The dichotomy of concentration and pricing power in banking

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Abstract

In our model, banks face two informational frictions: limited pledgeability and effort moral hazard. Agents who are identical to begin with can costlessly choose to enter or exit banking, and yet, those who become bankers make strictly higher profits than those who become depositors. Banks possess pricing power in the deposit market despite (costless) free entry and price competition. When pledgeability increases, banks can offer higher deposit rates and accept more deposits, which, in turn, leads to fewer banks (higher concentration). Thus, counterintuitively, but consistent with empirical evidence, equilibrium pricing power may decline as concentration increases.

Keywords: Bank concentration, Competition, Moral hazard, Pledgeability, Capacity constraints

Jel codes: D40, G21, G28

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1 Introduction

Deposits are the primary funding source for banks, with the US deposit market exceeding \$17.5 trillion in 2024, accounting for over 80% of bank liabilities. Despite a fiercely competitive landscape, evidence shows that banks possess significant pricing power in deposit markets (see Forssbaeck and Shehzad 2015 and Beck et al. 2013 for global evidence and Drechsler et al. 2017 and Corbae and D'Erasmo 2021 for US data). Banks primarily compete for deposits along a single dimension, price (i.e., deposit rates), and the deposit product itself is fairly simple. This makes product differentiation an unlikely explanation for banks' observed pricing power. This raises a key question: how do banks sustain pricing power in a seemingly homogeneous market? A common explanation is that depositors face switching costs. While this explanation seems plausible for the small (insured) deposits segment, it is arguably less suited in explaining why banks also exhibit pricing power in the larger (uninsured) deposits segment. Furthermore, empirical evidence suggests that greater bank concentration can lead to lower profitability (e.g., Berger 1995 and Claessens and Laeven 2004), a phenomenon that challenges traditional market power theories (including switching cost models). We propose a framework that endogenously derives concentration to provide a joint explanation for these related puzzles.

We present a model of bank competition in the deposit market which features two informational frictions: an effort moral hazard problem where agents must exert costly and unobservable effort, and a diversion constraint which limits banks' ability to pledge future output to secure funding in the deposit market. Despite price competition among banks in their attempt to attract deposits, the interaction of the moral hazard and the limited pledgeability constraints prevents the standard Bertrand outcome from arising – the mark-up exceeds the rent associated with either informational constraint alone. This is a particularly surprising result since we allow for (costless) free entry and exit, setting us apart from existing models in the industrial organization literature (such as Kreps and Scheinkman 1983 and Maggi 1996, see Section 5.2). Thus, our most striking theoretical result is that, even though agents are homogeneous to begin with, and there is free entry and exit, those agents who manage to become bankers in equilibrium earn strictly higher returns than those agents who become depositors.

Preview of the model and results.

In the model, identical agents who have an initial endowment of 1 unit may try to become bankers. If they do not become bankers, agents delegate the management of their funds to other agents who have managed to become bankers or put them in a storage technology. Bankers invest their own endowment and the funds collected from depositors directly in a project. There are two frictions in the model which are ex ante effort moral hazard and ex post diversion:

Banks can improve the probability of the project's success by exerting costly and unobservable effort (see, e.g., Holmstrom and Tirole 1997, Morrison and White 2005, and Mehran and Thakor 2011). The cost of effort is assumed to be sufficiently high that an agent investing only their own funds would not find it worthwhile to exert effort. However, when the agent also manages external funds and earns rents from doing so, effort exertion becomes incentive compatible. Hence, unlike the standard models of effort moral hazard, this incentive constraint imposes a lower, rather than an upper, bound on bank leverage.

Banks also possess a diversion technology which allows the manager to divert a fraction of the final cash flow from depositors (see, e.g., Calomiris and Kahn 1991, Hart and Moore 1995, Shleifer and Wolfenzon 2002, Holmstrom and Tirole 2011, Gennaioli and Rossi 2013, Donaldson et al. 2018, and Biswas and Koufopoulos 2022).[1]

In equilibrium, both the diversion constraint and the effort incentive constraint bind. Suppose that the effort incentive constraint is just binding, but the diversion constraint is slack. Then, a bank can increase its profits by offering a slightly higher deposit rate and attracting more depositors. Conversely, suppose that the diversion constraint is just binding, but the effort incentive constraint is slack. Then, an agent who is a depositor in this allocation can increase her profits by offering a slightly higher deposit rate to attract depositors from the incumbents and become a banker herself. Finally, there is no prof-

[1] In the context of banking, Acharya et al. (2011) document that during the financial crisis of 2007-2009, there were large scale dividend payouts despite widely anticipated credit losses, thereby transferring value from creditors to equity holders.

itable deviation from the intersection of the two constraints. At this allocation, one cannot attract depositors from existing bankers by offering a higher deposit rate, as such an offer would violate at least one of the two constraints.

In this equilibrium, banks make strictly positive profits. This is because, despite costless free entry and price competition in the deposit market, banks retain some pricing power allowing them to offer a deposit rate which is lower than the competitive rate. As we clarify in Section 2.4, if either the diversion constraint or the moral hazard constraint is removed from the model, the outcome reverts to the Bertrand benchmark. Thus, it is the interaction of the two frictions, rather than either friction alone, that drives the result that banks possess pricing power.

Empirical predictions and policy implications.

The interaction of the diversion constraint with the effort moral hazard constraint produces a number of new implications:

If investment opportunities improve, banks can lever up more since the total pledgeable income rises, all else given. At the same time, there is a countervailing force: as investment opportunities improve, banks earn higher rents per unit invested. As a result, they require fewer depositors to make effort exertion incentive compatible. We show that the second effect dominates leading to a decline in leverage when investment opportunities improve. The extent to which an increase in profitability due to stronger investment opportunities is passed through to depositors depends on pledgeability. The relationship between the pass-through effect and pledgeability is non-monotonic: it strengthens when pledgeability is low but weakens once pledgeability becomes sufficiently high.

Consistent with the evidence in Berger (1995), Claessens and Laeven (2004), and Demirguc-Kunt et al. (2004), our model predicts that an increase in bank concentration may coincide with a decline in pricing power. This decoupling between concentration and pricing power emerges as pledgeability rises: greater pledgeability enables banks to offer higher deposit rates and operate with higher leverage, yet increased leverage leads to fewer banks in equilibrium. We refer to this as the dichotomy of concentration and pricing power.

We present several other new predictions in Section 3.1. Finally, in Section 3.5, we present a range of applications beyond banking where our model may offer useful insights. These include diverse settings such as the labor market, microfinance, and the evolving role of data and AI in shaping firms' market power in the product market.

In terms of policy implications, we show that the number of banks is excessively high in the unregulated equilibrium. An utilitarian regulator can step in to eliminate this inefficiency by introducing an upper bound on the number of banking licenses issued. In this regulated equilibrium, those agents who become bankers will have even higher profits relative to those who become depositors compared to the unregulated equilibrium.

Related literature.

Although theories featuring switching costs can potentially explain the emergence of pricing power (e.g. Farrell and Klemperer 2007), they cannot predict the negative correlation between concentration and pricing power. Furthermore, we model the uninsured deposit market. This segment of the deposit market features large deposits. Drechsler et al. 2024 provide evidence that even though pricing power is somewhat smaller in the uninsured segment of the deposits market compared to insured segment, it remains substantial there. At the same time, fixed switching costs are less likely to be a significant factor in determining depositor behavior in this segment due to the size of the deposits. Finally, switching costs have become increasingly less relevant given recent regulation.[2] These observations suggest that existing models relying on switching costs are ill-suited for explaining pricing power in this part of the market. A new framework is therefore needed to rationalize substantial pricing power in the large-deposit market segment, while also accounting for the observed inverse relationship between market concentration and pricing power. Our model aims to fill this gap.

In one set of models, asymmetric information on the asset side endogenously restricts competition in the banking sector which enables banks to earn information rents (see, e.g., Broecker 1990, Shaffer 1998, Dell'Ariccia et al. 1999, and Boot and Thakor 2000, and Marquez 2002). In contrast, we focus on the funding side of banks. As noted by Beyhaghi et al. (2025), the nature of informational frictions on the asset side differs from those on

[2]E.g., in Europe, the open banking provisions in the Payment Services Directive 2 shifts the burden of switching from depositors to banks.

the funding side. For example, a key feature of the asset-side models is that some banks possess superior information about certain borrowers' credit quality. This type of friction is not relevant in the deposit market; hence, we consider a distinct problem. Another key difference is conceptual. In much of the existing literature, the structure of the banking industry is imposed rather than derived; even when entry is allowed, the baseline market configuration is typically taken as given (e.g., by assuming N incumbent banks). By contrast, we do not impose any default structure. Instead, we endogenize the emergence of market structure as an equilibrium outcome, which allows us to generate new insights.

