^A < \infty\right) = \frac{1}{\frac{q}{1-q}\frac{\alpha^A\alpha^B\left[F^B(\overline{r})-\frac{\alpha^B}{2\alpha^A}(F^B(\overline{r}))^2\right]+(1-\alpha^A)\alpha^B F^B(\overline{r})}{(1-\alpha^A)(1-\alpha^B)\left[F^B(\overline{r})-\frac{\alpha^B}{2\alpha^A}(F^B(\overline{r}))^2\right]+\alpha^A(1-\alpha^B)F^B(\overline{r})}+1},$$

$$0.5 = \frac{1}{2}\mathbb{P}(g^A = H) + \frac{1}{2}\mathbb{P}(g^B = H)F^B(\overline{r}) = \frac{q\alpha^A + (1-q)(1-\alpha^A)}{2} + \frac{[q\alpha^B + (1-q)(1-\alpha^B)]F^B(\overline{r})}{2},$$

where

$$F^B(\overline{r}) = \frac{\alpha^A\overline{r} - \underline{r}}{\alpha^A\alpha^B\overline{r} - \frac{1-q}{q}(1-\alpha^A)(1-\alpha^B)},$$

and

$$\underline{r} = \begin{cases} \frac{(1-q)\left(1-\alpha^B\right)}{q}, & \text{if } q\left(1-\alpha^A\right)\alpha^B\overline{r} < (1-q)\,\alpha^A\left(1-\alpha^B\right), \\ \frac{q\alpha^A\left(1-\alpha^B\right)\overline{r}+(1-q)\left(1-\alpha^A\right)\left(1-\alpha^B\right)}{q\alpha^A}, & \text{if } q\left(1-\alpha^A\right)\alpha^B\overline{r} \geq (1-q)\,\alpha^A\left(1-\alpha^B\right). \end{cases}$$

The resulting calibrated parameters are $\alpha^A = 0.984$, $\alpha^B = 0.977$, and $q = 0.510$, under which $\Delta r = 0.17\%$.

Non-zero recovery rate. We have solved the model with non-zero recovery in Appendix A.4. For calibration we set the recovery to be $\delta = 0.6$ which is about the average recovery rate in the

Y-14 data (including all types of collateral). We then recalibrate our three parameters for canonical models.

Importantly, a positive recovery does not affect the functional forms of the key empirical moments and they are still the same as above. However, endogenous equilibrium variables such as $F^B(\overline{r})$ which enter these moments is a function of recovery rate δ. For instance, for bad-news information structure, $F^B(\overline{r}) = \frac{\alpha^A \overline{r} - \underline{r}}{\alpha^A \alpha^B \overline{r} - \frac{1-q}{q}(1-\alpha^A)(1-\alpha^B)} = \frac{\overline{r} - \frac{(1-q)\left(1-\alpha^B\right)(1-\delta)}{q}}{\overline{r} - \frac{(1-q)(1-\alpha^A)(1-\alpha^B)(1-\delta)}{q}}$; the resulting calibrated parameters are the calibrated parameters are $q = 0.5006$, $\alpha^A = 0.9843$, $\alpha^B = 0.9789$ which yield a positive interest rate wedge of $\Delta r = 4 \times 10^{-4}$.

A.7 Is $\pi^B > 0$ a necessary condition for $\Delta r < 0$? A special case.

The discussion above seems to suggest that a profitable weak bank is necessary for a negative interest rate wedge. This is not true, as shown by Proposition A.2 which considers a degenerate general fundamental (so Bank B is uninformed) and a uniformly distributed specialized signal.

Proposition A.2. ***(A Special Case of Uniform Distribution)*** *Suppose $\overline{r} = \infty$ so that rejection is off equilibrium, general signals are degenerate ($q_g = 1$ or $\alpha_u = \alpha_d = 0.5$), and the specialized signal's distribution follows $\phi(s) = 1 + \epsilon\left[2 \cdot \mathbf{1}_{s \le 0.5} - 1\right]$. In equilibrium, i) $\pi^B = 0$ always, ii) $\Delta r = 0$ when $\epsilon = 0$ (i.e., $s \sim \mathbb{U}[0,1]$), and iii) $\Delta r > 0$ ($\Delta r < 0$) when $\epsilon > 0$ ($\epsilon < 0$) for infinitesimal ϵ.*

Proof. Based on the credit competition equilibrium in Proposition 1, the expected rates of a lender's issued loan are:

$$\mathbb{E}\left[r^A \middle| r^A < r^B \le \infty\right] = \frac{\underbrace{p_{HH}}_{g^A=g^B=H} \int_x^1 \underbrace{\left[1 - F^B\left(r^A(t)^-\right)\right]}_{A \text{ wins}} r^A(t)\,\phi(t)\,dt + \underbrace{p_{HL}}_{g^A=L, g^B=L} \int_x^1 r^A(t)\,\phi(t)\,dt}{p_{HH}\int_x^1 \left[1 - F^B\left(r^A(t)^-\right)\right]\phi(t)\,dt + p_{HL}\int_x^1 \phi(t)\,dt},$$

$$\mathbb{E}\left[r^B \middle| r^B < r^A \le \infty\right] = \frac{\underbrace{p_{HH}}_{g^A=g^B=H} \int_{\hat{s}}^1 \underbrace{\Phi(t)}_{B \text{ wins}} r(t)\,d\left[-F^B(r(t))\right] + \underbrace{p_{LH}}_{g^A=L, g^B=H} \int_x^1 r(t)\,d\left[-F^B(r(t))\right]}{p_{HH}\int_{\hat{s}}^1 \Phi(t)\,d\left[-F^B(r(t))\right] + p_{LH} F^B(\overline{r})}.$$

In positive weak equilibrium, $F^B(r(s))$ has a point mass of size $1 - F^B(\overline{r}^-)$ at $\overline{r}$ or $r^A(\hat{s})$.

In this proposition, we impose the following conditions a) general signals are degenerate with $q_g = 1$ and b) $\overline{r} \to \infty$. (The logic for $\alpha_u = \alpha_d = 0.5$ so that lenders ignore the general signals are the same.) Then

$$\mathbb{E}\left[r^A + 1 \middle| r^A < r^B \le \infty\right] = \frac{\int_0^1 \left[1 - F^B\left(r^A(t)^-\right)\right] r^A(t)\,\phi(t)\,dt}{\int_0^1 \left[1 - F^B\left(r^A(t)^-\right)\right]\phi(t)\,dt} = \frac{\int_0^1 \Phi(t)\,\phi(t)\,dt}{\int_0^1 \left[\int_0^t \nu\phi(\nu)\,dt\right]\phi(t)\,dt},$$

$$\mathbb{E}\left[r^B + 1 \middle| r^B < r^A \le \infty\right] = \frac{\int_0^1 \Phi(t)\,r(t)\,d\left[-F^B(r(t))\right]}{\int_0^1 \Phi(t)\,d\left[-F^B(r(t))\right]} = \frac{\int_0^1 \Phi(t)\left[\frac{t\Phi(t)}{\int_0^t \nu\phi(\nu)d\nu}\right]\phi(t)\,dt}{\int_0^1 \Phi(t)\,t\phi(t)\,dt},$$

where the first equality of both variables uses condition a) degenerate signals and $x = \hat{s} = 0$ which follows from condition b), and the second equality uses equilibrium strategy $r^A(t) = \frac{\Phi(s)}{\int_0^s t\phi(t)dt}$ and

