Banks as Secret Keepers

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Abstract

Banks are optimally opaque institutions. They produce debt for use as a trans-
action medium (bank money), which requires that information about the backing
assets not be revealed, so that bank money does not fluctuate in value, reduc-
ing its efficiency in trade. This need for opacity conflicts with the production of
information about investment projects, necessary for allocative efficiency. How
can information be produced and not revealed? Financial intermediaries exist
to hide such information; they are created and structured to keep secrets. For
the economy as a whole, this can be accomplished by a separation in how firms
finance themselves; they divide into bank finance and capital market/stock mar-
tet finance based on how well they can be used to maintain information away
from liquidity markets. Firms with large projects, risky projects or projects easy
to evaluate are less likely to be financed by banks.

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1 Introduction

Private money comes in many forms, such as private bank notes, demand deposits, money market fund shares, but also sale and repurchase agreements (repo) and commercial paper. These private claims must be backed by assets. To efficiently implement transactions agents want money that is not sensitive to information revelation, which would cause its value to change in an unanticipated manner. A characteristic of money like securities is that agents accept them at par when transacting and can redeem them at par with sufficiently high probability. Private agents cannot produce riskless assets to back money, so only risky claims are available. But, investment efficiency requires that information be produced to select and monitor private investments. The conundrum then is that information needs to be produced but not revealed. In this paper we ask two questions: Why do banks produce private money (rather than the agents themselves)? And, what are the optimal assets for backing private money?

Our answer is that financial intermediaries produce private money because they can keep the information that they produce on backing assets secret. Without banks, information leaks out and reduces the efficiency of private money. So, banks are optimally opaque. Moreover, banks select backing assets that minimize information leakage. For example, banks lend to small, relatively safe, firm, and to households. Contrary to the existing literature on the existence of banks, here banks are not needed to screen or monitor borrowers; this can be done as well by nonbanks. However, there is a complementarity between the production of private money and assets that minimize information leakage. Thus, the raison d'être of banking is secret-keeping for the production of private money.

We show this fundamental tradeoff between socially valuable information production and its negative externality on liquidity provision (trade using private money) with a very simple model in which there is investment and trade at an initial date and then, subsequently there is a possible extension of the original project and another transaction. Information production is needed to assess whether the extension should be undertaken. But, this information about the extension also reveals new information about the original project, which may then reduce the value of the money that was issued initially, potentially reducing its value so that it can implement less trade. The model displays the basic problem that information is needed for invest-
ment efficiency, but not wanted, for trading efficiency.

To begin, we analyze how two polar institutional arrangements can handle socially valuable information production and its negative externality on liquidity provision. First, in an informationally-efficient market system, the second project is financed with a security issued in the capital market where all agents can observe the price. In the second there is a banking system, where the bank finances the extension and can potentially hide this information. We use the terms bank and financial intermediary interchangeable.

We show that capital markets are not optimal in providing liquidity services because they reveal too much information about the original project, which backs the private money. In the basic model we show that a bank can effectively hide information and implement the first best allocation. In the basic model agents cannot produce private information and the bank is a benevolent social planner.

Then we allow agents to produce and trade on private information, potentially creating an information leakage. The bank can prevent such information leakage through its choice of assets. The banks optimal portfolio consists of assets for which private information is very costly to produce. The optimal backing assets that we determine correspond to those we observe in reality (new, difficult to evaluate, small, and relatively safe assets), but the reason is unrelated to any special ability of the bank to oversee these assets.

Furthermore, private money tends to be backed by assets that do not have traded equity that could reveal damaging information. This is a common feature of the assets backing private money. In the U.S. free banks in the 19th century were required to back their private bank notes by state bonds, which of course had no traded equity (but were risky). U.S. National Bank notes, which came into existence after the Civil War were backed by U.S. Treasury bonds, which of course also have no traded equity. Demand deposits are backed by portfolios of loans, mostly to consumers and small businesses, which again have no traded equity. Asset-backed securities (ABS) are very useful as collateral because these securities have no traded equity; equity is held by the originator of the underlying loans. And repo backed by ABS is a form of private money backed by an asset (the collateral) that is a senior claim on a portfolio, where the equity price is never revealed. Asset-backed commercial paper also is backed by a portfolio of asset-backed securities, which do not trade equity.
The model we analyze is related to Dang, Gorton, and Holmström (2012), but extended to include an interim investment decision, socially valuable information production and banks. They show, among other results, that the optimal trading security is debt and that the optimal backing collateral is also debt. Their setting is one in which there is the possibility of some agents producing private information, creating possible adverse selection in trading, which then reduces the value of private money. We analyze a further information externality, one due to possible public information. This extension allow us to study why banks exist and how they optimally choose their portfolio structure.

Our argument for the existence of financial intermediation is very different from other explanations explored previously by the literature. Here banks exist to produce debt that can be used in trading. This argument has been advanced by Gorton and Pennacchi (1990), although there the backing assets were riskless, while here they are risky. Diamond and Dybvig (1983) argue that the assets backing bank money are necessarily risky because the horizon of private investments which have risky payoffs is longer than the horizon of trading needs. We explore the case where backing assets are risky. What is special about the bank moneys backing assets is that they are selected to minimize information leakage. Bank uniqueness in this paper has to do with the function of banks in eliminating the externality of useful information about assets that hinders their liquidity value.

The usual view sees the uniqueness of banks in terms of their activities with respect to making loans. Banks are viewed as producing information about potential borrowers (screening) and producing information after the loan is made (monitoring); see, e.g., Boyd and Prescott (1986). In order for the bank itself to be monitored its liabilities are designed as a short leash, e.g., demand deposits that can be withdrawn at any moment. See Diamond (1984), Diamond and Rajan (2001) and Gorton and Winton (2003) for a survey of the banking literature. In this view, the structure of bank liabilities is dictated as a mechanism to ensure that the unique activities of making loans are undertaken. Our view is the opposite. There is nothing unique about bank loans. But, banks are unique in producing debt used as private money.

In this model banks exist to hide information that should be produced to extend loans efficiently. Capital markets cannot fulfill this function because they do not internalize the effect of useful information about assets in reducing the ability of claims over those assets to facilitate transactions.
In Section 2 we introduce the model, calculate the first best allocation, and then show the first best can be implemented by intermediation and not capital markets. In Section 3 we study what happens if agents can privately produce information, reducing the possibility of intermediaries to keep secrets. In Section 4 we determine the optimal portfolio choice of banks that allows them to hide information most effectively. Section 5 discusses empirical evidence on bank opacity. Finally, Section 6 concludes.

2 Model

In this section we present the model. Then, we derive the first best allocation and study the allocations achievable with capital markets and with a banking technology (or contract environment) that are able to keep secrets.