Our paper is also related to models of bank competition and financial stability (see, e.g., Hellmann et al. 2000, Repullo 2004, Martinez-Miera and Repullo 2010, and Vives and Ye 2025). As in the asset-side literature, these models typically take the baseline market configuration as given. In contrast, we endogenize the market structure as part of the equilibrium. Moreover, while much of this literature assumes some form of imperfect competition, we allow for perfect price competition.

Several models of imperfect competition in banking study how monetary policy shocks affect deposit franchise values and their transmission to the real economy (e.g., Drechsler et al. 2017, Drechsler et al. 2021, Wang et al. 2022, Drechsler et al. 2024). Our model introduces a channel through which shocks to banks' investment opportunities is transmitted to the liability side. Specifically, a positive shock to investment opportunities results in higher deposit rates, but leverage declines. By endogenizing the source of banks' market power our approach offers richer predictions.

Our work is also related to static models in industrial organization where price competition does not necessarily lead to zero profits which is the standard Bertrand result. Kreps and Scheinkman (1983) analyze a two-stage game where firms first commit to a production capacity which softens price competition in the subsequent stage (see Marquez 2002, Schliephake and Kirsten 2013, and Green 2007 for applications in banking and finance).

Unlike in Kreps and Scheinkman (1983), our results do not depend on the specific design of the competition game and they cannot be contracted away since they are driven by the interaction of two informational constraints which are both binding in equilibrium.

Thus, even though leverage (quantity) and the deposit rate (price) are determined simultaneously, as opposed to quantity first and price second as in the Kreps and Scheinkman (1983) game, price competition does not lead to the Bertrand outcome. Moreover, as we show in the Appendix (Section 5.2), if we adapt the Kreps and Scheinkman (1983) game and allow for costless free entry by banks at the ex ante stage (as we do in our model), then the unique equilibrium is the Bertrand outcome. This highlights that, despite the similarities at a superficial level, the constraints on competition in the two models work fundamentally differently. Finally, Kreps and Scheinkman (1983) consider a pre-specified and fixed number of firms without commenting on how the market structure comes to be, whereas, in our model, the number of banks in equilibrium is endogenous.

Maggi (1996) observe that in the Kreps and Scheinkman (1983) world, the equilibrium outcome is Bertrand in the absence of capacity constraints, and Cournot when such constraints are present. By allowing firms to produce quantities beyond the announced capacities at a higher marginal cost, Maggi (1996) captures intermediate situations between these two extremes. However, this result also relies on the assumption of fixed number of firms in the industry, since if we allow for free entry in this model, the unique equilibrium will be the Bertrand outcome (following the same logic that applies to the Kreps and Scheinkman 1983 model). In our model, despite free and costless entry and exit the markup lies within a range from monopoly to perfect competition and it is determined by the deep parameters underlying the diversion and effort moral hazard constraints.

2 Model

We develop a model in which banks raise funds in the deposit market and invest them directly. Direct investment by banks may be thought of as fee-generating investment banking activities. Another equivalent interpretation is that banks behave monopolistically in the loan market and extract the full surplus in this market. Even though entry is costless, banks make strictly positive profits in equilibrium.

2.1 Set-up

We consider an economy in which there is a measure 1 of agents, each with an initial endowment of 1 unit. To begin with, agents are identical. Heterogeneity across agents arises at the next stage since some agents become bankers, while others do not. Bankers manage their own funds and any funds that they raise externally. Agents who do not become bankers either invest in a costless but unproductive storage technology (which produces a zero net return), or become depositors, in which case they delegate the management of their funds to a banker.

There are two dates, $t = (0, 1)$. At $t = 0$, agents may offer contracts to other agents in their attempt to become bankers (for the details, see the description of the game, below). Entry into banking is costless. A fraction $\lambda \in [0, 1]$ of agents manage to become bankers, where λ is determined in equilibrium through the optimizing behavior of agents. Those who manage to become bankers raise funds in the deposit market through the contracts they have signed with the other agents, and directly invest in the project. At $t = 1$, the returns are realized. Per unit of investment, the project yields X if it succeeds, and 0 if it fails. The project exhibits constant returns to scale and is infinitely scalable.

There are two informational frictions:

Effort moral hazard. After obtaining the funds through deposits, a banker can choose to exert effort or not. The project succeeds with probability p_h and fails with probability $1 - p_h$ if the banker exerts effort. Effort is costly (in terms of utility) and consists of two components: a fixed cost, k, and a variable cost, c, per unit of investment. The fixed cost represents the investment required to become a skilled banker, while the variable cost reflects the increasing difficulty of managing a larger bank. If the banker does not exert effort, the project succeeds with a lower probability, $p_l < p_h$. We normalize the return from a project when the agent shirks to equal the return from the storage technology, i.e., $p_l X = 1$. We denote the incremental success probability from exerting effort, $p_h - p_l$, as Δ. Effort exertion is not observable or verifiable, and hence, effort is not contractible.

Diversion. A banker can divert a fraction, $(1 - \phi)$, of the realized output at $t = 1$, $\phi \in (0, 1)$. Diversion of funds is not verifiable, and hence, the banker cannot credibly commit ex ante to not diverting these funds even if she would like to be able to do so, i.e., pledgeability is limited.

We make the following parametric assumptions:

A1: $k > \Delta X - c > \phi \Delta X$

A2: $\phi < \frac{1}{p_h X}$

A3: $(1-\phi)k > ((1-\phi)\Delta X - c)(1 + \phi \Delta X)$

The first inequality in Assumption *A1* says that the fixed cost of effort is large implying that exerting effort would be worthwhile only if multiple agents pool their resources and share the cost. The second inequality in Assumption *A1* says that the marginal cost of effort is small. Assumption *A2* says that diversion is sufficiently large. These assumptions ensure that the two information constraints are binding in equilibrium. The final assumption ensures that a banker is privately better off managing a bank as opposed to depositing in a bank.[3] The following set of exogenous parameter values satisfies the assumptions made above: $p_h = 0.58$, $p_l = 0.33$, $\phi = 0.55$, $X = 3$, $k = 0.8$, and $c = 0.2$.

2.2 The Game

We consider the following game:

Stage 1a: An agent offers a contract, (d, R), to other agents where d is the amount of external funds that the agent will accept and this is publicly observable, and R is the promised repayment per unit.[4] The agent also specifies whether she will contribute her own endowment to the investment.

Stage 1b: After observing the amount of external funds that she has attracted, the agent decides whether she will become a banker and sign a contract with those offering funds to her, or withdraw her proposal, and either offer her own endowment to another agent (i.e., become a depositor) or invest in the storage technology. An agent can withdraw her proposal at zero cost (exit is costless).

[3] This assumption can be relaxed without affecting the results qualitatively, as we discuss later.

[4] If an agent is indifferent between two offered contracts, she randomizes with equal probability. However, if an agent who is already attached to a bank is offered a new contract that leaves her equally well off, she remains with her incumbent bank. This tie-breaking rule implies that any deviating offer must make depositors strictly better off in order to upset an equilibrium.

Stage 2: After signing the contracts with the providers of funds (depositors), the managers of funds (bankers) choose whether or not to exert unobservable effort, $e \in \{0, 1\}$. $e = 1$ denotes effort exertion and imposes a utility cost, $k + (1 + d)c$, on the bank, while $e = 0$ denotes shirking and the bank saves the cost.

We look for the sub-game perfect Nash equilibrium of this game. We solve for the equilibrium backwards.