$1-F^{B}\left(r^{A}\left(t\right)^{-}\right)=\frac{\int_{0}^{t}\nu\phi(\nu)d t}{q_{s}}.$

Additionally, c) the specialized signal distribution is $\phi\left(s\right)=1+\epsilon\left[2\cdot\mathbf{1}_{s\leq0.5}-1\right]$. Then

$$\mathbb{E}\left[r^{A}+1\middle|\,r^{A}<r^{B}\leq\infty\right]=2\cdot\frac{\frac{1}{8}\left(1+\epsilon\right)^{2}+\frac{\epsilon(1-\epsilon)}{2}+\frac{3}{8}\left(1-\epsilon\right)^{2}}{\frac{1}{24}\left(1+\epsilon\right)^{2}+\frac{\epsilon(1-\epsilon)}{4}+\frac{7}{24}\left(1-\epsilon\right)^{2}},$$

$$\mathbb{E}\left[r^{B}+1\middle|\,r^{B}<r^{A}\leq\infty\right]=2\cdot\frac{\frac{1}{8}\left(1+\epsilon\right)^{2}+\frac{\epsilon(1-\epsilon)}{2}+\frac{3}{8}\left(1-\epsilon\right)^{2}+\epsilon^{2}\left(1-\epsilon\right)\int_{0.5}^{1}\frac{\left(t-\frac{1}{2}\right)}{\frac{\epsilon}{2}+(1-\epsilon)t^{2}}dt+\epsilon\left(1-\epsilon\right)^{2}\int_{0.5}^{1}\frac{t\left(t-\frac{1}{2}\right)}{\frac{\epsilon}{2}+(1-\epsilon)t^{2}}dt}{\frac{1}{24}\left(1+\epsilon\right)^{2}+\frac{3\epsilon(1-\epsilon)}{8}+\frac{7}{24}\left(1-\epsilon\right)^{2}}.$$

Note that when $\epsilon=0$, $\Delta r=0$. When $\epsilon\to0$, we have (ignoring higher order terms of ϵ)

$$\frac{\partial\Delta r}{\partial\epsilon}=\lim_{\epsilon\to0}\frac{\Delta r\left(\epsilon\right)}{\epsilon}=\frac{1}{\epsilon}\left(\frac{1}{\frac{1}{3}-\frac{1}{4}\epsilon}-\frac{1+\epsilon-\epsilon\ln2}{\frac{1}{3}-\frac{1}{8}\epsilon}\right)=3\ln2-\frac{15}{8}>0.$$

Hence, when $\epsilon>0$ ($\epsilon<0$), i.e., $\phi(s)$ tilts toward less (more) favorable realizations, we have $\Delta r>0$ ($\Delta r<0$). □

A.8 Information Acquisition

In this section, we characterize the incentive compatibility condition and lending profits and then provide a numerical illustration in which the specialization equilibrium arises.

Incentive compatibility conditions. Banks make their information acquisition decisions simultaneously, and we assume that information acquisition is observable when banks enter the credit market competition game. Therefore a lender's deviation from the proposed equilibrium information acquisition will lead to a different information structure in the credit market competition, and we need to derive equilibrium lending profits in all possible subgames following a deviation.

Denote by $\Pi_{j}^{i}\left(I_{A}^{g},I_{A}^{s},I_{B}^{s},I_{B}^{s}\right)$ the expected lending profits of bank j in firm i when the information structure in firm i is given by $\left(I_{A}^{g},I_{A}^{s},I_{B}^{g},I_{B}^{s},\right)$, where I_{j}^{g} and I_{j}^{s} take value of one if bank j acquired general and specialized signals in firm i, respectively, and zero otherwise. The symmetry on industries implies that a bank's expected lending profits in firm i only depend on the information structure in that industry but not on the industry itself, i.e.,

$$\Pi_{j}^{a}\left(I_{A}^{g},I_{A}^{s},I_{B}^{s},I_{B}^{g}\right)=\Pi_{j}^{b}\left(I_{A}^{g},I_{A}^{s},I_{B}^{g},I_{B}^{s}\right). \tag{64}$$

Therefore, we drop index i from the expected lending profits. Moreover, we focus on Bank A's incentives in what follows since the no deviation conditions for banks A and B are symmetric.

Bank A can deviate along three dimensions: it can choose not to acquire general information, it can choose not to acquire specialized information about firm a, and it can choose to acquire specialized information in firm b. Bank A's incentives to deviate along these dimensions will depend on the costs of acquiring information. As one would expect, the lower the cost of acquiring general information, the more likely Bank A has incentives to acquire general information and not deviate along this dimension. For deviations along the specialized information dimension, the cost of acquiring specialized information has to be low enough such that it is worth acquiring specialized information in firm a and having an informational advantage over Bank B in this firm but high enough such that it is not worth acquiring specialized information in firm b to stop being the less informed lender. This intuition can be formally stated in the following incentive compatibility constraints. Bank A does not want to deviate by

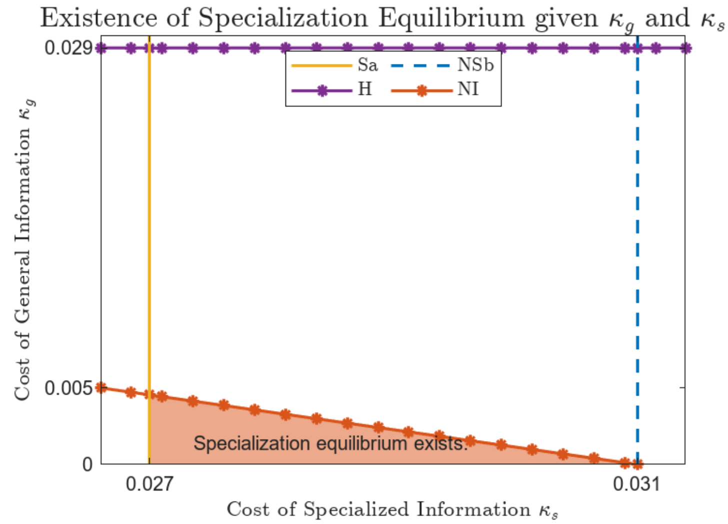

Figure A.1: **Specialization Equilibrium.** This figure depicts the incentive compatibility constraints where Bank A does not want to deviate from the specialization equilibrium. Parameters: $\bar{r} = 0.36$, $q_g = 0.8$, $q_s = 0.9$, $\alpha_u = \alpha_d = \alpha = 0.7$, and $\tau = 1$. Note τ captures the signal-to-noise ratio of Bank A's specialized information technology as $s = \mathbb{E}[\theta_s|\theta_s + \epsilon]$ and $\epsilon \sim \mathcal{N}(0, 1/\tau)$.