2.1 Setting

Consider an economy with a single good, three dates, \( t \in \{0, 1, 2\} \), and four agents: a Firm (\( F \)), an Early consumer (\( E \)), a Late consumer (\( L \)), and a Bank (\( B \)). Preferences and endowments are the following:

\[
U_F = \sum_{t=0}^{2} C_{Ft} \quad \omega_F = (0, 0, 0)
\]

\[
U_E = \sum_{t=0}^{2} C_{Et} + \alpha \mathbb{I}(C_{E1} \leq k) C_{E1} \quad \omega_E = (\epsilon, 0, 0)
\]

\[
U_L = \sum_{t=0}^{2} C_{Lt} \quad \omega_L = (0, \epsilon_L, 0)
\]

\[
U_B = \sum_{t=0}^{2} C_{Bt} \quad \omega_B = (0, 0, 0)
\]

where \( C_{ht} \) denotes the consumption of agent \( h \in \{F, E, L, B\} \) at date \( t \in \{0, 1, 2\} \), \( \alpha \) and \( k \) are positive constants and \( \mathbb{I}(C_{E1} \leq k) \) is an indicator function that equals 1 if \( C_{E1} \leq k \) and 0 otherwise. The firm has no endowment of goods; the early consumer has \( \epsilon \) units of goods at \( t = 0 \) and nothing at other dates and the late consumer has \( \epsilon_L \) units of goods at \( t = 1 \) and nothing at other dates. In few words, all agents are risk
neutral and indifferent between consuming in any period, with the exception of the early consumer, who prefers to consume up to $k$ at $t = 1$.

Even though the firm does not have any endowment, it has an investment opportunity. At $t = 0$ the firm can invest, at a cost $w$, in a project that generates $x > w$ at $t = 2$ with probability $\lambda$, and zero otherwise, all in terms of the single good. At $t = 1$, the firm has the opportunity to extend the original investment, at a cost $\hat{w}$, which generates $\hat{x} > \hat{w}$ at $t = 2$ only if the original investment is successful, and zero otherwise. This implies the original project and its extension are perfectly correlated.

We assume the original project has a positive net present value and its operation is ex-ante efficient (this is, $\lambda x > w$), while the extension has a negative ex-ante net present value (this is, $\lambda \hat{x} < \hat{w}$). We assume the firm has hard information at $t = 1$ about whether the original project is successful, and hence whether the extension is profitable. The firm can communicate this information to the rest of agents at no cost.

We also assume the endowment of early consumers are not enough to cover both their liquidity needs and firms’ investment needs, while total endowment in the economy (the endowment of both early and late consumers) is enough to cover both liquidity and investment needs. We summarize these restrictions next

**Assumption 1  Projects and endowments**

1. Projects are ex-ante efficient but extensions are not. $\lambda x > w$ and $\lambda \hat{x} < \hat{w}$.

2. Early consumers can cover their liquidity and investment needs, but not both. $e > k$, $e > w$ and $e < k + w$.

3. Total endowment is enough to cover both liquidity and investment needs. $e_L + e > k + w + \hat{w}$.

Some further assumptions are worth noting. First, endowments are fixed and storable, which implies that banks will not be necessary to move endowment inter-temporally. The early consumer can store up to $k$ of his endowment to guarantee its consumption at $t = 1$. However, in this case, the early consumer would not have enough resources to invest in the project, since $e - k < w$. In contrast, if the early consumer finances the
project at $t = 0$, since claims on the project pay at $t = 2$, the only possibility to consume $k$ at $t = 1$ is to trade a fraction of those claims with late consumers, who have enough resources to finance potentially profitable extensions and to buy the claims for early consumers to cover their liquidity needs.

The trade between early and late consumers that would implement first best, however, is hindered by information revelation about the project at $t = 1$. The information about the realization of the original project is positive because it allows the extension to be financed only when it is optimal to do so. This information, however, have a negative impact on the early consumers ability to trade its claims on the original project – if the original project was unsuccessful the claims held by early consumers are worthless and then late consumers would not be willing to buy them, exposing early consumers to not covering their liquidity needs.

We will show that, even though the bank is a neutral individual without any endowment or special abilities, it will be able to improve welfare by participating as an opaque intermediary, who uses the information to allocate investment optimally, but hide that information to avoid it interfering with trade. In a sense, a bank that keeps secrets can eliminate the negative externality imposed by information on trade.

### 2.2 Autarky and First Best

In autarky early and late consumers just store their endowment and do not interact with the firm, then $U^A_F = U^A_B = 0$, $U^A_E = e + \alpha k$ and $U^A_L = e_L$.

Clearly it is possible for the economy to do better than autarky. Consider the problem of a social planner. At $t = 0$, it is socially efficient for the firm to invest in the project. The planner would then like to transfer an amount $w$ from the early consumer, who has the required endowment at $t = 0$, to the firm. Still it is also optimal for the early consumer to consume $k$ in period $t = 1$, but the early consumer has only $z = e - w < k$ remaining on its own to consume at $t = 1$. Then it is optimal for the planner to commit transferring $k - z$ resources from the late consumer to the early consumer. It is also optimal to use $\hat{x}$ from the late consumer to finance an extension in case the original project is successful.

These allocations are feasible because $e_L > k - z + \hat{x}$, from assumption 1. Note that relaxing this assumption is not critical, and just restricts the first best outcome, intro-
ducing a trade-off between reducing investment (allocating less than \( w \) to the project or less than \( \hat{w} \) to the extension) or distorting consumption (making early consumers to consume less than \( k \) at \( t = 1 \)).

The next question is how to split the surplus. We choose to assign the surplus from these efficient transfers to firms. This assumption just allows for a clear welfare comparison across scenarios with and without intermediaries, but it is irrelevant for the results. As we discuss later, banks create value regardless of who keeps the surplus. Under this first best allocation, then, the ex-ante expected utilities of the agents are \( U_{FB}^B = 0 \), \( U_{FB}^E = e + \alpha k \), \( U_{FB}^L = e_L \) and \( U_{FB}^F = \lambda x - w + \lambda(\hat{x} - \hat{w}) \).

The gains from trading are clear in this comparison. First, the project gets funded, which generates an expected gain \( \lambda x - w \). Second, the extension of the project gets funded only if the original project is good, in which case the extension generates a positive net gain \( (\hat{x} - \hat{w}) \). Once the project is financed, there are gains that arise from late consumers transferring resources to early consumers to cover with certainty their liquidity needs \( k \) of consumption at \( t = 1 \).

In summary, it is optimal the project gets financed at \( t = 0 \), that the extension gets financed only when the original project is succesful at \( t = 1 \), and that there is trade between the early and the late consumer for \( k - z \) at \( t = 1 \). As we will show, if the information about the results of the original project leaks out, it may hinder the trade between early and late consumers. Reducing in expectation the amount that can be traded between early and late consumers is the negative externality that, otherwise beneficial, information about the project introduces. This leakage happens in capital markets, but not with “secret keeping” intermediaries.