2.3 Equilibrium

First, we consider the optimization problem of a banker. The banker invests her own funds and the funds raised externally from depositors. Suppose that the amount of funds raised externally is d, implying that a bank's total investment is $(1 + d)$ units. With probability p_h or p_l (depending upon the level of effort exertion), these funds produce X (per unit), and they produce 0 with the complementary probability. In the event of success, the banker repays dR to depositors. In maximizing her profits, a banker faces five constraints at $t = 0$:

1. the diversion constraint: Given Assumption *A2*, an agent who tries to attract deposits will always invest her own unit in the project because otherwise she will not be able to attract any external funds (deposits). Due to the possibility of diversion, the total expected verifiable cash flow is $\phi(1 + d)p_h X$. This total expected verifiable cash flow must be weakly greater than the sum of the total expected promised repayments, which comprises the promised return, $dp_h R$, to the depositors, and the expected cash flow contractually retained by the banker himself, say, $p_h R_s$.

$$\phi p_h(1 + d)X \geq p_h dR + p_h R_s \tag{1}$$

2. the effort incentive constraint: exerting effort leads to a higher success probability, but it imposes a cost on the banker. A banker will exert effort only if she is (weakly)

better off from exerting effort than not. The incentive constraint is written as follows:

$$\begin{aligned} &(1+d)p_hX - dp_hR - 1 - k - (1+d)c \geq (1+d)p_lX - dp_lR - 1 \\ \implies\ & d[\Delta(X-R) - c] \geq k + c - \Delta X \end{aligned} \tag{2}$$

3. the depositors' participation constraint: the depositors must be weakly better off from depositing their funds with the bank, in which case they obtain, p_hR, than investing in the storage technology.

$$p_hR \geq p_lX = 1 \tag{3}$$

4. the banker's limited liability constraint: the promised repayment cannot exceed X.

$$R \leq X \tag{4}$$

5. the banker's participation constraint: It must be the case that managing a bank is (weakly) more profitable than depositing in a bank:

$$\Pi = (1+d)p_hX - dp_hR - 1 - k - (1+d)c \geq p_hR - 1 \tag{5}$$

$$\implies (1+d)[p_h(X-R) - c] \geq k \tag{6}$$

Note that, given Assumption *A1*, it is more profitable to invest in the storage technology than deposit funds in a shirking bank, implying that the incentive constraint must be satisfied in equilibrium. Suppose that the effort incentive constraint is satisfied. Then, profit maximization requires that the diversion constraint must be relaxed to the maximum extent possible. For any $R < X$, since the bank retains a fraction of the surplus generated from investing the externally raised funds, bank profits are strictly increasing in the number of external investors, d. To maximize the number of external investors, the optimal arrangement entails that $R_s = 0$. That is, external investors receive the most senior claim which we refer to as deposits. The banker retains the junior claim and becomes the residual claimant (the equity-holder). This arrangement is privately optimal for the banker since it allows the bank to attract the maximum amount of funds from outside investors.

Lemma 1 (Optimal contracts) *There are d outside investors in the bank, the optimal contract for the outside investors is debt/deposit, and the banker holds the residual claim which is equity.*

Proof. The proof is in the Appendix. ■

Following Lemma 1, we set $R_s = 0$, and the diversion constraint becomes:

$$d \leq \frac{\phi X}{R - \phi X} \tag{7}$$

The diversion constraint puts an upper bound on the amount of funds that the depositors are willing to provide to the bank. To derive the slope of the diversion constraint in the (d, R) space, we totally differentiate Equation (7) with respect to d and R:

$$\left.\frac{dd}{dR}\right|_{DC} = -\frac{d}{R - \phi X} < 0 \tag{8}$$

The slope of the diversion constraint is negative (and it is concave). This reflects that as each depositor is promised a higher repayment, the bank can accept fewer deposits since the diversion constraint tightens. A feasible equilibrium must lie on or below the diversion constraint. Indeed, it must be the case that, in equilibrium, the diversion constraint binds. If the diversion constraint is slack, a bank can profitably deviate by accepting more deposits by offering an ϵ higher deposit rate (where ϵ is positive but arbitrarily small), which attracts depositors away from other banks. This deviation is feasible as long as $R < X$ (assuming that the incentive constraint is not violated), since when $R = X$, the bank's liability constraint binds, and it cannot offer an ϵ higher deposit rate.

Lemma 2 *The equilibrium in the deposit market is such that the diversion constraint must bind for any $R < X$.*

Proof. The proof is in the Appendix. ■

The depositors' participation constraint, $R = \frac{1}{p_h} = R^P$, and the banker's limited liability constraint, $R = X$ are vertical lines in the (d, R) space. Given that the bank-managed projects are profitable when they exert effort, the depositors' participation constraint lies to the left of the limited liability constraint. A feasible equilibrium must lie to the right of the depositors' participation constraint and to the left of the limited liability constraint.

Next we turn to the incentive constraint. In contrast to existing models featuring this friction (e.g., Holmstrom and Tirole 1997), it imposes a *lower* bound on bank leverage. The intuition is as follows. Given Assumption *A1* that the fixed cost of effort is high, $k > \Delta X - c$, it is not worthwhile for agents to exert effort when investing solely their own funds. Effort becomes worthwhile only when the agent manages external funds and thereby obtains rents from doing so. For any R, if a given level of deposits d provides sufficient rents for the banker to satisfy the incentive constraint, then the constraint must also hold for any higher d.

To derive the slope of the incentive constraint in the (d, R) space, we totally differentiate Equation (2) with respect to d and R:

$$\left.\frac{dd}{dR}\right|_{IC} = \frac{d}{X - R - \frac{c}{\Delta}} > 0 \tag{9}$$

The effort incentive constraint has a positive and convex slope. The positive slope reflects that as depositors are offered a higher promised repayment, bankers retain a smaller share of the surplus, thereby reducing their incentive to exert effort. Starting from a (d, R) pair that lies on the incentive constraint – such that the bank is just willing to exert effort – an increase in R must be accompanied by a higher d in order to preserve incentive compatibility. Moreover, as R increases, the slope of the constraint becomes steeper, approaching ∞ as $R \to X - \frac{c}{\Delta}$ (i.e., the constraint becomes vertical in the limit). A feasible equilibrium must lie on or above the incentive constraint.

For the market to clear, the demand for deposits by banks, $d\lambda$ (there are banks of a measure λ, each of which attracts d depositors), must equal the supply of deposits, $1 - \lambda$:

$$d\lambda = 1 - \lambda \tag{10}$$

The market clearing condition is a horizontal line in the (d, R) space. When very few agents become bankers, i.e., λ is very small, the market clearing condition lies above the intersection of the diversion constraint and the depositors' participation constraint. A higher λ pushes the market clearing condition down in the (d, R) space. λ adjusts given the equilibrium d and R, i.e., the market clearing condition is endogenously determined.

Increasing the fixed cost of exerting effort, k, makes the effort incentive constraint tighter, but it does not affect any of the other constraints. The intersection of the effort incentive constraint and the diversion constraint depends on the fixed cost of effort. The lower the cost, the intersection of the two constraints is further to the right in the (d, R) space. Given the parametric restrictions made above, there are three cases to consider:

1. $k > \frac{(1-\phi)\Delta X - c}{1-\phi p_h X} \equiv \bar{k}$
2. $k = \bar{k}$
3. $\bar{k} > k > \max\{\underline{k}, \Delta X - c\}$

where $\underline{k} = \frac{((1-\phi)\Delta X - c)(1+\phi \Delta X)}{1-\phi}$. Given the normalization, $p_l X = 1$, $\bar{k} > \underline{k}$ for any $\phi \in \left(0, \frac{1}{p_h X}\right)$, where $\frac{1}{p_h X}$ is the upper bound on ϕ as stated in Assumption *A2*. By Assumption *A1*, $k > \Delta X - c$. $\underline{k} < \Delta X - c$ if $c > \frac{(1-\phi)(\Delta X)^2}{1+\Delta X}$.

2.3.1 Case 1: $k > \bar{k}$

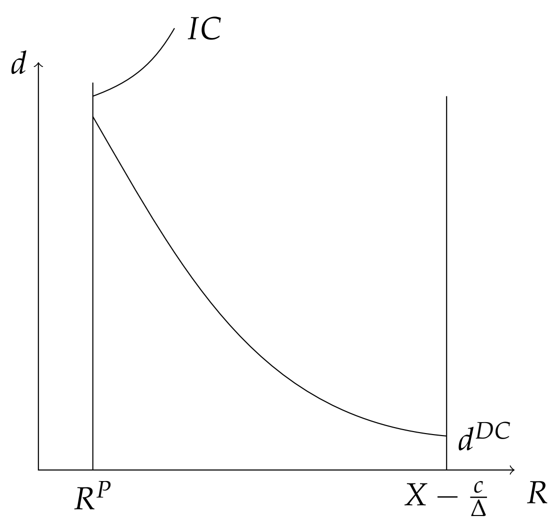

Figure 1: No banks

We illustrate the depositors' participation constraint, the diversion constraint, the limited liability constraint, and for $k > \bar{k}$, the incentive constraint in Figure 1. In this case, the incentive constraint intersects the diversion constraint to the left of the depositors' participation constraint. Agents exert effort for a (d, R) pair which lies above the incentive constraint. It can be seen that the set of parameters where agents exert effort, and at the same time, none of the constraints is violated, is empty. That is, the cost of effort is so high that the surplus generated from effort exertion is always strictly less than the cost. Anticipating that it is never incentive-compatible for banks to exert effort – and thus that depositors would not deposit their funds in banks – none of the agents makes an offer to become a banker. Instead, they invest in the storage technology. We summarize this results in the proposition below:

Proposition 1 **(No banks)** *Suppose that $k > \bar{k}$. No agent becomes a banker and all agents invest in the storage technology.*

2.3.2 Case 2: $k = \bar{k}$

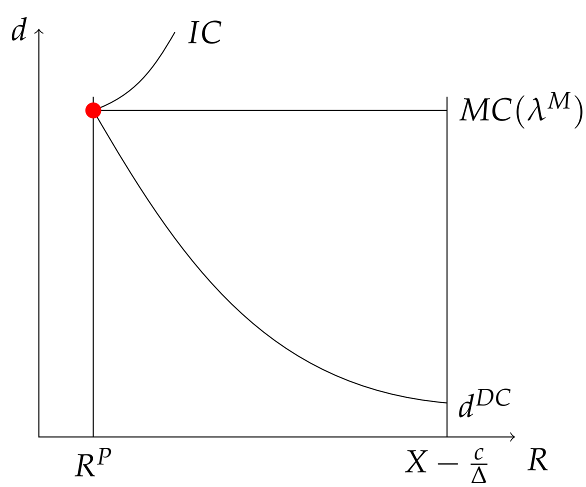

Figure 2: Monopoly pricing

In Figure 2, we consider the $k = \bar{k}$ case. Now, the incentive constraint goes through the intersection of the depositors' participation constraint and the diversion constraint (the red dot), which is characterized as follows:

$$d = \frac{\phi p_h X}{1 - \phi p_h X} \equiv d^M \tag{11}$$

$$R = \frac{1}{p_h} = R^P \tag{12}$$

Suppose that the market clears. To derive the fraction of agents who manage banks at the red dot, we substitute $d = d^M$ and $R = R^P$ in the market clearing condition, which gives:

$$\lambda = 1 - \phi p_h X \equiv \lambda^M \tag{13}$$

Given Assumption *A2*, $d^M > 0$ and $1 > \lambda^M > 0$. We need to check that the bank's participation constraint is satisfied. Substituting $d = d^M$, $R = R^P$, and $k = \bar{k}$ in Equation (6) yields:

$$\frac{\phi \Delta X}{1 - \phi p_h X} > 0 \tag{14}$$

Given Assumption *A2*, the above condition is always satisfied, implying that the banker's participation constraint is slack.

If the fraction of agents who become bankers is smaller than λ^M, the only feasible equilibrium is at the red dot. If $\lambda < \lambda^M$, the market would not clear and there would be an excess supply of deposits. An agent would be strictly better off if she can make an offer to other agents and this offer is accepted. However, this offer may not be accepted because she cannot offer a deposit rate greater than R^P since doing so would violate either the incentive constraint or the diversion constraint (or both). That is, depositors cannot be made strictly better off from this offer. Thus, they will not offer their funds to the deviant, and so, an equilibrium with $\lambda < \lambda^M$ can sustain. The same argument applies to the case where $\lambda = \lambda^M$. This implies that there is a continuum of equilibria for any $\lambda \in [0, \lambda^M]$.

Proposition 2 (Monopoly pricing) *Suppose that $k = \bar{k}$. A fraction $\lambda \in [0, \lambda^M]$ of agents become bankers. Although banks compete in prices and entry is costless, they offer the monopoly deposit rate and make strictly positive profits. The equilibrium features $d = d^M$ and $R = R^P$.*

In this equilibrium, the depositors are on their participation constraint. Hence, we refer to this as the monopoly pricing equilibrium.

2.3.3 Case 3: $\bar{k} > k > \max\{\underline{k}, \Delta X - c\}$

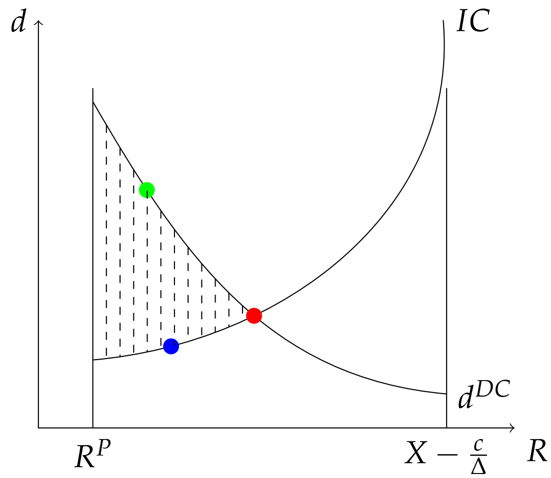

Figure 3: Oligopoly pricing

In Figure 3, we consider the $\bar{k} > k > \underline{k}$ case. In this case, the incentive constraint intersects the diversion constraint between the depositors' participation constraint and the banker's limited liability constraint and this intersection is represented by the red dot. If banks do not exert effort, their investment will be negative-NPV, and investors will not be able to recover their funds. Hence, banks will not obtain funds implying that any contract below the IC constraint can be ignored. By a similar argument, contracts above the diversion constraint can also be ruled out. Thus, the feasible contracts are in the shaded area. We argue below that the unique equilibrium of the game is at the intersection of the two constraints.

First, we rule out any equilibria in the shaded region below the diversion constraint since the diversion constraint must bind. If an equilibrium lies below the diversion constraint anywhere in the shaded region (say, the blue dot) a banker can always offer an ϵ higher deposit rate and attract more depositors and increase her profits (see Lemma 2). Now suppose that the equilibrium lies anywhere along the diversion constraint to the left of the red dot (say, the green dot). This cannot be an equilibrium since the incentive constraint is slack. We assume now and verify in the proof of Proposition 3 that, to the left of the red dot, agents are strictly more profitable as bankers than as depositors along the incentive constraint. Hence, they must also be strictly more profitable as bankers than as depositors at the green dot where the incentive constraint is slack. This implies that an agent who is a depositor at the green dot allocation can increase her profits by offering a slightly higher deposit rate to attract depositors from the incumbents and become a banker herself, thereby pushing the equilibrium down the diversion constraint towards the red dot. Therefore, no allocation except that at the intersection of the two constraints can be an equilibrium.

Next we show that this allocation at red dot is indeed an equilibrium. In this allocation, each banker has sufficient deposits to be profitable (as we verify below), implying that incumbents do not exit the market. At the same time, an agent who is currently not a banker cannot enter the market either. To attract depositors away from incumbent banks, a new entrant must offer a deposit rate ϵ higher than the one at the red dot. But such an offer violates at least one of the two constraints, and hence, the deviation is not feasible. Finally, one cannot offer a lower deposit rate since depositors will not accept a lower deposit rate when they can get the rate at the red dot. Thus, there is no profitable deviation, and hence, the allocation at the red dot indeed constitutes an equilibrium. Further, since we have previously ruled out all other possible equilibria, this equilibrium is unique.

Finally, we argue that the deposit market endogenously clears in equilibrium. Suppose that there there are too few banks so that there are agents who have not managed to become depositors in a bank, and hence, these agents use the storage technology. Then, by the arguments presented above, it is strictly profitable for one of them to deviate by offering a contract with a deposit rate $R > R^P$ in the shaded region to become a banker. This offer will be clearly accepted by those agents who are not depositors yet because the deposit rate offered exceeds the rate of return on the storage technology. This process continues until there is no agent who is not either a banker or a depositor. Conversely, if there are too many bankers, the bankers who have not managed to obtain enough depositors to be profitable will exit the market since exit is costless.

Using the diversion constraint and the incentive constraint, we derive the expressions for d and R at the red dot:

$$d = \frac{k + c - (1-\phi)\Delta X}{(1-\phi)\Delta X - c} \equiv d^* \tag{15}$$

$$R = \frac{\phi k X}{k + c - (1-\phi)\Delta X} \equiv R^* \tag{16}$$

We substitute d^* and R^* in the market clearing condition to derive the fraction of agents who manage banks:

$$\lambda = \frac{1}{k}[(1-\phi)\Delta X - c] \equiv \lambda^* \tag{17}$$

Given Assumptions *A1* and *A2*, $d^* > 0$, $R^P < R^* < X$ and $1 > \lambda^* > 0$. We need to verify that the bank's participation constraint is satisfied, that is, an agent makes strictly more profits as a banker rather than as a depositor. Substituting $d = d^*$ and $R = R^*$ in Equation (6) yields $(1-\phi)k > ((1-\phi)\Delta X - c)(1 + \phi\Delta X)$, which is satisfied due to Assumption *A3*.[5]

We summarize these results in the proposition below:

Proposition 3 (Oligopoly pricing) *Suppose that $\bar{k} > k > \underline{k}$. A fraction λ^* of agents become bankers and the market clears. The unique equilibrium is characterized by $(d^*,\ R^*,\ \lambda^*)$.*

Proof. The proof is in the Appendix. ■

We refer to this as the oligopoly pricing equilibrium since while depositors are better off compared to their outside option, banks offer a deposit rate which is low enough to allow them to make a strictly positive profit but it is higher than the monopoly pricing deposit rate.