1. not acquiring general information:

$$\Pi_A (I_A^g = 1, I_A^s = 1, I_B^g = 1, I_B^s = 0) - \Pi_A (I_A^g = 0, I_A^s = 1, I_B^g = 1, I_B^s = 0) + \\ \Pi_A (I_A^g = 1, I_A^s = 0, I_B^g = 1, I_B^s = 1) - \Pi_A (I_A^g = 0, I_A^s = 0, I_B^g = 1, I_B^s = 1) \geq \kappa_g; \tag{G}$$

2. not acquiring general information nor specialized information in firm a:

$$\Pi_A (I_A^g = 1, I_A^s = 1, I_B^g = 1, I_B^s = 0) - \Pi_A (I_A^g = 0, I_A^s = 0, I_B^g = 1, I_B^s = 0) + \\ \Pi_A (I_A^g = 1, I_A^s = 0, I_B^g = 1, I_B^s = 1) - \Pi_A (I_A^g = 0, I_A^s = 0, I_B^g = 1, I_B^s = 1) \geq \kappa_g + \kappa_s; \tag{NI}$$

3. not acquiring specialized information in firm a:

$$\Pi_A (I_A^g = 1, I_A^s = 1, I_B^g = 1, I_B^s = 0) - \Pi_A (I_A^g = 1, I_A^s = 0, I_B^g = 1, I_B^s = 0) \geq \kappa_s; \tag{Sa}$$

4. and, acquiring specialized information in firm b:

$$\Pi_A (I_A^g = 1, I_A^s = 1, I_B^g = 1, I_B^s = 1) - \Pi_A (I_A^g = 1, I_A^s = 0, I_B^g = 1, I_B^s = 1) \leq \kappa_s. \tag{NSb}$$

Essentially, constraints (G) and (NI) impose an upper bound on κ_g so that Bank A wants to acquire general information. Analogously, constraints (NI) and (Sa) impose an upper bound on κ_s so that Bank A wants to acquire specialized information in firm a, while Constraint (NSb) imposes a lower bound on κ_s to ensure that it does not want to be specialized in firm b.

Figure A.1 illustrates the existence of a symmetric specialization equilibrium. The lines in the figure represent the combination of information acquisition costs such that the incentive compatibility constraints are satisfied with equality. The shaded area represents the combinations of information acquisition costs for which all constraints are satisfied, and hence, a specialization equilibrium exists. The figure uses the characterization of lending profits in the next section.

Lending Profits

We characterize lending profits as a function of information acquisition, $\Pi_A\left(I_A^g, I_A^s, I_B^g, I_B^s\right)$ (we focus on Bank A due to symmetry.) We omit the case where there is an uninformed lender.

$\mathbf{I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=0}$ **(Specialization).** This is the equilibrium that we focus on—each lender has a general information signal and only Bank A has a specialized signal s. Bank A's expected lending profit before signal realizations is thus

$$\Pi_A\left(I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=0\right)=\int_x^1 \pi^A\left(r^A(s)\middle| s\right)\phi(s)\,ds,$$

where $\pi^A\left(r^A(s)\middle| s\right)$ is the profits for given signal realizations H and s and is given in Eq. (9). Using the equilibrium strategies in Proposition 1, we have

$$\pi^A\left(r^A(s)\middle| s\right)=p_{HH}\cdot\frac{\int_0^{\max\{s,\hat{s}\}}(s-t)\,\phi(t)\,dt}{q_s}+\left(\pi^B+p_{LH}\right)\cdot\frac{s}{q_s}-p_{HL},\ \text{for } s\geq x.$$

The expression shows that Bank A earns the information rent from the specialized signal. Bank A observes s, while Bank B may only negatively update the prior q_s when winning the competition that $s^A\leq s(r)$; this is reflected in the terms $\frac{s}{q_s}$ and $\frac{1}{q_s}\int_0^{\min\{s,\hat{s}\}}(s-t)\,\phi(t)\,dt$.

In this case, Bank B's profit $\Pi_B\left(I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=0\right)=\pi^B$ is given in Lemma 2. By symmetry, $\Pi_A\left(I_A^g=1, I_A^s=0, I_B^g=1, I_B^s=1\right)=\Pi_B\left(I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=0\right)=\pi^B$.

$\mathbf{I_A^g=0, I_A^s=1, I_B^g=1, I_B^s=0}$ **(Asymmetric technology).** In this case, Bank A only collects specialized information while Bank B only collects general information in industry a. This case is nested in the previous case of specialization ($I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=0$), by reformulating Bank A to have an uninformative general signal, e.g.,

$$\mathbb{P}\left(g^A=H\middle|\theta_g=1\right)=\mathbb{P}\left(g^A=H\middle|\theta_g=0\right)=1.$$

$\mathbf{I_A^g=1, I_A^s=0, I_B^g=1, I_B^s=0}$ **(General information only).** In this case, both lenders only acquire general information, i.e., investing in IT and data processing that apply to both industries. The credit competition corresponds to Broecker (1990) with two lenders. Lenders are symmetric and the lending profit of, say Bank A, is

$$\Pi_A\left(I_A^g=1, I_A^s=0, I_B^g=1, I_B^s=0\right)=\max\left\{p_{HL}\left(\mu_{HL}q_s\overline{r}-1\right),0\right\}.$$

The "max" operator arises because either both lenders withdraw with positive probability (zero profits), or both lenders make profits and neither has a point mass at $\overline{r}$, i.e., $F^j\left(\overline{r}^-\right)=1$.

$\mathbf{I_A^g=1, I_A^s=1, I_B^g=1, I_B^s=1}$ **(Acquire all information).** In this symmetric case, each lender invests in both information technologies and receives both the general and specialized signals. We characterize the credit market equilibrium based on Riordan (1993) which considers the competition between two lenders each with a continuous private signal. Here, each lender additionally has a binary signal that represents the general information. Following the modeling of Riordan (1993), we work with the direct specialized signal z. Specifically, let z and Z denote the realization and the random variable of the specialized signal respectively, and let

$$\tilde{F}(z)\equiv\mathbb{P}\left(Z\leq z\middle|\theta_s=1\right),\ \tilde{G}(z)\equiv\mathbb{P}\left(Z\leq z\middle|\theta_s=0\right)$$

denote the CDFs of Z conditional on the underlying state θ_s, with the corresponding PDFs denoted by $\tilde{f}$ and $\tilde{g}$. Introduce $\mu(z) \equiv \mathbb{P}(\theta_s = g|\, S)$ as the posterior belief, which is s in our baseline model.

A lender only bids when the general signal is H and the specialized signal $z \geq x$. Let $R(z) \equiv r(z) + 1$ denote the equilibrium gross rate quote. Given competitor's strategy $R(z)$, the lending profits from any R is then

$$\pi(R|z) = \left[p_{HH}\mu_{HH}\mu(z)\tilde{F}(t(R)) + p_{HL}\mu_{HL}\mu(z)\right]R \\ - p_{HH}\left[(1-\mu(z))\tilde{G}(t(R)) + \mu(z)\tilde{F}(t(R))\right] - p_{HL}, \tag{65}$$

where $t(R)$ the signal such that the other bank offers R. The first order condition w.r.t. R is

$$\frac{\partial\pi(R(t)|z)}{\partial R} = \left[p_{HH}\mu_{HH}\mu(z)\tilde{F}(t) + p_{HL}\mu_{HL}\mu(z)\right] \\ + \left\{p_{HH}\mu_{HH}\mu(z)\tilde{f}(t)R(t) - p_{HH}\left[(1-\mu(z))\tilde{g}(t) + \mu(z)\tilde{f}(t)\right]\right\}\frac{dt}{dR}.$$

The equilibrium strategy satisfies

$$\left.\frac{\partial\pi(R(t)|z)}{\partial t}\right|_{t=z} = 0.$$

By symmetry, we have

$$\frac{dt}{dR} = \frac{1}{R'(t)}.$$

These two conditions imply

$$p_{HH}\mu_{HH}\tilde{f}(z)R(z) + \left(p_{HH}\mu_{HH}\tilde{F}(z) + p_{HL}\mu_{HL}\right)R'(z) = \frac{p_{HH}(1-\mu(z))\tilde{g}(z) + p_{HH}\mu(z)\tilde{f}(z)}{\mu(z)}, \tag{66}$$

or equivalently,

$$\frac{d\left\{\left[p_{HH}\mu_{HH}\tilde{F}(z) + p_{HL}\mu_{HL}\right]R(z)\right\}}{dz} = \frac{p_{HH}(1-\mu(z))\tilde{g}(z) + p_{HH}\mu(z)\tilde{f}(z)}{\mu(z)}.$$