### 2.3 Capital Markets

We now show the inability of capital markets to implement efficient allocations.

At \( t = 0 \) the firm finances the project by issuing a security to the early consumer in exchange for \( w \). Define \( s(0) \) the contingent claim on the project at \( t = 2 \) if the project fails and \( s(x) \) the contingent claim on the project at \( t = 2 \) if the project succeed. Assuming the firm faces limited liability, \( s(0) = 0 \).

At \( t = 1 \) two transactions may occur. First, the firm may seek financing for an extension of the project if the original project is good by issuing a new security, which we
denote as $s(\tilde{x})$, which can be bought by the late consumer. We assume that finance is specific, i.e. the security issued is backed by the specific project. This assumption simplifies the analysis but it is not crucial. Second, since the early consumer prefers to consume $k$ at $t = 1$, but only have $z \equiv e - w < k$ available, he sells part of his security to the late consumer. Figure 1 shows the sequence of events in the case of a capital market.

![Figure 1: Timing Model with Capital Markets](image)

Since information is hard, the firm cannot lie about the project’s results. In capital markets, all agents observe whether a firm is raising funds for an extension or not, so all of them observe whether the original project was successful or not. This leakage of information from the financing of the extension to the information about the original project’s expected payoffs has an impact (an externality) on trade between the two consumers. The next Proposition shows that capital markets do not internalize this negative effect of information about projects on trade, hence not implementing the first best allocation.

**Proposition 1** *Capital markets do not implement the first best allocation.*

**Proof** We start the analysis backwards. If the project fails, the firm does not look to finance an extension, revealing that the original project was a failure. If the project succeeds, the firm seeks to finance an extension by issuing a security that pays $s(\tilde{x}) = \hat{w}$ in $t = 2$. This is because we assume the firm has hard information about the project’s results, and also the bargaining power such that it keeps the surplus $(\tilde{x} - \hat{w})$ of the extension.
The previous stage is critical to define the optimal choices of the late consumer. If the late consumer learns the project is bad (because the firm never shows up asking for a loan to finance the extension), then it is better off just consuming (or storing to consume later) his endowment \( e_L \).

If the late consumer learns the project succeeds, then it chooses to finance the extension and to buy a fraction \( \theta \) of the claims for the original project from the early consumer, at a price \( s(x) \). Since the early consumer only needs to sell up to \( k - z \) to consume in period \( t = 1 \), the budget constraint for the late consumer in case the original project is successful is

\[
\hat{w} + \theta s(x) \leq e_L
\]

This implies that

\[
\theta s(x) = \min \{ k - z, e_L - \hat{w} \} = k - z
\]

from assumption 1. This implies late consumers have enough funds to cover the investment needs of firms and also the remaining liquidity needs of early consumers.

Now we can study the choices of the early consumer. If the early consumer does not finance the original project, he stores his endowment and obtains a certain utility \( U_{E|\text{Store}} = e + \alpha k \). In contrast, if the early consumer decides to finance the project, then he faces a lottery because the project is risky. Then the expected utility for the early consumer to finance the project is

\[
U_{E|\text{Finance}} = (1 + \alpha)z + \lambda[(1 + \alpha)\theta s(x) + (1 - \theta)s(x)]
\]

Replacing with equation (1) and assuming the firm has the bargaining power, the early consumer should be indifferent between financing the project or storing the endowment (this is \( U_{E|\text{Finance}} = U_{E|\text{Store}} \)), which implies

\[
(1 + \alpha)z + \lambda s(x) + \lambda \alpha(k - z) = e + \alpha k
\]

and then, the price \( s(x) \) of the security that makes early consumers indifferent between financing the project or not (considering also the restriction of limited liability such that \( s(x) \leq x \)) is

\[
s(x) = \min \left\{ \frac{w}{\lambda} + \frac{\alpha(1 - \lambda)}{\lambda}(k - z), x \right\}
\]

(2)
The first component of the first argument corresponds to the certainty equivalent cost of the loan. The second component corresponds to the compensation to the early consumer for taking the risk of not consuming \( k \) (but only \( k - z \)) in period \( t = 1 \), loosing the additional utility \( \alpha \) with probability \( 1 - \lambda \), when the project fails. The minimum just captures limited liability since the claim cannot payout more than the underlying payoff of the project in case of success, \( x \).

Naturally, when \( s(x) = x \), and limited commitment binds, then \( U_{E|Finance} < U_{E|Store} \) and the project (and then the extension) would not be financed. In this case, early consumers would rather store the endowment since the expected surplus from the project is not enough to compensate for the risk from financing the project. In this case the project is not financed at all, inducing an autarky allocation.

By construction (bargaining power to the firm) the expected utility of the two consumers and the bank do not change with respect to the first best (or autarky). However the expected utility for the firm is

\[
U_{CM}^F = \lambda x - \lambda s(x) + \lambda (\bar{x} - \bar{w}) < U_{FB}^F = \lambda x - w + \lambda (\bar{x} - \bar{w})
\]

since, as clear from equation (2), \( \lambda s(x) > w \). In the extreme, when \( s(x) = x \) and there is no financing of the project, \( U_{CM}^F = 0 \).

The costs of capital markets vis a vis the first best outcome is the reduction in firm’s consumption to compensate early consumers for facing the possibility of not covering their liquidity needs. Specifically, the gap between the welfare of first best and capital markets is

\[
U_{FB}^F - U_{CM}^F = \lambda s(x) - w = \min \{ \alpha (1 - \lambda) (k - z), U_{FB}^F \}
\]

Q.E.D.

Intuitively, the securities of the early consumer are subject to information revelation about the project’s result, facing the risk of a bad news such that they cannot sell those securities, and then not having enough resources to face their liquidity needs. The next Figure illustrates the source of risk aversion given by the limited liquidity needs of the early consumer.

Since early consumers’ liquidity needs effectively make them risk averse, the firm has to compensate that risk by promising in expectation more than the loan size,
$w$, inducing the same ex-ante utility when early consumers choose to store his endowment. The implication is that liquidity needs induce an inefficient transfer of resources. Even though it is feasible for the late consumer to cover the liquidity needs of the early consumer, the late consumer is not willing to do that in case of learning the project is bad. Hence the firm needs to compensate the early consumer to take the risk by financing the project.