2.4 Both frictions matter

Strikingly, even though entry and exit are costless, banks make strictly positive profits in equilibrium. Indeed, these profits exceed the informational rent, $\frac{c}{\Delta} - c$. At first sight, it

[5] If Assumption *A3* is violated, the banker's participation constraint binds before the incentive constraint. In this case, the equilibrium is determined at the intersection the participation constraint (Equation (6)) and the diversion constraint. Since the participation constraint is also upward-sloping in the (d, R) space, like the incentive constraint, the results remain qualitatively unchanged.

may seem that this result is driven by the diversion constraint which acts as a capacity constraint. However, as we show below, if either the diversion constraint or the effort moral hazard constraint is removed, the outcome reverts to the corresponding Bertrand benchmark. Thus, it is the interaction of the two frictions, rather than either friction alone, that drives the results.

To see it clearly, consider the case in which there is no effort moral hazard, $k = c = 0$. In this case, the equilibrium deposit rate will be equal to that under full information, i.e., $R = X$. Hence, given free entry and exit, bank profits will be 0 if the only constraint faced by banks is the diversion constraint. As before, the equilibrium must lie on the diversion constraint. Suppose the equilibrium occurs at some $R < X$. Then, agents at $t = 0$ observe that banks earn strictly positive profits. Since entry is costless, new entrants can profitably offer a slightly higher deposit rate, attracting depositors away from incumbent banks. This process iterates until $R = X$. Thus, when the moral hazard constraint does not bind, the Bertrand outcome obtains.

Lemma 3 *If $k = c = 0$, the Bertrand outcome obtains in which case, $R = X$.*

Next, consider the case that pledgeability is perfect, $\phi = 1$ (this violates Assumptions *A1* and *A2*). In this case, the diversion constraint no longer binds, so there is no upper limit on the amount of deposits a bank can accept. For any $R < X - \frac{c}{\Delta}$, banks would undercut each other by offering a slightly higher deposit rate (by an arbitrarily small ϵ) to capture the entire market, implying that the Bertrand logic applies. Any offer above $X - \frac{c}{\Delta}$, however, would violate the incentive constraint and is therefore infeasible.

Lemma 4 *If $\phi = 1$, in equilibrium, a bank attracts the full measure of agents in the economy by offering $R \to X - \frac{c}{\Delta}$ and the effort incentive constraint is binding.*

In Kreps and Scheinkman (1983), a capacity constraint along with an exogenously fixed number of firms in the industry chokes competition and allows these firms to make strictly positive profits. As we show in Section 5.2, when we allow for costless free entry in the Kreps and Scheinkman (1983) game, the Bertrand outcome obtains as the unique equilibrium. In contrast, in our model, the positive profits arise due to the interaction of two informational constraints (neither of which can be contracted away) even under free costless entry and exit in the industry. This contrast highlights that, despite superficial similarities, the mechanisms at work are fundamentally different.

2.5 Degree of competition

Suppose that $k = \Delta X - c + \epsilon$, where ϵ is strictly positive but arbitrarily small.[6] Substituting into Equation (16), as $\epsilon \to 0$, we obtain:

$$R^* \to X - \frac{c}{\Delta} \tag{18}$$

This implies that as k becomes very small (while still satisfying Assumptions *A1-A3*), the equilibrium is the same as the Bertrand outcome under only effort moral hazard (in absence of the diversion constraint) in which the margin that banks charge is arbitrarily close to the gross informational rent, $\frac{c}{\Delta}$. Thus, the level of competition, whether it is monopoly, oligopoly, or perfect competition, is traced to the primitives of the economy, as summarized in the following proposition:

Proposition 4 *The degree of competition lies within a range from monopoly to perfect competition and is determined by the deep parameters:*

1. $k = \bar{k}$*: Monopoly pricing,* $R = R^P$.
2. $\bar{k} > k > \max\{\underline{k}, \Delta X - c\}$*: Oligopoly,* $R = R^* > X - \frac{c}{\Delta}$.
3. $k \to \Delta X - c > \underline{k}$*: Perfect competition,* $R \to X - \frac{c}{\Delta}$.

This result is reminiscent of Maggi (1996) who capture all situations between the Cournot and the Bertrand outcome, depending on parameters in their model. Different from them, the number of banks in our model is endogenous as we allow for free entry and exit. As in the Kreps and Scheinkman (1983) model, when we allow for free costless entry in Maggi (1996), the unique equilibrium is the Bertrand outcome.

[6] It is feasible for k to be this small without violating any of the Assumptions if $c > \frac{(1-\phi)(\Delta X)^2}{1+\Delta X}$ (this ensures that $\underline{k} < \Delta X - c$ is satisfied).

3 Implications

In this section, we present the empirical and policy implications of the model which arise from the interaction of the diversion constraint and the ex ante effort moral hazard constraint.

3.1 Comparative statics

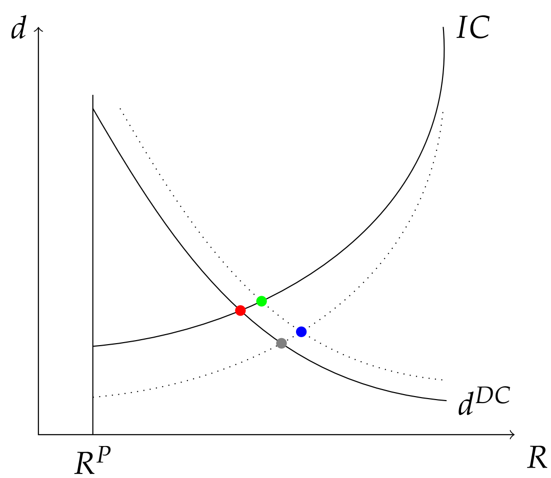

Figure 4: Comparative Statics

In this section, we derive some novel empirical predictions out of the model. Consider the case that the cost of effort is in the intermediate range, $0 < k < \bar{k}$, implying that banks retain a part of the surplus.

Lemma 5 *An increase in banks' investment opportunities, X, leads to more banks, λ^*, a higher deposit rate, R, and a lower bank leverage, d.*

Proof. The proof is in the Appendix. ■

When the bank's investment opportunities improve, which is captured by a higher X, there are two forces at play:

It pushes the diversion constraint out and it also relaxes the effort incentive constraint and pushes it down. The new intersection of these two constraints is at the blue dot. Both forces have a positive effect on the deposit rate, which increases as a result of a higher X. Interestingly, the two forces have conflicting effects on leverage – the first effect boosts leverage, taking as given the number of banks operating, but the second effect boosts the number of banks operating in equilibrium, and it pushes up λ, which leads to a lower bank leverage. We show in the proof of Lemma 4 that the second effect dominates, and the new equilibrium features a lower d when X increases – in Figure 4, the equilibrium moves from the red to the blue dot. That is, even though banks' investment opportunities improve allowing banks to attract more deposits (all else given), more agents become bankers due to the relaxed effort constraint, and this leads to a lower equilibrium leverage.

Lemma 6 *An increase in pledgeability, ϕ, leads to fewer banks, a higher deposit rate, R, and a higher bank leverage, d.*

Proof. The proof is in the Appendix. ■

When pledgeable income increases because diversion, $1 - \phi$, falls, the diversion constraint is pushed out, while the other constraints are unaffected. The equilibrium moves up along the incentive constraint implying that there are fewer banks, and it features a higher R and a higher d – in Figure 4, the equilibrium moves from the red to the green dot. Intuitively, a higher ϕ implies that banks can pledge more of their output to depositors. This intensifies competition for depositors leading to higher deposit rates. As a result, per unit of investment, banks retain a smaller surplus, and an increase in leverage is necessary to satisfy the effort incentive constraint.