Integrating over z, we have

$$R(z) = \frac{\int_{\underline{z}}^{z}\frac{p_{HH}(1-\mu(t))\tilde{g}(t)+p_{HH}\mu(t)\tilde{f}(t)}{\mu(t)}dt + constant}{p_{HH}\mu_{HH}\tilde{F}(z) + p_{HL}\mu_{HL}}. \tag{67}$$

The unknown constant is pinned down by the boundary condition $\pi(\overline{r}+1|x) = 0$: Upon the threshold signal x, a lender quotes the maximum interest rate $\overline{r}+1$ and makes zero profit,

$$0 = \left[p_{HH}\mu_{HH}\mu(x)\tilde{F}(x) + p_{HL}\mu_{HL}\mu(x)\right](\overline{r}+1) - p_{HH}\left[(1-\mu(x))\tilde{G}(x) + \mu(x)\tilde{F}(x)\right] - p_{HL}. \tag{68}$$

Then a lender's lending profit is

$$\Pi_A(I_A^g = 1, I_A^s = 1, I_B^g = 1, I_B^s = 1) = \int_x^{\overline{z}}\pi(R(z)|\,z)\left[q_s\tilde{f}(z) + (1-q_s)\tilde{g}(z)\right]dz,$$

where $R(z)$ is given by Eq. (67) and (68), profit $\pi(R(z), z)$ is given by Eq. (65).

A.9 Generalized Information Structure

It is convenient to work with the direct specialized signal z (now posterior s may depend on the realizations of the general signals). We focus on the well-behaved structure (i.e., smooth distribution of interest rates over $[\underline{r}, \overline{r})$ and decreasing $r^A(z)$) and show that the lender strategies in Proposition A.3 correspond to an equilibrium. We impose the following primitive conditions under which the general signal is decisive.

Assumption 3. *i) Bank A rejects the borrower upon an L general signal, regardless of any specialized signal z:*

$$\mu_{L\cdot}(\overline{z})(\overline{r}+1)-1<0. \tag{69}$$

ii) Bank B is willing to participate if and only if its general signal $g^B = H$:

$$\int_{\underline{z}}^{\overline{z}} p_{\cdot H}(t)\left[\mu_{\cdot H}(t)(\overline{r}+1)-1\right]dt>0. \tag{70}$$

Consider a specialized signal $z \sim \phi_z(z)$ for $z \in [\underline{z}, \overline{z}]$ where both $\underline{z}$ and $\overline{z}$ can be unbounded. Denote by $\mu_{g^A g^B}(z) \equiv \mathbb{P}\left(\theta = 1 \middle| g^A, g^B, z\right)$ the posterior probability density for $\theta = 1$, i.e., the state of project success. Without loss of generality, we assume that $\mu_{HH}(z)$ strictly increases in z (as we can always use $\mu_{HH}(z)$ as a signal; recall the posterior s serves as the signal in the baseline model given in Section 1). This implies that just as in the baseline, there exists $\hat{z}$ at which Bank A starts quoting $\overline{r}$, and z_x below which it starts rejecting borrowers. Let $\overline{\mu}_{g^A g^B} \equiv \mathbb{P}\left(\theta = 1 | g^A, g^B\right)$ denote the posterior probability of $\theta = 1$ based on general signals.

Let $p_{g^A g^B}(z) \equiv \mathbb{P}\left(g^A, g^B, z\right)$, $\overline{p}_{g^A g^B} \equiv \mathbb{P}\left(g^A, g^B\right)$, and $\alpha_u^j \equiv \mathbb{P}\left(g^j = H | \theta = 1\right)$ for $j \in \{A, B\}$ (so two lenders can differ in their precisions in general signals). Finally, let $\phi_z(z|\theta = 1)$ be the density of z conditional on $\theta = 1$. The following proposition generalizes Proposition 1 by showing that the simple equilibrium structure survives under the more generalized information structure. This is because lenders only consider the marginal good type borrower who is payoff relevant, so the key argument in the baseline model still applies given signals' independence conditional on project success. As a result, the effects of specialized and general signals on equilibrium strategies are separable, and a simple characterization as in Proposition A.3 ensues.

Proposition A.3. ***(Credit Market Equilibrium under General Information Structure)*** *Lender $j \in \{A, B\}$ rejects the borrower (by quoting $r = \infty$) upon $g^j = L$; when $g^j = H$, lender j may make offers from a common support $[\underline{r}, \overline{r}]$ (or reject) with the following properties.*

1. *Bank A who observes a specialized signal z offers*

$$r^A(z)=\begin{cases}\min\left\{\dfrac{\pi^B+\int_{\underline{z}}^{z}p_{HH}(t)dt+\overline{p}_{LH}}{\int_{\underline{z}}^{z}p_{HH}(t)\cdot\mu_{HH}(t)dt+\overline{p}_{LH}\overline{\mu}_{LH}}-1,\overline{r}\right\}, & for \quad z\in[z_x,\overline{z}]\\ \infty, & for \quad z\in[\underline{z},z_x).\end{cases} \tag{71}$$

   This equation pins down $\underline{r} = r^A(\overline{z})$, $\hat{z} = \sup\left\{z : r^A(z) = \overline{r}\right\}$, and $z_x = \sup\left\{z : r^A(z) = \infty\right\}$.

2. *Bank B makes an offer by randomizing its rate according to:*

$$F^B(r)=\begin{cases}\frac{\alpha_u^A}{\alpha_u^B}\left[1-\int_{\underline{z}}^{z^A(r)}\phi_z(t|\theta=1)\,dt\right], & for \quad r\in[\underline{r},\overline{r}),\\ 1-\mathbf{1}_{\{\pi^B=0\}}\cdot\left\{1-\frac{\alpha_u^A}{\alpha_u^B}\left[1-\int_{\underline{z}}^{\hat{z}}\phi_z(t|\theta=1)\,dt\right]\right\}, & for \quad r=\overline{r}.\end{cases} \tag{72}$$

3. *The endogenous non-specialized Bank B's profit $\pi^B \geq 0$ is determined similarly as Lemma 2, with detailed expression provided in Appendix A.9.*

Proof. Similar as the derivation in the baseline model, we first take π^B as given to characterize lender strategy, and then solve for π^B.