![Figure 2: Costs of Capital Markets](image)

In essence, capital markets reveal too much information, reducing the expected utility of early consumers since their money cannot buy as much when the bad state is revealed. On the one hand, information about the project is valuable because in its absence some good extensions of the project would not be financed given their negative ex-ante net present value. However such information generates an externality by revealing bad news about the original project, hence inefficiently reducing trade at $t = 1$ between early and late consumers. For compensating the early consumer of for the risk of not covering his liquidity needs, the firm has to sell a larger share of total cash flow. In summary, when firms raise funds in capital markets there is inefficient risk-bearing in the economy – those with liquidity needs are the ones who face the risk, rather than those without those needs.
2.4 Financial Intermediation

The previous analysis shows that capital markets may not implement the efficient investment if the early consumer cares about liquidity, and, even if there is efficient investment, there is inefficient risk bearing in the economy. Now we show that intermediation dominates capital markets in providing financing and can potentially implement first best.

Since intermediaries create value by providing liquidity and reallocating risk, they can offer a rate for loans to firms such that they prefer to finance through intermediaries. However, there are limits to these results since some projects cannot be exploited by intermediaries to provide liquidity, given they introduce incentives for information acquisition by lenders even though banks try to hide such information. In this section we assume consumers cannot privately acquire information about the quality of the project, so there are no limits to the possibilities of financial intermediaries to improve welfare. In the next Section we relax this restriction.

An essential assumption is that bankers do not want or cannot use information about the quality of the project in their own interest. In such an equilibrium, information would be revealed and the whole purpose of banks would be eliminated. How bankers can avoid the temptation to announce when the projects is successful, hence promising less for deposits?

There are different ways to think about the implementation of these intermediaries. One is to think of banks (our dummy agents, without endowment or productive activities so far) setting a technology that is complex, bureaucratic and opaque to delay or avoid easy and timely information communication about the quality of the project in period $t = 1$. As opposed to markets, which operate openly and allow for fast information transmission through observable prices, banks do not post prices but have to show hard evidence to convince projects are good. The opaque banking technology can be introduced to delay a credible flow of information about such hard evidence.

The second interpretation is that a firm can instead hire the dummy (banks) and commit to pay bankers a fixed wage in period $t = 2$ for running a banking institution. If this contract is credible and cannot be modified in period $t = 1$, bankers who have information about the quality of the project will not have incentives to communicate such information to consumers since there are nothing for them to gain in that situation. This contracting environment then can allow information about the projects
to be used to decide financing but not to spread out to impede trade between consumers. Effectively these fixed contracts work as commitment devices for firms not to spread information by going to capital markets.

Regardless of this discussion, in this section we simply assume that a banking technology, fixed contracts or other commitment devices do exist. Figure 3 shows the sequence of events, which we now describe. The game now has four active agents. At \( t = 0 \) the early consumer deposits \( e \) in the bank, which then lends \( w \) to the firm to invest in the original project. The firm issues a contingent security that pays \( s(0) \) in case of failure and \( s(x) \) in case of success at \( t = 2 \). At the time the bank receives the deposit from the early consumer, it promises to pay \( r^E_1 = k \) at \( t = 1 \) and a contingent claim that pays \( r^E_2(b) \) at \( t = 2 \) if the project fails and \( r^E_2(g) \) if the project succeed. This state is common information to everybody at \( t = 2 \).

**Figure 3: Timing Model with Financial Intermediaries**

<table>
<thead>
<tr>
<th>Date ( t = 0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The early consumer deposits ( e ) with the bank. The bank promises an unconditional payment ( r^E_1 ) at ( t = 1 ) and a conditional payment ( r^E_2(g) ) if the project succeeds and ( r^E_2(b) ) if the project fails at ( t = 2 ).</td>
</tr>
<tr>
<td>The bank lends ( w ) to the firm with a loan contract, where the firm pays ( s(0) ) if the project fails and ( s(x) ) if it succeeds.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date ( t = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The firm learns whether the project will pay ( x ) (success) or ( 0 ) (failure) in ( t = 2 ).</td>
</tr>
<tr>
<td>If the project succeeds the firm finances an extension of cost ( \hat{w} ) by issuing a new security, ( s(x) ). The bank maintains this information in secret.</td>
</tr>
<tr>
<td>The late consumer deposits ( e_L ) and the bank promises a conditional payment ( r^E_2(g) ) if the project succeeds and ( r^E_2(b) ) if the project fails at ( t = 2 ).</td>
</tr>
<tr>
<td>The early consumer withdraws ( r^E ) and consumes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date ( t = 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project payoffs realized and loans are repaid.</td>
</tr>
</tbody>
</table>

At \( t = 1 \), the late consumer deposits \( e_L \) in the bank, which issues a security that promises to pay \( r^L_2(b) \) if the state is bad (the original project ends up failing and the bank is liquidated) and \( r^L_2(g) \) if the state is good (both the original project and its extension are successful). Meanwhile, the early consumer withdraws \( k \) from the bank. If the bank determines that the firm has a good project, then it lends \( \hat{w} \) to the firm for the extension of the project which issues a security that pays \( s(x) \). If the bank
determines that the firm has a bad project, then the loan to the firm for an extension is not made and the additional $\tilde{w}$ is stored until $t = 2$.

Note that the early consumer does not need to trade directly with the late consumer, but just withdraws $k$ from the bank. Alternatively, and equivalently, the early consumer could trade with the late consumer directly by writing a check or using a bank note issued by the bank. The key is that none of the consumers observe whether the bank has given the loan to the firm to finance the extension of the project or not. The intermediary, by hiding such information, allows for efficient trade between consumers at $t = 1$ and then cover early consumers’ liquidity needs.

Financial intermediaries achieve a first best allocation by channeling funds to firms efficiently and permitting trade across consumers, exploiting information to make efficient loans, and hiding that same information to allow for efficient trade. The next proposition summarizes this result.

**Proposition 2** Financial intermediaries implement the first best allocation.

**Proof** We work backwards. If the project succeeds the bank gives a loan $\tilde{w}$ to the firm, which issues a security that pays $s(\tilde{x}) = \tilde{w}$ in $t = 2$. If the project fails, the best alternative option for the bank is not to finance the extension and store the additional endowment $\tilde{w}$.

Since consumers are risk neutral, the bank promises to consumers are not determined, and there are many alternatives that make the consumers indifferent. Here we assume $r^E_2(b) = 0$ and in the next Section we justify this choice by showing it is the one that minimizes the incentives for late consumers to acquire information, making promises more credible.