Various regulatory measures over the years have fortified stability in the banking system and presumably led to greater pledgeability. Our model thus predicts the banking sector should get more concentrated over time featuring fewer banks and banks should be more levered. There are numerous studies providing supporting evidence for these predictions: Saunders and Wilson (1999) document that the banking sectors in the US, UK, and Canada have become increasingly consolidated over the very long run, and at the same time, banks have become more levered. Corbae and D'Erasmo (2020) document increasing concentration in the US banking sector and Miles et al. (2013) find that UK banks have become more levered over time.

If we assume that the strength of institutions is increasing in GDP/capita, then richer countries are characterized by a lower threat of diversion. Given this, the prediction is that bank pricing power is falling in GDP/capita, but the banking sector is more concentrated (fewer banks).

Thus, when pledgeable income increases, the effect on the deposit rate is unambiguously positive regardless of whether X or ϕ contributes to the increase in pledgeable income – higher pledgeable income leads to lower pricing power in the deposit market. However, the effect of a higher pledgeable income on bank leverage may be positive or negative depending upon whether ϕ or X contributes to the increase in pledgeable income. If pledgeable income increases due to institutional factors which allows banks to commit to diverting a smaller fraction of the output (e.g., the regulatory environment), then it leads to higher leverage. However, if pledgeable income increases due to improved investment opportunities, then it leads to lower leverage.

Lemma 7 *A fall in the cost of effort, c or k, leads to more banks, a higher deposit rate, R, and a lower bank leverage, d.*

Proof. The proof is in the Appendix. ■

When the cost of effort, c or k, falls, it relaxes the effort incentive constraint and pushes it down, while the other constraints are unaffected. The equilibrium moves down along the diversion constraint and features a higher R and a lower d – in Figure 4, the equilibrium moves from the red to the gray dot. This prediction aligns with the intuition that lowering the cost of effort increases the number of banks. Somewhat less obvious, however, is the accompanying decline in leverage.

3.2 The dichotomy of concentration and pricing power

High concentration in the banking sector can coexist with low pricing power.

When pledgeability increases, banks can offer higher deposit rates and accept more deposits. This, in turn, leads to fewer banks. To see this, note that a higher ϕ relaxes the diversion constraint, pushing it upwards, while leaving the other constraints unaffected. As shown in Figure 4, the equilibrium shifts from the red to the green dot. This new equilibrium is characterized by fewer banks, and yet, a higher deposit rate. Thus, a negative correlation between the deposit rate and the number of banks can emerge. Consistent with this prediction, Berger (1995) and Claessens and Laeven (2004) document that the correlation between bank concentration and pricing power can be negative (see also Demirguc-Kunt et al. 2004). In the same vein, Simons and Stavins (1998) find that bank mergers leading to higher concentration do not lead to sustainable increases in pricing power.

At the same time, holding the degree of diversion constant, an increase in the fixed cost of effort, k, pushes the IC constraint up and reduces the number of banks, leading to higher concentration, and banks enjoy greater pricing power in this new equilibrium. Thus, our model also delivers the conventional prediction of a positive correlation between pricing power and concentration (see, e.g., Berger and Hannan 1989 for supporting empirical evidence).

Thus, there are countervailing forces which determine the correlation between concentration in the banking sector and the deposit rate, which can go either way depending on which of the two forces dominate. In general, although the US banking sector has become increasingly concentrated over the last few decades (as documented widely, see e.g., Corbae and D'Erasmo 2020), bank profitability has remained at a roughly similar level over time (see Drechsler et al. 2021), thereby highlighting the disconnect between concentration and profitability. In our model, a simultaneous fall in diversion and an increase in the cost of effort (both, possibly due to heightened regulatory burden) can reconcile the observed rise in market concentration with stable profitability. Our analysis shows that treating concentration as an endogenous outcome rather than an exogenous variable yields a richer set of predictions.

3.3 The pass-through effect

The pass-through effect increases with pledgeability, ϕ, when ϕ is low, and decreases in ϕ when ϕ is high.

The extent to which an increase in X (e.g., due to a rise in the monetary policy rate) is passed through to depositors is given by:

$$\frac{\delta R^*}{\delta X} = \frac{\phi k(k+c)}{[k+c-(1-\phi)\Delta X]^2} \tag{19}$$

The pass-through effect is *partial* (i.e., the change in the equilibrium deposit rate is smaller than the change in X) if this derivative is less than one. Thus, there can be partial pass-through even when banks compete in prices, and there is neither product differentiation nor a switching cost for depositors. The pass-through depends on ϕ:

$$\frac{\delta^2 R^*}{\delta X\, \delta\phi} = \frac{k(k+c)[k+c-(1+\phi)\Delta X]}{[k+c-(1-\phi)\Delta X]^3} \tag{20}$$

The pass-through is increasing in ϕ if:

$$\phi < \frac{k+c-\Delta X}{\Delta X} \tag{21}$$

This implies that when pledgeability is low, an increase in ϕ leads to greater pass-through, but when pledgeability is already high, the relationship may reverse.

3.4 Optimal policy

A utilitarian regulator can eliminate a problem of excessively high number of banks by introducing an upper bound on the number of bank licences to be allocated.

When $k = \bar{k}$, there is monopoly pricing, and (in one of the equilibria) the minimum number of bankers enter the market, $\lambda = 1 - \phi p_h X$, such that the market for deposits clears. Thus, in ths monopoly equilibrium, the entire initial endowment of the economy is managed by banks, and at the same time, this arrangement minimizes the exertion of costly effort. For $\bar{k} > k > \underline{k}$, there is inefficient duplication of the fixed component of effort since there are too many banks, $\lambda > 1 - \phi p_h X$. As the fixed cost of effort, k falls, the net surplus in the economy increases, and more agents become bankers. However, *for a given* k, net social surplus in the economy is maximized by minimizing the number of bankers to the extent that the deposit market clears.

Suppose $\bar{k} > k > \underline{k}$. A regulator whose objective is to maximize the net social surplus can eliminate the inefficiency by announcing a cap on the number of banking licences. The regulator will choose a maximum of $1 - \phi p_h X$ agents to apply for a banking licence on a first-come-first-served basis. Since $k < \bar{k}$, the incentive constraint is slack and all chosen bankers exert effort. Thus, the problem of too many banks is eliminated since there are just enough banks in equilibrium such that the market clears. This regulated equilibrium resembles the unregulated monopoly equilibrium which arises when $k = \bar{k}$ in terms of the outcome variables, d and R. However, in contrast to the laissez faire monopoly, the agents who become bankers in the regulated monopoly extract a higher fraction of the surplus (so, there is no multiple equilibria, as in the laissez-faire monopoly case).

Unlike the charter value hypothesis (see, e.g., Hellmann et al. 2000) in which a higher market power promotes stability by making banks more prudent in anticipation of higher charter values, in our theory, restricting competition in the banking sector improves efficiency by mitigating an excessive effort provision problem.

3.5 Applications beyond banking

Although our analysis is framed in a banking context, the insights developed in this paper apply more broadly to other environments where effort moral hazard and ex post diversion are salient concerns. We provide some examples below:

A prime example is the labor market. Firms cannot always credibly commit the full value of future output to workers, due to factors such as limited liability, strategic default, or the need to preserve incentives. In the United States, for instance, Chapter 11 bankruptcy allows a firm to restructure its obligations in a way that can effectively erase the accumulated claims of ex-employees, even if their prior efforts contributed to the firm's success. Our model suggests that even though ex ante homogeneous agents sort into becoming entrepreneurs and workers, entrepreneurs will earn higher returns than workers.

Another relevant application is in microfinance. Borrowers often face strong incentives to divert proceeds once loans are disbursed and the output depends on the borrower's efforts. The mechanisms explored in this paper shed light on the broader challenge of securing cooperative outcomes when future surplus is both uncertain and only partially pledgeable. Even though borrowers are competing for funds, they retain some market power against the lenders due to the informational constraints.

A third potential application concerns how improvements in data access or computing power, driven by advances in Artificial Intelligence (AI), affect firms' market power. Suppose financially constrained firms face limited pledgeability and require incentives to exert effort. These frictions restrict their leverage and, consequently, their scale. In turn, limited scale enables them to charge positive mark-ups in the product market. On one hand, advances in tasks such as credit underwriting, fraud detection, or asset management, enabled by better data or computing power, increase the pledgeable share of future surplus. This leads to lower equilibrium mark-ups. On the other hand, achieving these outcomes requires substantial investment in data acquisition and processing, where the associated effort is unobservable. If the cost of such effort rises over time, due to increasing complexity or data scarcity, for example, firms may be able to sustain higher mark-ups. The interactions studied in this paper offer a useful lens to understand these opposing forces.