Bank A's strategy

In the region of $z \in (\hat{z}, 1]$ that corresponds to $r^A(z) \in [\underline{r}, \overline{r})$, $r^A(\cdot)$ is strictly decreasing so the inverse function $z^A(\cdot) \equiv r^{A(-1)}(\cdot)$ is properly defined. Bank B's lending profit when quoting $r \in [\underline{r}, \overline{r})$ is

$$\pi^B(r) = \underbrace{\overline{p}_{HH}}_{g^A=H} \cdot \underbrace{\int_{\underline{z}}^{z^A(r)}}_{B\,\text{wins}} \left[\underbrace{\mu_{HH}(t)}_{\text{repay}}(1+r) - 1\right]\phi_z(t|HH)\,dt + \underbrace{\overline{p}_{LH}}_{g^A=L}\left[\underbrace{\overline{\mu}_{LH}}_{\text{repay}}(1+r) - 1\right]$$
$$= (1+r)\left[\int_{\underline{z}}^{z^A(r)} p_{HH}(t)\,\mu_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}\right] - \int_{\underline{z}}^{z^A(r)} p_{HH}(t)\,dt - \overline{p}_{LH} \tag{73}$$

Bank A's equilibrium strategy $r^A(z)$ for $z \in [\hat{z}, 1]$ is such that Bank B is indifferent across $r \in [\underline{r}, \overline{r})$. Hence,

$$r^A(z) = \frac{\overbrace{\pi^B + \int_{\underline{z}}^{z} p_{HH}(t)\,dt + \overline{p}_{LH}}^{B\text{'s lending amount}}}{\underbrace{\int_{\underline{z}}^{z} p_{HH}(t)\cdot\mu_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}}_{B\text{'s customers who repay}}} - 1, \quad \text{where} \quad \hat{z} \leq s \leq \overline{z}. \tag{74}$$

Note that this pins down $\underline{r} = (r^A)^{-1}(\overline{z})$ which is a function of π^B.

In addition, $r^A(z) = \overline{r}$ for $z \in [z_x, \hat{z})$ and Bank A rejects the borrower when $z \in [\underline{z}, z_x)$, where z_x satisfies

$$\pi^A\left(r^A(z_x) = \overline{r}\,\middle|\, z_x\right) = 0.$$

This completes the proof of Bank A's strategy in Proposition A.3.

Bank B's strategy

Bank A's offered interest rate $r^A(z)$ upon $z \in [\hat{z}, \overline{z}]$ maximizes

$$\pi^A\left(r^A(z)\middle| z\right) = \underbrace{p_{HH}(z)}_{g^B=H}\underbrace{\left[1 - F^B(r)\right]}_{A\text{ wins}}\left[\underbrace{\mu_{HH}(z)}_{\text{repay}}(1+r) - 1\right] + \underbrace{p_{HL}(z)}_{g^B=L}\left[\underbrace{\mu_{HL}(z)}_{\text{repay}}(1+r) - 1\right]$$

The FOC with respect to r is

$$\underbrace{\left[-\frac{d\left[F^B(r)\right]}{dr}\right]}_{\Delta\text{winning prob}}\underbrace{p_{HH}(z)\left[\mu_{HH}(z)(1+r) - 1\right]}_{\text{profit upon winning}} + \underbrace{p_{HH}(z)\left[1 - F^B(r)\right]\mu_{HH}(z) + p_{HL}(z)\,\mu_{HL}(z)}_{\text{existing customer}} = 0.$$

Bank A's optimal strategy $r^A(z)$ satisfies this first-order condition,

$$0 = -\frac{d\left[F^B\left(r^A(z)\right)\right]}{dr} p_{HH}(z)\left[\mu_{HH}(z)\left(1+r^A(z)\right)-1\right] + p_{HH}(z)\left[1-F^B\left(r^A(z)\right)\right]\mu_{HH}(z) + p_{HL}(z)\mu_{HL}(z). \tag{75}$$

From Eq. (74) about $r^A(z)$, we derive the following key equation by taking derivatives w.r.t. z,

$$\underbrace{\frac{dr^A(z)}{dz}\left[\int_{\underline{z}}^{z} p_{HH}(t)\mu_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}\right]}_{\text{B: }\uparrow\text{marginal customer return}} + \underbrace{p_{HH}(z)\left[\left(r^A(z)+1\right)\mu_{HH}(z)-1\right]}_{\text{B: }\uparrow\text{existing customer revenue}} = 0.$$

Plug this equation into the FOC (75), and we have

$$-\frac{d\left[F^B\left(r^A(z)\right)\right]}{dz}\left[\int_{\underline{z}}^{z} p_{HH}(t)\mu_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}\right] = p_{HH}(z)\left[1-F^B(r)\right]\mu_{HH}(z) + p_{HL}(z)\mu_{HL}(z),$$

which is equivalent to

$$\frac{d}{dz}\left\{\frac{1-F^B\left(r^A(z)\right)}{\int_{\underline{z}}^{z}\mu_{HH}(t)p_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}}\right\} = \frac{p_{HL}(z)\mu_{HL}(z)}{\left[\int_{\underline{z}}^{z} p_{HH}(t)\mu_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}\right]^2}. \tag{76}$$

Since signals are independent conditional on the state being $\theta=1$, the right-hand-side equals

$$\begin{aligned}
&\frac{q\mathbb{P}(HL|\theta=1)\phi_z(z|\theta=1)}{\left[\int_{\underline{z}}^{z} q\mathbb{P}(HH|\theta=1)\phi_z(t|\theta=1)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}\right]^2} \\
&= -\frac{\mathbb{P}\left(g^B=L\middle|\theta=1\right)}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)}\frac{d}{dz}\left[\frac{1}{\int_{\underline{z}}^{z} q\mathbb{P}(HH|\theta=1)\phi_z(t|\theta=1)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}}\right].
\end{aligned}$$

Then the solution $F^B\left(r^A(z)\right)$ to the ODE (76) satisfies

$$\frac{1-F^B\left(r^A(z)\right)}{\int_{\underline{z}}^{z}\mu_{HH}(t)p_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}} = -\frac{\mathbb{P}\left(g^B=L\middle|\theta=1\right)}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)}\left[\frac{1}{\int_{\underline{z}}^{z}\mu_{HH}(t)p_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}}\right] + Const.$$

Using the boundary condition $F^B\left(r^A(\overline{z}) = \underline{r}\right) = 0$, we solve for the constant

$$Const = \frac{1}{\mathbb{P}(\theta=1)}\frac{1}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)^2}.$$

Therefore,

$$\begin{aligned}
F^B(r) =& \frac{1}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)} - \frac{\int_{\underline{z}}^{z^A(r)}\mu_{HH}(t)p_{HH}(t)\,dt + \overline{p}_{LH}\overline{\mu}_{LH}}{\mathbb{P}(\theta=1)\mathbb{P}\left(g^B=H\middle|\theta=1\right)^2} \\
=& \frac{1}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)} - \frac{\mathbb{P}(\theta=1)\mathbb{P}(HH|\theta=1)\int_{\underline{z}}^{z^A(r)}\phi_z(t|\theta=1)\,dt + \mathbb{P}(\theta=1)\mathbb{P}(LH|\theta=1)}{\mathbb{P}(\theta=1)\mathbb{P}\left(g^B=H\middle|\theta=1\right)^2} \\
=& \frac{\mathbb{P}\left(g^A=H\middle|\theta=1\right)}{\mathbb{P}\left(g^B=H\middle|\theta=1\right)}\left[1-\int_{\underline{z}}^{z^A(r)}\phi_z(t|\theta=1)\,dt\right].
\end{aligned}$$