In the proposed first best contract, in which the bank promises $r^E_1 = k$, the assets of the bank at $t = 2$ depend on whether the project fails or succeed. When the project fails assets are,

$$A_b = e_L + e - w - k.$$

When the project succeeds, considering that $s(\tilde{x}) = \tilde{w}$, assets are

$$A_b + s(\tilde{x}).$$
Since \( r_1^E = k \) and \( r_2^E(b) = 0 \), we can compute \( r_2^E(g) \) from the indifference condition of the early consumer. This is,

\[
(1 + \alpha)k + \lambda r_2^E(g) = e + \alpha k.
\]

Then

\[
r_2^E(g) = \frac{e - k}{\lambda}. \tag{3}
\]

Since \( r_2^E(b) = 0 \), from the resource constraint of banks when the project fails,

\[
r_2^L(b) = A_b < e_L, \tag{4}
\]

and, from the indifference condition of the late consumer

\[
\lambda r_2^L(g) + (1 - \lambda)r_2^L(b) = e_L
\]

we can obtain the last promise that remains to determine

\[
r_2^L(g) = e_L + \frac{(1 - \lambda)}{\lambda} [w + k - e] > e_L. \tag{5}
\]

Finally, we have to check that these payments are feasible when the project succeed, or which is the same

\[
r_2^E(g) + r_2^L(g) \leq A_b + s(x).
\]

Then, the restriction on the claim for a successful projects has to be

\[
s(x) \geq \frac{w}{\lambda}.
\]

Since the firm has all the bargaining power, \( s(x) = \frac{w}{\lambda} \), which is always feasible given our assumption that \( \lambda x > w \). This implies that the surplus for the firm is \( U_{FI}^F = \lambda(x - s(x)) + \lambda(\bar{x} - s(\bar{x})) \), and then

\[
U_{FI}^F = \lambda x - w + \lambda(\bar{x} - \bar{w}) = U_{FB}^F.
\]

Since by construction we guarantee \( U_{FB}^F = 0 \), \( U_{E}^FI = e + \alpha k \) and \( U_{L}^FI = e_L \), then financial intermediation implements the first best allocation.

Q.E.D.
Intuitively, a bank that credibly commits to hide information about the quality of the project can implement the first best because it allows information to be used at $t = 1$ for investment purposes, but delays its revelation until $t = 2$ to prevent such information to deter the efficient trade across consumers at $t = 1$. In this way banks transfer the risk-bearing from the early consumers who want to consume in $t = 1$ to the late consumers who do not have any preference about when to consume. In essence banks eliminate the negative externality that information has on liquidity.

This is a very stark result because so far we have assumed that bankers can keep secrets at no cost. Furthermore it is impossible for late consumers to learn about those secrets. We relax the first assumption next and the second assumption in next two Sections.

**Costly Bank Technology:** What happens if bankers cannot keep secrets at no cost? To consider this possibility, we define consumption net of efforts as

$$\tilde{C}_{ht} = C_{ht} - e_{ht},$$

where $h \in \{F, E, L, B\}$ and $t \in \{0, 1, 2\}$, and redefine utilities as before in terms of $\tilde{C}_{ht}$. Assume that hiding information or setting a banking structure is costly in terms of efforts to the banker. In such a case, the firm has to compensate bankers for those efforts such that banks break even. Specifically this implies that $s(x) = \frac{w + e_{B1}}{\lambda}$.

Computing the welfare for the firm then delivers,

$$U_{FI}^F = \lambda x - w + \lambda(\tilde{x} - \tilde{w}) - e_{B1} < U_{FB}^F.$$

Banking is feasible as long as $s(x) < x$, or $e_{B1} < \lambda x - w$, which basically implies that the project has a positive net present value after the cost of setting a technology to hide information. Finally, banking is preferred to capital markets as long as $U_{FI}^F \geq U_{CM}^F$ or

$$e_{B1} < \lambda s(x) - w = \min \{\alpha(1 - \lambda)(k - z), U_{FB}^F\}.$$

So far, we have made a critical assumption – banks are very effective in hiding information and late consumers cannot obtain that information, even if they want to. What if late consumers can, privately and costly, produce information on their own about the projects’ results? In the next section we relax this assumption and show this
possibility make some projects unable to sustain liquidity services by banks, leading to the coexistence of banking and capital markets in the economy.

In essence, some projects for which private information acquisition by late consumers can be avoided are useful as inputs for banks to provide liquidity. Since banks can produce value and firms have the bargaining power, banks are willing to charge less for funds to those projects than capital markets. This implies that those projects prefer to raise funds from a bank and not from capital markets. When projects’ information become difficult to hide, then banks cannot charge less for funds and those projects prefer to be financed in capital markets. Hence, we characterize the coexistence of banks and capital markets based on how difficult is for late consumers to produce information privately.

3 Private Information Acquisition

In this section we assume that late consumers can privately learn about the project’s results by exerting efforts \( e_{L1} = \gamma \). First we study the conditions that limit the use of a banking structure to improve welfare, basically because the potential late depositors have incentives to acquire information about the quality of the project on their own. Then, we introduce a continuum of heterogeneous projects to study how financing sort into banking and capital markets. Finally, we show how banks can avoid private information acquisition, not only by choosing the right projects to finance (small, safe and low information costs), but also by financing many, asymmetric and uncorrelated projects.

When the bank makes one loan, producing information about the value of the bank is the same as producing information about the value of the project. While the cost of producing information is \( \gamma \), the benefits are given by the possibility of avoiding depositing in a bank with a failing bank in its assets. Specifically, if late consumers do not acquire private information about the project and deposit in the bank, their expected gains are

\[
\lambda r^g_L(g) + (1 - \lambda) r^b_L(b).
\]

In contrast, if late consumers acquire information at a cost \( \gamma \) and finds out the project is successful (with probability \( \lambda \)) then they prefer to deposit in the bank being certain they will obtain \( r^g_L(g) > e_L \) at \( t = 2 \) (from equation 5). If they find out the project is
a failure (with probability $1 - \lambda$) then they prefer to store their endowment $e_L$ rather than depositing and obtaining $r^L_2(b) < e_L$ at $t = 2$ (from equation 4). This implies the expected gains from acquiring information are

$$\lambda r^L_2(g) + (1 - \lambda)e_L - \gamma.$$ 

Comparing these two expected gains, late consumers prefer to deposit their endowment without acquiring information if

$$(1 - \lambda)[e_L - r^L_2(b)] \leq \gamma. \quad (6)$$ 

At this point it is clear the optimality of our assumption that $r^F_2(b) = 0$. Banks want to maximize the payments to late consumers when the project fails to minimize their incentives to acquire information. This leads to the following proposition.

**Proposition 3** When consumers are able to learn privately about the quality of projects at a cost $\gamma$, banks can implement the first best outcome only if

$$k - z \leq \frac{\gamma}{1 - \lambda}.$$ 

The proof just requires to replace $r^F_2(b) = A_b = e_L + z - k$ from equation (4) into condition (3). Naturally, if this condition is not fulfilled, banks cannot credibly promise to pay $k$ to the early consumer. The late consumer would have incentives to learn about the quality of projects, not depositing in the bank if the project fails. In this case the bank would not obtain always the deposits at $t = 1$ to pay $k$ to early consumers. In other words, if the condition above is not fulfilled, the use of banks to achieve the first best is unsustainable.

In essence, banks are more likely to sustain a contract proposed in the previous section when projects have a low probability of default (high $\lambda$), they are difficult to monitor (high $\gamma$), they are relatively small (low $w$), the liquidity needs are relatively small (low $k$) or the early consumer is relatively rich (high $e$). This is relatively safe, small and complex projects are more likely to be observed in the portfolio of banks.