4 Conclusion

We develop a model of bank competition in the deposit market in which there are two key frictions at play – an ex post threat of diversion and an ex ante effort moral hazard constraint. The interaction of these two constraints (which cannot be contracted away) allows banks to make positive profits in the deposit market despite price competition and free entry and exit. Also, the deposit market clears endogenously, and this determines the number of banks in equilibrium.

Our model generates novel implications: While an increase in banks' investment opportunities allows them to increase leverage in a static sense, it also relaxes banks' effort incentives, leading to more banks in equilibrium. Taking into account the latter effect, the banking sector features more banks and each bank exhibits lower leverage. High concentration in the banking sector can coexist with low pricing power, implying that the use of concentration-based proxies for market power can be misleading unless the level of diversion is appropriately accounted for in empirical studies. In terms of policy implications, there may exist an excessively high number of banks in the banking industry. In this case, the regulator can introduce an upper bound on the number of bank licences to be allocated which would correct the inefficiency.

5 Appendix

5.1 Proofs

Proof of Lemma 1.

Proof. A bank's profits net of own investment and effort costs are Π (see Equation 5). For any $R < X$, since the bank retains a fraction of the surplus generated from investing the externally raised funds, bank profits are strictly increasing in the number of external investors, d. Given the observation that bank profits are increasing in d, we solve for the maximum d which is consistent with the diversion constraint being satisfied. We re-write the diversion constraint as follows:

$$(p_h R - \phi p_h X)d \leq \phi p_h X - p_h R_s \tag{22}$$

The LHS is increasing in d. Hence, to relax this constraint to the maximum extent possible (while not affecting any of the other constraints) we set $R_s = 0$. Thus, external investors have priority over the verifiable fraction of the cash flow, implying that they receive the most senior claim which we refer to as deposit. The banker obtains the junior claim and becomes the residual claimant (the equity-holder). ■

Proof of Proposition 3.

Proof. The arguments above the proposition relied on the assumption that, along the incentive constraint curve, agents are strictly more profitable as bankers than as depositors to the left of the red dot. That is, the IC constraint lies above the PC constraint to the left of the red dot. We verify below that this assumption is satisfied. Substituting $R = 0$ in Equations (2) and (6) gives the vertical-axis intercepts of the IC and PC constraints, respectively:

$$d = \frac{k + c - \Delta X}{\Delta X - c} \equiv d^{IC} \mid_{R=0} \tag{23}$$

$$d = \frac{k + c - p_h X}{p_h X - c} \equiv d^{PC} \mid_{R=0} \tag{24}$$

On the vertical axis, $d^{IC} \mid_{R=0} > d^{PC} \mid_{R=0}$ if:

$$p_l X > 0 \tag{25}$$

This condition is always satisfied. Therefore, the PC constraint lies strictly below the IC constraint on the vertical axis. By Assumption *A3*, this ordering also holds at the red dot, implying that the IC constraint lies above the PC constraint to the left of the red dot, which completes our proof. ■

Proof of Lemma 5.

Proof.

Differentiating d^* with respect to X:

$$\frac{\delta d^*}{\delta X} = -\frac{(1-\phi)\Delta k}{[(1-\phi)\Delta X - c]^2} < 0 \tag{26}$$

Differentiating R^* with respect to X:

$$\frac{\delta R^*}{\delta X} = \frac{\phi k(k+c)}{[k + c - (1-\phi)\Delta X]^2} > 0 \tag{27}$$

Differentiating λ^* with respect to X:

$$\frac{\delta\lambda^*}{\delta X} = \frac{1}{k}(1-\phi)\Delta > 0 \tag{28}$$

Below we provide a graphical proof which illustrates the mechanism. Totally differentiating the diversion constraint with respect to R and X:

$$\left.\frac{dR}{dX}\right|_{DC} = \frac{\phi(1+d)}{d} \tag{29}$$

Totally differentiating the incentive constraint with respect to R and X:

$$\left.\frac{dR}{dX}\right|_{IC} = \frac{1+d}{d} \tag{30}$$

For a given increase in X, both the diversion and incentive constraints shift to the right in the (d, R) space indicating that a higher X leads to an increase in R. To assess the impact of a higher X on leverage and entry, we compare the magnitude of the lateral shift in the two constraints. The magnitude of the lateral shift in the diversion constraint is smaller than that of the incentive constraint if:

$$\begin{aligned}\frac{\phi(1+d)}{d} &< \frac{1+d}{d} \\ \implies \phi &< 1\end{aligned}$$

The above condition is always satisfied. Given this observation that an increase in X leads to a smaller lateral shift in the diversion constraint than in the incentive constraint, when X increases, the diversion and incentive constraints intersect at a lower point. This implies that a higher X leads to more banks and a lower d. ■

Proof of Lemma 6.

Proof.

Differentiating d^*, R^*, and λ^* with respect to ϕ:

$$\frac{\delta d^*}{\delta\phi} = \frac{k\Delta X}{[(1-\phi)\Delta X - c]^2} > 0 \tag{31}$$

Differentiating R^* with respect to ϕ:

$$\frac{\delta R^*}{\delta \phi} = \frac{kX(\overbrace{k + c - \Delta X}^{>0 \text{ by A1}})}{[k + c - (1 - \phi)\Delta X]^2} > 0 \tag{32}$$

Differentiating λ^* with respect to ϕ:

$$\frac{\delta \lambda^*}{\delta \phi} = -\frac{\Delta X}{k} < 0 \tag{33}$$

■

Proof of Lemma 7.

Proof.

Differentiating d^* with respect to k:

$$\frac{\delta d^*}{\delta k} = \frac{1}{\underbrace{(1 - \phi)\Delta X - c}_{>0 \text{ by A1}}} > 0 \tag{34}$$

Differentiating R^* with respect to k:

$$\frac{\delta R^*}{\delta k} = \frac{\phi X[\overbrace{c - (1 - \phi)\Delta X}^{<0 \text{ by A1}}]}{[k + c - (1 - \phi)\Delta X]^2} \tag{35}$$

Differentiating λ^* with respect to k:

$$\frac{\delta \lambda^*}{\delta k} = \frac{c - (1 - \phi)\Delta X}{k^2} < 0 \tag{36}$$

Differentiating d^* with respect to c:

$$\frac{\delta d^*}{\delta c} = \frac{k}{[(1 - \phi)\Delta X - c]^2} > 0 \tag{37}$$

Differentiating R^* with respect to c:

$$\frac{\delta R^*}{\delta c} = -\frac{\phi k X}{[k + c - (1-\phi)\Delta X]^2} < 0 \tag{38}$$

Differentiating λ^* with respect to c:

$$\frac{\delta \lambda^*}{\delta c} = -\frac{1}{k} < 0 \tag{39}$$

■

5.2 Kreps and Scheinkman (1983) with free entry

In this section, we consider the Kreps and Scheinkman (1983) game with capacity constraints and fixed number of firms in the industry. We extend this game to allow for free (costless) entry, and show that, in this extended game, the Bertrand outcome arises as the unique equilibrium.

Consider a simplified version of our model in which there are no informational frictions and the project always succeeds (i.e., $p_h = 1$). Lets now apply the Kreps and Scheinkman (1983) approach to this setting. There are N banks indexed $i = \{1, ..N\}$, each demanding deposits, d_i. They face an upward sloping supply curve, $R = a + D$, where a is a positive constant, R is the deposit rate, and D is the total deposits demanded by banks, $D = \sum_{i=1}^{N} d_i$. Banks use deposits to make loans and the loan rate is exogenously given and constant at X, where $0 < a < X$. This corresponds to the exogenously given marginal cost in Kreps and Scheinkman (1983).

The original game has two stages: In Stage 1 of the game, banks simultaneously and independently choose their capacity to accept deposits, l_i. In Stage 2, each bank observes the other banks' choices of their pre-committed capacities, and they simultaneously choose the deposit rate. We look for the sub-game perfect Nash equilibrium of this game and solve for the equilibrium backwards.

In Stage 2, given capacities, l_i, depositors deposit their funds first to the bank offering the highest deposit rate till this bank's capacity is exhausted. Then, depositors take the residual supply to the bank offering the next highest deposit rate and so on. This iterates till the deposit rate reaches depositors' reservation price. If banks offer the same deposit rate, the market is split equally among them.

In Stage 1, banks set their capacity to accept deposits by anticipating the outcome in the next stage. If the total capacity is higher than the supply of deposits, then banks set the deposit rate equal to the loan rate, X. Thus, to avoid this Bertrand price war, banks choose capacity, l_i to be equal the Cournot quantities, d^*, thereby softening price competition in the following stage.