Bank B's profit π^B

Now we are left with one unknown variable π^B in Eq. (74). Similar to the baseline model, the equilibrium could be positive-weak or zero-weak, depending on who—Bank A receiving threshold specialized signal z_A^{be} and quoting $\overline{r}$ or Bank B—breaks even first in competition. We define z_A^{be} and z_B^{be} as

$$\begin{aligned}
0 = \pi^A\left(\overline{r}\left|z_A^{be}\right.\right) =& p_{HH}\left(z_A^{be}\right)\frac{\mathbb{P}\left(g^A = H\right|\theta = 1)}{\mathbb{P}\left(g^B = H\right|\theta = 1)}\left[1 - \int_{\underline{z}}^{z_A^{be}} \phi_z\left(t\right|\theta = 1)\,dt\right]\cdot\left[\mu_{HH}\left(z_A^{be}\right)(1+\overline{r}) - 1\right] \\
&+ p_{HL}\left(z_A^{be}\right)\left[\mu_{HL}\left(z_A^{be}\right)(1+\overline{r}) - 1\right], \\
0 = \pi^B\left(\overline{r}; z_B^{be}\right) =& \int_{\underline{z}}^{z_B^{be}} p_{HH}\left(t\right)\mu_{HH}\left(t\right)(1+\overline{r})\,dt - \int_{\underline{z}}^{z_B^{be}} p_{HH}\left(t\right)dt + \overline{p}_{HL}\left[\overline{\mu}_{HL}\left(1+\overline{r}\right) - 1\right].
\end{aligned}$$

Equilibrium π^B is then

$$\pi^B = \max\left\{\int_{\underline{z}}^{z_A^{be}} p_{HH}\left(t\right)\mu_{HH}\left(t\right)(1+\overline{r})\,dt - \int_{\underline{z}}^{z_A^{be}} p_{HH}\left(t\right)dt + \overline{p}_{HL}\left[\overline{\mu}_{HL}\left(1+\overline{r}\right) - 1\right], 0\right\}.$$

When $z_A^{be} > z_B^{be}$, equilibrium is positive weak with $\pi^B > 0$, and $\hat{z} = z_x = z_A^{be}$; when $z_A^{be} \leq z_B^{be}$, equilibrium is zero weak with $\pi^B = 0$, and $z_B^{be} = \hat{z} > z_x$. □

B Empirical Analysis

B.1 Data

We use Y14Q-H.1 data that is collected by the Federal Reserve System as part of its stress-testing efforts, covering all C&I loans to which a stress-tested bank has committed more than 1 million USD (around 75% of all U.S. C&I lending). As such, the data covers 40 banks – in an unbalanced panel – between 2011 and 2023 and includes millions of loan-quarter observations.

We focus on term loans and limit our sample to loans that are likely newly originated or new to the lender. We cut our data before 2012 to avoid accidentally labeling a loan as "newly originated," simply because of the point at which the data collection begins. We define a loan as new when it first appears in our data. We remove loans to financial or insurance entities. Our final sample covers 350,000 new term loans. Besides loan amount, we can track key loan data such as the interest rate paid by the borrower, the loan's purpose, and the performance of the loan while it remains in our sample, as we can see if it ever falls into arrears.

B.2 Statistics

Key summary statistics for loans in our sample are outlined in Table B.1. The average loan commitment in our sample is just over 12 million USD in size and the average loan interest rate is 3.7%. We define a loan as non-performing if it is ever 90+ days in arrears, ever has negative maturity (i.e. has not been repaid at maturity), or has outright defaulted. We then take a loan as "ever" non-performing if it becomes so at any point after origination. The percentage of non-performing loans is around 4% in our data, which is slightly higher than the average default rate given our wider definition.

As we have explained in Section 3.4, we do not have data on firm characteristics typically used by banks to assess a loan's risk for all firms. Hence, to sidestep this issue, we use three rating categories (high-risk, mid-risk, and safe) based on the banks' internal ratings of a loan to proxy for observable loan qualities. Banks report loan risk on a scale of 1-10. We have created terciles (1-3), which allow us account for whether a loan is high, medium, or low risk without relying on bank-specific knowledge. For the subsample for which we have firm characteristics, however, we can confirm that our three risk categories capture aspects linked to (prior) expected loan quality. Table B.2 shows the average borrower Debt/EBITDA, return on assets, and assets-to-debt for each of the three loan risk categories we use as risk metrics in our baseline regression. For instance, as expected, the high-risk category with Rating 3 has the highest Debt/EBITDA, lowest RoA, and lowest asset-to-debt.

B.3 Alternative Risk Controls

We can show that our results are not determined by the construction of our risk controls (see above). Instead of dummies for three risk categories, for instance, we can instead use dummies for the exact risk assigned to a loan by the lending bank. This gives us 10 dummies for the risk groups 1-10. We show the results of these specification in Table B.3. As can be seen, our results are unaffected by the choice of risk control. In Panel B of Table B.3 we use firm characteristics for the subsample of firms that report these data to their Y14 lenders. This reduces our sample by 50%. Nevertheless, we can again show that our results are unaffected by the choice of risk control.

B.4 The COVID Period

We have included the period between 2020 and 2021 in our analyses discussed in Section 4, above. We recognize that this period may be unique in recent history, given the large-scale interventions that sought to help banks extend credit to shuttered businesses. As can be seen in Table B.4, we are able to exclude these years from our data without affecting our analyses. Our coefficients are not statistically different from those in the baseline regression. The COVID period neither drove nor severely impacted the difference between specialized and non-specialized banks. Lenders charge lower rates to borrowers in the industry in which they specialize without suffering worse loan performance as a consequence in both COVID and non-COVID periods.

B.5 Multiple Specialized Lenders in One Industry

We have studied the interaction between specialization and whether the industry has multiple specialized lenders, aiming to rule out the alternative hypothesis that negative interest wedge is driven purely by competition among specialized lenders within one industry. In the baseline we define an industry to have "Multiple Specialized Lenders" if two or more banks specialize in it.

Table B.5 lists the number of banks that are specialized in two-digit industries in our data. We have obscured the exact industry definition in favor of stylized industry names in Table B.5, though each represents a two-digit industry (with the omission of finance and insurance). As shown in Table B.5, the number of banks that are specialized in industries varies greatly. Some industries are home to no specialized banks, while other industries see nine banks that are specialized. We do not show a similar table for four-digit specialization, as this would involve depicting over 300 industries. However, it is worth noting that the modal number of banks specialized in a single four digit industry is 0 (compared with a mode of 2 for 2-digit industries). The mean number of specialized banks is 1.7. There is some temporal variation, as the degree to which a single lender is specialized at the four-digit level may be affected by individual large loans originated in a single quarter. However, the rank order of preferences (i.e. the degree to which individual banks prefer one industry over another) remains relatively stable across time.

Recognizing the great variation of the number of specialized lenders across industries, we introduce additional tests to show that our results discussed above (wherein we interact our variable of interest with a dummy for lender multiplicity) are robust to alternative definition of the multiplicity of specialized lenders. In Table B.6 we take the number of banks in an industry directly, and show that interacting bank specialization with this continuous measure does not change our baseline results. Results are the same at the four-digit level (not shown for brevity).

B.6 SNC vs. Y14 Data

We have thus far made use of Y14 filings as the primary data source in the paper. Y14 has the advantage of recording a number of loan characteristics that are of use to us. However, as a tool for stress testing, it is inherently a data set focused on the largest banks. An alternative data set, which records loan characteristics and includes smaller banks, is the Syndicated National Credit (SNC) registry. This data set tracks all syndicated loans held by at least two (now three) banking entities with a total size of 20 (now 100) million USD (changes occurred in 2018). Unfortunately, the SNC data has some short comings that make it less useful than the Y14 as a baseline data set. It is inherently focused on larger syndicated loans, which are a specific subset of all loans[28]. Perhaps more importantly, the SNC data does not include information on rates paid, which is a key variable in our analyses on information based loan pricing.