The natural question is, can still the bank improve welfare if this condition is not fulfilled? We show the bank can improve welfare but not achieve the first best allocation. When condition (3) binds, banks need to either distort risk-bearing or distort
the investment to avoid information production by late consumers. We next show the conditions under which banks still dominate capital markets if they distort the risk-bearing in the economy and if they distort investment. Then, we discuss the condition under which banks prefer to distort risk-bearing rather than investment.

3.1 Distorting Risk-Bearing

If late consumers have incentives to acquire information about the banks’ assets when the bank offer the contract that implements the first best, banks can distort risk-bearing in a way that they still dominate capital markets.

**Proposition 4** If \( k - z > \frac{\gamma}{1 - \lambda} \) banks still improve welfare relative to capital markets if

\[
\lambda(k - z) \leq \frac{\gamma}{1 - \lambda},
\]

which is implemented by distorting risk-bearing in the economy, promising early consumers a certain return \( r^E_1 < k \) in \( t = 1 \).

**Proof** How can banks distort risk-bearing to avoid information acquisition? Since expected benefits for late consumers to acquire information are given by \((1 - \lambda)[e^L - r^L_2(b)]\), and their costs are \( \gamma \), a way for banks to discourage information acquisition is to promise late consumers no less than

\[
r^L_2(b) = e^L - \frac{\gamma}{1 - \lambda} \tag{7}
\]

in case the project is a failure.

However, under our assumption \( w - z > \frac{\gamma}{1 - \lambda} \), total assets when the project fails are not enough to promise both \( k \) to early consumers and \( e^L - \frac{\gamma}{1 - \lambda} \) to late consumers because

\[
A_b \equiv e^L + z - k < e^L - \frac{\gamma}{1 - \lambda}.
\]

The only possibility to guarantee the resource constraint and avoid information acquisition is to promise early consumers \( r^E_1 < k \). From the inequality above,

\[
r^E_1 = z + \frac{\gamma}{1 - \lambda} < k \tag{8}
\]
The bank has to distort risk-bearing because it has to offer a contract that makes a non-contingent payment at \( t = 1 \), otherwise information would be revealed. Since the bank promises a lower payment at \( t = 1 \), it has to offer a larger payment at \( t = 2 \) in case the project succeed, which compensates for not covering completely the liquidity needs of the early consumers, making them still indifferent between storing or depositing, this is

\[
(1 + \alpha)r_1^E + \lambda r_2^E(g) = e + \alpha k.
\]

Replacing \( r_1^E \) (from equation 8) above

\[
r_2^E(g) = \frac{e - k}{\lambda} + \frac{(1 + \alpha)}{\lambda} \left[ k - z - \frac{\gamma}{1 - \lambda} \right]. \tag{9}
\]

From the indifference condition of the late consumer,

\[
\lambda r_2^L(g) + (1 - \lambda) r_2^L(b) = e_L,
\]

and using equation (7)

\[
r_2^L(g) = e_L + \frac{\gamma}{\lambda}. \tag{10}
\]

Now, we have to check these payments are feasible when the project succeed, or

\[
r_2^E(g) + r_2^L(g) \leq e_L + z - r_1^E + s(x).
\]

Then, the restriction on the claim for a successful projects, together with the firm having the full bargaining power implies

\[
s(x) = \frac{w}{\lambda} + \frac{\alpha}{\lambda} \left[ k - z - \frac{\gamma}{1 - \lambda} \right]. \tag{11}
\]

Note that in the first best \( s(x) = \frac{w}{\lambda} \). When risk-bearing is distorted, banks have to charge the firm the gap \( k - z - \frac{\gamma}{1 - \lambda} \) adjusted by making the early consumer to consume in period \( t = 2 \) rather than in \( t = 1 \) (adjusted by \( \frac{\alpha}{\lambda} \)). This is unfeasible if \( s(x) > x \).

Again, by construction, the utilities of the bank and the two consumers are the same as in all previous cases. However, the firm’s utility when risk-bearing is distorted is

\[
U_{FB}^{Dist} = \lambda(x - s(x)) + \lambda(\bar{x} - \bar{w}) = U_{FB}^{FB} - \alpha \left[ k - z - \frac{\gamma}{1 - \lambda} \right].
\]
Assuming it is feasible for firms to raise funds in capital markets, comparing the firm’s utility when risk-bearing is distorted with the firm’s utility when raising funds in capital markets, banks can still implement a larger welfare if

\[ \alpha \left[ k - z - \frac{\gamma}{1 - \lambda} \right] < \alpha(1 - \lambda)(k - z), \]

or

\[ \lambda(k - z) < \frac{\gamma}{1 - \lambda}. \]

Q.E.D.

Here we show intuitively why, in case the condition in proposition 4 is not fulfilled, it is preferable to finance the project through capital markets rather than distortionary intermediaries. In Figure 4 we depict a case in which capital markets dominate distorting financial intermediaries. When intermediaries distort risk-bearing in the economy effectively the utility function changes. The reason is the bank pays \( r_E^1 = z + \frac{\gamma}{1 - \lambda} < k \) with certainty in the first period (delivering utility \( 1 + \alpha \)) and then provides a lottery that pays in the second period (delivering a utility of just 1). The utility function then becomes as depicted in red, with a kink located in \( r_E^1 \).

In both cases the welfare loss is given by \( \lambda s(x) - w \). In capital markets, \( s(x) = \frac{w}{\lambda} + \frac{\alpha(1 - \lambda)}{\lambda}(k - z) \) and the loss is given by \( \alpha(1 - \lambda)(k - z) \). With distorting financial intermediaries \( s(x) = \frac{w}{\lambda} + \frac{\alpha}{\lambda} \left[ k - z - \frac{\gamma}{1 - \lambda} \right] \) and the loss is given by \( \alpha(k - r_E^1) \). When the condition in proposition 4 is not fulfilled, the loss from capital markets is smaller than the loss from distortionary intermediaries, and then firms can raise funds a a lower rate in capital markets.

### 3.2 Distorting Investment

Assume now the project is divisible and it is possible for bank to invest in just a fraction \( \eta \) of the original project and to store the rest of the deposits (for example in treasury bonds or other safe assets)\(^1\). In this case banks can distort investment in order to discourage information acquisition.

\(^1\)This analysis is isomorphic to imposing capital requirements under which banks are regulatory mandated to invest a fraction of deposits on safe assets.
Figure 4: Case in which Capital Markets Dominate Banks

**Proposition 5** If $k - z > \frac{\gamma}{1 - \lambda}$ banks still improve welfare relative to capital markets if

$$
\psi(k - z) \leq \frac{\gamma}{1 - \lambda},
$$

where $\psi \equiv \left(1 - \frac{\omega(1 - \lambda)}{U_F^P}\right)$, which is implemented by distorting investing in the economy, providing funds only for a fraction $\eta$ of the original project.