A bank j's profit function is:

$$\Pi_j = (X - R)d_j \tag{40}$$

Using $R = a + D$, and taking the first order condition with respect to d_j:

$$d_j = \frac{X - a - \sum_{i \neq j} d_i}{2} \tag{41}$$

In the symmetric equilibrium, $d_j = d^*$. Substituting, we derive the equilibrium of the Kreps and Scheinkman (1983) game:

$$l_i = d_i = d^* = \frac{X - a}{N + 1}$$

Thus, the total amount of deposits demanded in equilibrium is $D = Nd^*$. Substituting into R:

$$R^* = \frac{NX + a}{N + 1} < X$$

Because banks choose their capacity in the first stage of the game, they are able to earn strictly positive profits even though they compete in deposit rates in the final stage. Anticipating the equilibrium deposit rate that will prevail in the next stage, each bank sets its capacity such that it is exactly filled – there is no excess supply of deposits. As a result, banks can offer a deposit rate strictly below the loan rate, X, since the limited capacity prevents undercutting by competitors from driving the rate up to X.

We now introduce to the Kreps and Scheinkman (1983) game the possibility of bank entry in the first stage of competition. Suppose, as we do throughout the paper, entry is free and costless. Then, anticipating positive profits, a new bank (indexed $i = N + 1$) enters the market and offers the same capacity in the first stage. This leads to unfulfilled demand in the next stage. Anticipating this, banks adjust their announced capacity. As the number of entrants go up, the equilibrium approaches the Bertrand outcome, and in equilibrium, $R^* = \frac{NX+a}{N+1} = \frac{X+\frac{a}{N}}{1+\frac{1}{N}} = X$ since $N = \infty$.

Proposition 5 (Kreps and Scheinkman (1983) with free entry) *When banks can freely enter the market, the equilibrium reverts to the Bertrand outcome, even if banks can pre-commit to capacity constraints before competing in prices. This implies that pass-through is full,* $\frac{\delta R}{\delta X} = 1$.

The Kreps and Scheinkman (1983) model shows that with a fixed number of firms, pre-committed capacity followed by price competition can yield Cournot-like outcomes. However, once free entry is introduced, firms have an incentive to enter until all economic profits are dissipated. This undermines the disciplining role of capacity constraints, and the outcome reverts to the perfectly competitive Bertrand benchmark.

References

Acharya, V. V., Gujral, I., Kulkarni, N., and Shin, H. S. (2011). Dividends and bank capital in the financial crisis of 2007-2009. *NBER Working paper*.

Beck, T., Jonghe, O. D., and Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation*, 22:218–244.

Berger, A. (1995). The profit-structure relationship in banking – tests of market-power and efficient-etructure hypotheses. *Journal of Money, Credit, and Banking*, 27(2):404–431.

Berger, A. N. and Hannan, T. H. (1989). The price-concentration relationship in banking. *Review of Economics and Statistics*, 71(2):291–299.

Beyhaghi, M., Fracassi, C., and Weitzner, G. (2025). Adverse selection in corporate loan markets. *Journal of Finance*. Forthcoming.

Biswas, S. and Koufopoulos, K. (2022). Bank capital structure and regulation: Overcoming and embracing adverse selection. *Journal of Financial Economics*, 143(3):973–992.

Boot, A. and Thakor, A. (2000). Can relationship banking survive competition? *Journal of Finance*, 55(2):679 – 713.

Broecker, T. (1990). Credit-worthiness tests and interbank competition. *Econometrica*, 58(2):429–452.

Calomiris, C. and Kahn, C. (1991). The role of demandable debt in structuring optimal banking arrangements. *American Economic Review*, 81(3):497–513.

Claessens, S. and Laeven, L. (2004). What drives bank competition? some international evidence. *Journal of Money, Credit and Banking*, 36(3):563 – 583.

Corbae, D. and D'Erasmo, P. (2020). Rising bank concentration. *Journal of Economic Dynamics and Control*, 115(C).

Corbae, D. and D'Erasmo, P. (2021). Capital buffers in a quantitative model of banking industry dynamics. *Econometrica*, 89(6):2975–3023.

Dell'Ariccia, G., Friedman, E., and Marquez, R. (1999). Adverse selection as a barrier to entry in the banking industry. *RAND Journal of Economics*, 30(3):515–534.

Demirguc-Kunt, A., Laeven, L., and Levine, R. (2004). Regulations, market structure, institutions, and the cost of financial intermediation. *Journal of Money, Credit, and Banking*, 36(3):593–622.

Donaldson, J. R., Piacentino, G., and Thakor, A. V. (2018). Warehouse banking. *Journal of Financial Economics*, 129(2):250–267.

Drechsler, I., Savov, A., and Schnabl, P. (2017). The deposits channel of monetary policy. *Quarterly Journal of Economics*, 132(4):1819–1876.

Drechsler, I., Savov, A., and Schnabl, P. (2021). Banking on deposits: Maturity transformation without interest rate risk. *Journal of Finance*, 76(3):1091–1143.

Drechsler, I., Savov, A., Schnabl, P., and Wang, O. (2024). Deposit franchise runs. *Working paper*.

Farrell, J. and Klemperer, P. (2007). Coordination and lock-in: Competition with switching costs and network effects. volume 3 of *Handbook of Industrial Organization*, pages 1967–2072. Elsevier.

Forssbaeck, J. and Shehzad, C. T. (2015). The conditional effects of market power on bank risk - cross country evidence. *Review of Finance*, 19:1997–2038.

Gennaioli, N. and Rossi, S. (2013). Contractual resolutions of financial distress. *Review of Financial Studies*, 26(3):602 – 634.

Green, R. C. (2007). Presidential address: Issuers, underwriter syndicates, and aftermarket transparency. *Journal of Finance*, 62(4):1529–1550.

Hart, O. and Moore, J. (1995). Debt and seniority: An analysis of the role of hard claims in constraining management. *American Economic Review*, 85(3):567–585.

Hellmann, T. F., Murdock, K. C., and Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review*, 90(1):147–165.

Holmstrom, B. and Tirole, J. (1997). Financial intermediation, loanable funds and the real sector. *Quarterly Journal of Economics*, 112(3):663–691.

Holmstrom, B. and Tirole, J. (2011). *Inside and Outside Liquidity*. The MIT Press, Cambridge, MA.

Kreps, D. M. and Scheinkman, J. A. (1983). Quantity precommitment and bertrand competition yield cournot outcomes. *Bell Journal of Economics*, 14(2):326–337.

Maggi, G. (1996). Strategic trade policies with endogenous mode of competition. *American Economic Review*, 86(1):237–258.

Marquez, R. (2002). Competition, adverse selection, and information dispersion in the banking industry. *Review of Financial Studies*, 15(3):901–926.

Martinez-Miera, D. and Repullo, R. (2010). Does competition reduce the risk of bank failure? *The Review of Financial Studies*, 23(10):3638–3664.

Mehran, H. and Thakor, A. (2011). Bank capital and value in the cross-section. *Review of Financial Studies*, 24(4):1019–1067.

Miles, D., Yang, J., and Marcheggiano, G. (2013). Optimal bank capital. *The Economic Journal*, 123(567):1–37.

Morrison, A. and White, L. (2005). Crisis and capital requirements in banking. *American Economic Review*, 95(5):1548–1572.

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation*, 13(2):156–182.

Saunders, A. and Wilson, B. (1999). The impact of consolidation and safety nets on bank risk-taking. *Journal of Banking & Finance*, 23(2-4):327–358.

Schliephake, E. and Kirsten, R. (2013). Strategic effects of regulatory capital requirements in imperfect banking competition. *Journal of Money, Credit and Banking*, 45(4):675–700.

Shaffer, S. (1998). The winner's curse in banking. *Journal of Financial Intermediation*, 7(4):359–392.

Shleifer, A. and Wolfenzon, D. (2002). Investor protection and equity markets. *Journal of Financial Economics*, 66(1):3–27.

Simons, K. and Stavins, J. (1998). Has antitrust policy in banking become obsolete? *Federal Reserve Bank of Boston New England Economic Review*, pages 13 – 26.

Vives, X. and Ye, Z. (2025). Fintech entry, lending market competition, and welfare. *Journal of Financial Economics*, 168:104040.

Wang, Y., Whited, T., Wu, Y., and Xiao, K. (2022). Bank market power and monetary policy transmission: Evidence from a structural estimation. *Journal of Finance*, 77(4):2093–2141.