Nevertheless, the fact that we are able to use a larger set of banks as well as the fact that we are able to use a longer data series make the SNC registry useful as a tool for confirming our above findings. In order to obtain rates paid for loans, we merge SNC data with Dealscan data. We follow the fuzzy matching approach laid out by Cohen, Friedrichs, Gupta, Hayes, Lee, Marsh, Mislang, Shaton, and Sicilian (2018), based on the borrower name and common loan variables. We keep all loans originated between 2000 and 2019 in order to obtain a consistent sample. We remove loans that have performance issues by the time they are first observed in the data and all loans that are originated more than a year before they are observed, as we are interested in new loans only. We include each loan only once – to avoid counting the large term B loans hundreds of times – and use the specialization of the arranging entity. Our sample comprises just over 11,000 loans for which we have rate data and just over 30,000 loans for which we have performance data. These loans are originated by 218 different banks (measured at the level of the high-holder). Though still large entities, many of these are smaller than the banks covered by the Y14.

In Table B.7 we show that the rates paid by borrowers for syndicated loans arranged by more specialized banks are lower, on average. (We use All-in-Drawn Spread; the base rate will be absorbed by year-quarter fixed effect anyway.) The difference is not always significant if we include a full set of detailed controls (see column (3)). In this case, including arranger×time fixed effects absorbs a lot of variation given the outsized role a few arrangers play in our data and the fact that our key variable varies at the arranger*time level. Even so, the coefficient remains strongly negative.

Figure B.1 replicates Figure from the introduction, but focuses only on the spread paid for loans in our combined SNC/Delascan data. We plot the raw difference in rates paid to specialized vs un-specialized lenders as well as the difference accounting for controls. We can see from Figure B.1 that the rate differential is almost always negative, even if it is insignificant at times. This adds strong corroboration to our regression results, discussed above. Moreover, the figure reveals that the crisis period of 2008-2010 does not change our results. In fact, borrowers are more likely to pay lower rates to specialized lenders during this time period.

In columns (4)-(6) of Table B.7 we further show that the performance of loans made by specialized lenders is always somewhat better than the performance of loans made by less specialized lenders. This difference is small, but nonetheless noteworthy given the small average default rate of loans in the SNC sample (<4%). It is noteworthy that the magnitude of our coefficients in SNC analyses are highly similar to those in our baseline Y14 regressions, discussed above.

[28]The specialization of the arranging entity may be less relevant in cases where hundreds of loan participants influence loan term flexing.

Table B.1: **Summary Statistics of Key Variables**

	N	Mean	SD	Specialized	Non-Specialized	Differential
Interest Rate	353,544	3.69	1.64	3.55	3.69	-0.13***
Non-Performing	353,544	0.04	0.19	0.03	0.04	-0.01***
Loan Amount	353,544	12.42	5.43	10.5	12.99	2.5***

Note: This table shows summary statistics for loans in our sample. We count each bank-loan combination only once, on the date when it is first observed in our data (this may be a different date from the loan's first origination date for a small subset of loans only as we censor our data and start in 2012, one year after collection began in 2011). Loan size is scaled by 1 million USD. The interest rate is the unadjusted cost of the loan, measured in percent."Non performing" is a dummy that takes the value of 1 if the loan ever falls in arrears, has negative maturity or is otherwise in default after the first observation in our sample. The mean values of each variable data are split by whether a loan is made by a specialized bank or not.

Table B.2: **Summary Statistics for Rating Categories**

Rating Group	Debt/EBITDA	Return on Assets	Leverage (Assets to Borrowing)
1	2.9	0.111	3.16
2	3.31	0.109	3.59
3	3.92	0.055	4.26

Note: For around (50%) of firms in our data that report EBITDA, ROA, or leverage information, we show how Debt/EBITDA, RoA, and Leverage relate to our three risk categories ("high risk," "mid-risk," and "safe" – abbreviated as 1-3) in our data.

Table B.3: **Interest Rate and Loan Performance – Alternative Risk Definition**

Panel A – Original (1-10) Credit Risk Rating

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Non-Performing Loans	
Specialized Bank	-0.064***	-0.142***	-0.083***	-0.005***	-0.004***	-0.004***
	[0.006]	[0.006]	[0.007]	[0.001]	[0.001]	[0.001]
Log loan amount	-0.158***	-0.169***	-0.176***	-0.000	0.000	-0.000
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating (1-10) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.044	0.047
N	353,544	353,537	351,776	353,544	353,537	351,776

Panel B – Borrower Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Non-Performing Loans	
Specialized Bank	0.053	-0.093***	-0.049***	-0.008***	-0.009***	-0.004***
	[0.037]	[0.009]	[0.010]	[0.001]	[0.001]	[0.001]
Log loan amount	-0.201***	-0.206***	-0.204***	-0.003***	-0.003***	-0.003***
	[0.003]	[0.003]	[0.003]	[0.000]	[0.000]	[0.000]
Borrower leverage	0.006**	0.007**	0.007**	0.006***	0.005***	0.005***
	[0.003]	[0.003]	[0.003]	[0.000]	[0.000]	[0.000]
EBIT to ST-Debt	-0.016***	-0.019***	-0.017***	-0.006***	-0.006***	-0.006***
	[0.003]	[0.003]	[0.003]	[0.000]	[0.000]	[0.000]
EBIT to LT-Debt	0.015***	0.024***	0.021***	0.002***	0.002***	0.002***
	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.34	0.43	0.45	0.0091	0.025	0.031
N	175,842	175,840	175,534	175,842	175,840	175,534

Note: In Columns (1) – (3), we regress the loan rate paid by a given firm on the fixed effects specified at the bottom of the table and a dummy denoting whether the firm is borrowing from a bank that is specialized in the industry in which said firm operates. We define a bank as specialized if it is over-invested by 4% or more in an industry, relative to what would be expected from diversification. In Columns (4) – (6), we use the same specifications as in previous columns, but use whether the loan in question ever becomes non-performing at any date it is in our sample after its origination. A loan becomes non-performing if it is ever in arrears, has not been paid down at maturity, or defaults outright. We use rating dummies (high risk, medium risk, low risk) in columns (1)-(3) and interest rate in columns (4)-(6) as risk controls. Panel B replicates Panel A. It makes use of firm leverage (debt to assets) and short term as well as long term debt to EBIT as measures of borrower riskiness as opposed to loan interest rates or bank risk ratings. Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table B.4: **Interest Rate and Loan Performance – Excluding COVID Period**

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Non-Performing Loans	
Specialized Bank	-0.082***	-0.156***	-0.085***	-0.007***	-0.005***	-0.005***
	[0.006]	[0.006]	[0.007]	[0.001]	[0.001]	[0.001]
Log loan amount	-0.165***	-0.174***	-0.181***	-0.001**	-0.001*	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.044	0.047
N	302,312	302,312	302,312	302,312	302,312	302,312

Note: In Columns (1) – (3), we regress the loan rate paid by a firm on the fixed effects specified at the bottom of the table and a dummy denoting whether the firm is borrowing from a bank that is specialized in the industry in which said firm operates. We define a bank as specialized if it is over-invested by 4% or more in an industry, relative to what would be expected from diversification. In Columns (4) – (6), we use the same specifications as in previous columns, but use whether the loan in question ever becomes non-performing at any date it is in our sample after its origination. A loan becomes non-performing if it is ever in arrears, has not been paid down at maturity, or defaults outright. We exclude loans originated in 2020 or 2021, as these are denoted as "abnormal COVID periods". Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table B.5: **Number of Banks Specialized per Industry**