**Proof** How can the bank distort investment in the project to avoid information acquisition? Since expected benefits for late consumers to acquire information are given by $(1 - \lambda)[e_L - r_L^b(b)]$, and their costs are $\gamma$, a way for banks to discourage information acquisition is to promise late consumers no less than equation (7).

A way for banks to discourage information acquisition is to publicly store a fraction $(1 - \eta)$ of the endowment $e$ of the early consumer, and promising to repay them deposits $k$. Another interpretation is that the bank invests in the project with probability $\eta$, even when it is ex-ante efficient to always invest in the project.
This implies that in expectation, if the bank promises to pay $k$ to the early consumer, what remains to the late consumer in case of a bad shock is $r^L(b) = \eta(e_L + z - k) + (1 - \eta)(e_L + z - k + w) = e_L + z - k + (1 - \eta)w$ (with probability $\eta$ we have the same situation as above, and with probability $(1 - \eta)$ the bank stores the endowment of early consumers without spending $w$ in the project and then it does not need as much money from late consumers to compensate early consumers).

In this case, the condition for late consumers not acquiring information is

$$(1 - \lambda)[e_L - e_L - z + k - (1 - \eta)w] < \gamma,$$

and then, the investment distortion that allows for optimal risk-bearing (paying $r^E_1 = k$ always to early consumers), assuming $k - z > \frac{\gamma}{1 - \lambda}$ is given by

$$\eta = 1 - \frac{k - z}{w} + \frac{\gamma}{w(1 - \lambda)} < 1.$$

Since the rest of the original first best contract remains unchanged by construction, the utilities of the bank and the two consumers are the same as in the previous cases, while for the firm

$$U^{Dist}_F = \eta U^{FB}_F.$$

This implies that the loss from distorting investment is

$$(1 - \eta)U^{FB}_F = \left(\frac{k - z}{w} - \frac{\gamma}{w(1 - \lambda)}\right)[\lambda x - w + \lambda(\hat{x} - \hat{w})].$$

Banks that distort investment dominate capital markets if

$$\left(k - z - \frac{\gamma}{1 - \lambda}\right)\frac{U^{FB}_F}{w} < \alpha(1 - \lambda)(k - z).$$

Then

$$\left(1 - \alpha w(1 - \lambda)\right)\frac{U^{FB}_F}{w} < \frac{\gamma}{1 - \lambda},$$

Q.E.D.

Finally, we obtain the conditions under which it is better to distort risk-bearing than to distort investment, just from comparing $\lambda$ and $\psi$ from Propositions 4 and 5.
Proposition 6  Banks prefer to distort risk-bearing rather than investment if

\[ \mu \equiv \frac{w}{x + \hat{x} - \hat{w}} < \frac{\lambda}{1 + \alpha} \]

Proof  The costs of distorting risk-bearing are smaller than the costs of distorting investments if

\[ \alpha \left[ k - z - \frac{\gamma}{1 - \lambda} \right] < \frac{U^F_B}{w} \left[ k - z - \frac{\gamma}{1 - \lambda} \right] \]

Since \( U^F_B = \lambda(x + \hat{x} - \hat{w}) - w \),

\[ (1 + \alpha) < \frac{\lambda x + \hat{x} - \hat{w}}{w} \]

Q.E.D.

Intuitively, banks would distort risk-bearing rather than investment when the welfare costs of risk-bearing (captured by \( 1 + \alpha \)) is lower than the welfare costs of not financing the projects (captured by the net gains per unit of investment \( 1/\mu \) times the probability of success \( \lambda \)). Then, it is clear that banks distort risk-bearing more likely when liquidity needs are small (low \( \alpha \)), when relative costs of the projects are small (low \( w \) and \( \hat{x} \)), or when projects are very likely to succeed and pay a lot on case of success (high \( \lambda \), \( x \) and \( \hat{x} \)).

4 Optimal Portfolio

In this section we assume there are many, potentially heterogenous, projects that need financing in the economy. First, we study the case in which each project seeks financing from a single bank. In essence there are many matches of one firm and one bank, which replicates the previous analysis for a continuum of heterogenous projects. We characterize which projects are financed by banks that replicate first best, which ones are financed by banks that have to endeavor on a distortion of risk-bearing or investment (not implementing the first best because they need to avoid information acquisition) and which ones are financed by capital markets.

After this discussion about the coexistence of banks and capital markets we study the problem of a single bank that have to choose two projects to finance and discuss
which is the optimal portfolio that minimizes the probability of information acquisition and preserves secrets. In particular we show banks prefer to finance two projects that are not very correlated with each other and that banks can cross subsidize across different projects to avoid information acquisition and distortions.

4.1 Continuum of Heterogenous Projects

Assume we replicate the previous analysis for a single early and late consumers, a single bank and a single projects in an economy with a continuum of early and late consumers, a continuum of banks and a continuum of projects \( i \) characterized by pairs \((\lambda_i, \gamma_i)\), this is their probability of success and the cost of monitoring their results. There is a mass 1 of each agent and each bank forms a match with a angle early and late consumers and finances a single project. The cost of financing all projects is \( w \), each early consumer has endowment \( e \) at \( t = 0 \) and each late consumer has endowment \( e_L \) at \( t = 1 \). Preferences, technologies and the problem for each single individual are exactly the same as specified in the case for a single project.

If the projects are i.i.d., then effectively financing each project has exactly the same characterization as the previous analysis. Hence, we divide projects in their two dimensional characterization among those that are financed by banks implementing first best allocations, those that are financed by banks that distort risk-bearing or investment and those that are financed by capital markets.

Proposition 7 Coexistence of Banks and Capital Markets

Projects are not financed if \( \lambda_i < \mu \) (which implies \( U_{FB}^F < 0 \)).

Projects are financed by banks without distortions if

\[
\frac{\gamma_i}{(1 - \lambda_i)(k - z)} > 1,
\]

they are financed by banks that distort risk-bearing if

\[
\lambda_i \leq \frac{\gamma_i}{(1 - \lambda_i)(k - z)} < 1 \quad \text{and} \quad \lambda_i \geq (1 + \alpha)\mu
\]
and they are financed by banks that distort investment if

\[ \psi_i \leq \frac{\gamma_i}{(1 - \lambda_i)(k - z)} < 1 \quad \text{and} \quad \mu \leq \lambda_i < (1 + \alpha)\mu. \]

Finally, projects are financed in capital markets if

\[ \frac{\gamma_i}{(1 - \lambda_i)(k - z)} < \lambda_i \quad \text{and} \quad \lambda_i \geq (1 + \alpha)\mu \]

or

\[ \frac{\gamma_i}{(1 - \lambda_i)(k - z)} < \psi_i \quad \text{and} \quad \mu \leq \lambda_i < (1 + \alpha)\mu \]

These regions arises trivially from combining propositions 4-6 for a single project. Graphically

It is important to highlight at this point that the assumption of i.i.d., projects is critical to sort projects as described. As an illustration, take the extreme opposite case of perfect correlation across projects (if one succeed, all succeed). In this case it is easy
to see that if a late consumer observes that a firm financing the original project in capital markets did not try to finance an extension also in capital markets, then no late consumer would be willing to deposit in the bank because they can infer all other projects in the economy failed. In this extreme case, then, correlation kills completely the possibility of using banks and improving welfare, being all projects financed in capital markets.