Industry	Number of Specialized Banks	Numb. Loans by Specialized Banks	Numb. Loans by Ordinary Banks
A	0	0	3,406
B	1	263	5,331
C	3	1,395	4,899
D	0	0	12,936
E	2	744	10,459
F	2	839	17,909
G	4	2,818	25,478
H	3	4,176	21,253
I	7	9,187	17,543
J	0	0	3,576
K	2	2,077	19,117
L	0	0	1,327
M	3	2,400	7,906
N	9	18,338	30,496
O	2	1,072	15,865
P	1	491	4,792
Q	0	0	6,843
R	2	3,018	7,627
S	9	10,830	16,879
T	1	137	6,025
U	4	2,489	11,088
V	3	5,972	14,590
W	5	7,225	9,933

Note: We indicate the number of banks specialized in stylized 2-digit industries. We define a bank as specialized if it is over-invested by 4% or more in an industry, relative to what would be expected from diversification (i.e. a bank that invests 14% of its C&I portfolio in an industry that accounts for 10% of all C&I lending would be specialized in that industry.) An industry is competitive if 2 or more banks are specialized in it. Additionally, we show the number of loans made by specialized and non-specialized (ordinary) lenders in each industry.

Table B.6: **Interest Rate and Loan Performance – Alt. Def. of Multi-Specialized-Lenders**

	(1)	(2)	(3)	(4)	(5)	(6)
		Interest Rate			Non-Performing Loans	
Specialized Bank	-0.240***	-0.245***	-0.084***	-0.010***	-0.005**	-0.008***
	[0.012]	[0.013]	[0.014]	[0.002]	[0.002]	[0.002]
# Specialized Banks in Ind. × Specialized	0.038***	0.021***	0.000	0.000	0.000	0.001
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Log loan amount	-0.157***	-0.171***	-0.176***	-0.000	-0.000	-0.001**
	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
# Specialized Banks in Ind.	-0.020***	-0.012***		-0.001***	-0.001***	
	[0.001]	[0.001]		[0.000]	[0.000]	
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating Category (1-3) FE	X	X	X	X	X	X
Bank-Year FE		X	X		X	X
Industry-Year FE			X			X
R^2	0.31	0.39	0.4	0.031	0.044	0.047
N	353,544	353,537	351,776	353,544	353,537	351,776

Note: In Columns (1) – (3), we regress the loan rate paid by a firm on the fixed effects specified at the bottom of the table and a dummy denoting whether the firm is borrowing from a bank that is specialized in the industry in which said firm operates. We define a bank as specialized if it is over-invested by 4% or more in an industry, relative to what would be expected from diversification. We interact the dummy of "Specialization" with "# Specialized Banks in Ind." which is the number of specialized banks in the industry in question. In Columns (4) – (6), we use the same specifications as in previous columns, but use whether the loan in question ever becomes non-performing at any date it is in our sample after its origination. A loan becomes non-performing if it is ever in arrears, has not been paid down at maturity, or defaults outright. We interact our variable of interest with the number of banks that are considered "specialized" in an industry. Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table B.7: **Interest Rate and Loan Performance – SNC Data**

	(1)	(2)	(3)	(4)	(5)	(6)
	Allindrawn Spread			Non-Performing Loans		
Specialized Bank	-0.109**	-0.104*	-0.031	-0.006**	-0.009**	-0.009**
	[5.436]	[4.731]	[7.597]	[0.003]	[0.004]	[0.004]
Log loan amount	-0.013***	-0.013***	-0.012***	0.000	0.000	0.000
	[0.001]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Year-Quarter FE	X	X	X	X	X	X
Purpose FE	X	X	X	X	X	X
Rating FE	X	X	X	X	X	X
Bank-Year FE			X			X
Industry-Year FE		X	X		X	X
R^2	0.61	0.69	0.71	0.24	0.33	0.36
N	11,460	11,460	11,460	32,391	32,391	32,391

Note: In Columns (1) − (3), we regress the allindrawn spread (from Dealscan) on the fixed effects specified at the bottom of the table and a dummy denoting whether the firm is borrowing from a bank that is specialized in the industry in which said firm operates (i.e. whether the lead arranger in a syndicate is over-invested in the banks industry). We define a bank as specialized if it is over-invested by 3.5% or more in an industry, relative to what would be expected from diversification. This corresponds to being among the top 20% of lenders by over-investment at a given point in time. In Columns (4) − (6), we use the same specifications as in previous columns, but use whether the loan in question ever becomes non-performing at any date it is in our sample after its origination. A loan becomes non-performing if it is ever in arrears, has not been paid down at maturity, or defaults outright. Standard errors are clustered at the firm-time level and are heteroskedasticity robust while *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

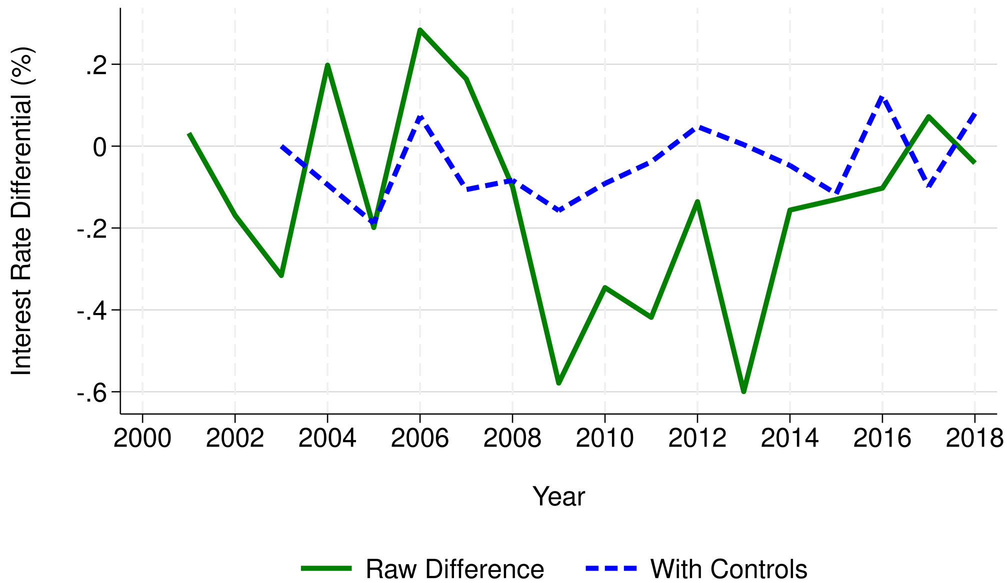

Figure B.1: **Rates in SNC Data.** This figure plots the difference in interest rates paid by borrowers for loans arranged by specialized vs. unspecialized banks in SNC data over time. We define specialized lenders as those with more than 3.5% over-investment in an industry, where over-investment is measured as deviations from a diversified portfolio $\frac{LoanAmount_{b,i,t}}{\sum_s LoanAmount_{b,i,t}} - \frac{LoanAmount_{i,t}}{\sum_i LoanAmount_{i,t}}$ for bank b in industry i at time t. We use loans from SNC that have been merged with Dealscan as described in Cohen, Friedrichs, Gupta, Hayes, Lee, Marsh, Mislang, Shaton, and Sicilian (2018). The green line does not account for loan characteristics while the blue line accounts for origination date, purpose, loan type, loan riskiness and agent fixed effects.