4.2 A Single Bank Finances Two Projects

In this section we assume a single project finances two identical projects using the funds from two identical early consumers and two identical late consumers. This is enough to capture how the bank can exploit many projects to avoid information acquisition. We assume each late consumer can choose to privately learn about the quality of one, and only one, project at a cost $\gamma$. As will become clear later, introducing more projects just complicates the analysis without adding any new insight to the main conclusions derived with just two projects.

4.2.1 Two Identical Projects

Here we show it is easier for a bank to finance two projects and avoid information acquisition than financing a single project and avoid information acquisition. First we assume the results of the two projects are independent from each other.

**Proposition 8** It is easier for banks to avoid information acquisition if financing two identical projects rather than a single one. Banks can implement the first best outcome if

$$k - z \leq \frac{\gamma}{1 - \lambda} + \frac{w}{2}$$

Banks can implement first best outcomes even if $\gamma = 0$ when $e > k + \frac{w}{2}$.

**Proof** If the bank finances two projects, there are three possible states:

- With probability $\lambda^2$ both projects are successful ($gg$), and the bank’s assets at period $t = 2$ are $2[A_b + s(x)]$. 

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With probability \(2\lambda(1 - \lambda)\) only one project is successful (\(gb\) or \(bg\)), and the bank’s assets at period \(t = 2\) are \(2A_b + s(x)\).

With probability \((1 - \lambda)^2\) no project is successful (\(bb\)), and the bank’s assets at period \(t = 2\) are \(2A_b\).

In this proof we study the conditions for the bank to implement the first best, hence we impose banks to pay each early consumer \(r_1^E = k\) at \(t = 1\) and charge to firms \(s(x) = \frac{w}{2}\), which we know maximize the utility of firms and both consumers. The question is then, what is the condition for this contract to be feasible and implementable (no incentives for information acquisition).

Since late consumers can only produce information about one project (the condition for information acquisition if the late consumer can produce information about both projects is the same as in the previous analysis of financing a single project), the condition for no information acquisition becomes

\[
\lambda \left( \max\{E(r^L|g), e_L\} - E(r^L|g) \right) + (1 - \lambda) \left( \max\{E(r^L|b), e_L\} - E(r^L|b) \right) \leq \gamma,
\]

where

\[
E(r^L|g) = \lambda r_2^L(gg) + (1 - \lambda) r_2^L(gb)
\]

are the expected payoffs of a late consumer when finding out the project for which information has been acquired is successful, and

\[
E(r^L|b) = \lambda r_2^L(bg) + (1 - \lambda) r_2^L(bb)
\]

are the expected payoffs of a late consumer when finding out the project for which information has been acquired is a failure.

As before, banks want to compensate late consumers as much as possible when all projects fail. Then \(r_2^E(bb) = 0\) and \(r_2^E(bb) = A_b\). Assume this is also the case when also one project fails, this is \(r_2^E(gb) = r_2^E(bg) = 0\). Then, from the resource constraint when one project fails, \(r_2^E(gb) = r_2^E(bg) = A_b + s(x)/2\), since the two late consumers are identical and the proceeding of the single successful project are split in two.

From the break even condition of the early consumer

\[(1 + \alpha)k + \lambda^2 r_2^E(gg) = e + \alpha k.\]
Then
\[ r^E_2(gg) = \frac{e - k}{\lambda^2}. \]  
(12)

Using this result in the resource constraint when both project succeed,
\[ r^L_2(gg) = A_b + s(x) - \frac{e - k}{\lambda^2}. \]  
(13)

Replacing these results in the break even condition for the late consumer it is clear that the expected gains from depositing in the banks are exactly \( e_L \).
\[ \lambda^2 r^L_2(gg) + 2\lambda(1 - \lambda)r^L_2(gb) + (1 - \lambda)^2 r^L_2(bb) = e_L. \]

Given the promises that implement first best are feasible, we need to check the incentives for late consumers to acquire information based on those promises. Expected gains for late consumers from depositing when observing a project failing are
\[ E(r^L|b) = e_L + e - k - \frac{w}{2}, \]
while the expected gains for late consumers from depositing when observing a project succeeding are
\[ E(r^L|g) = e_L - \frac{(1 - \lambda)}{\lambda} \left[ e - k - \frac{w}{2} \right]. \]

If \( e < k + \frac{w}{2} \), then \( E(r^L|b) < e_L \) and \( E(r^L|g) > e_L \). This implies late consumers would deposit in banks when privately observing a project failing and store the money if privately observing a project succeeding. The condition for late consumers not acquiring information is,
\[ (1 - \lambda)[e_L - E(r^L|b)] \leq \gamma \]
or
\[ k - z \leq \frac{\gamma}{1 - \lambda} + \frac{w}{2}. \]

If this condition is satisfied, then first best allocations are implementable.

In contrast, if \( e > k + \frac{w}{2} \), \( E(r^L|b) > e_L \) and \( E(r^L|g) < e_L \). This implies late consumers would deposit in banks when privately observing a project failing and store the money if privately observing a project succeeding. However there are enough resources for banks to offer a contract to late consumers such that \( E(r^L|g) = E(r^L|b) = \)
$e_L$, eliminating the incentives to acquire information regardless of information costs. The intuitive way for banks to achieve this result is to still pay $r^E_L(bb) = 0$ but $r^E_L(bg) = r^E_L(gb) > 0$, which reduces expected payoffs to late consumers when a project fails and increases their expected payoffs when a project succeeds.

Following this reasoning, we derive the promises that eliminate the incentives for information acquisition when $e < k + \frac{w}{2}$. Since $r^E_L(bb) = A_b$ and we want to achieve $E(r^E_L|b) = e_L$, then

$$r^L_L(bg) = r^L_L(gb) = \frac{e_L - (1 - \lambda) A_b}{\lambda}.$$  \hspace{1cm} (14)

From the resource constraint in the case only one project succeeds

$$r^E_L(bg) = r^E_L(gb) = \frac{e - k}{\lambda} - \frac{w}{2\lambda} > 0.$$ \hspace{1cm} (15)

From early consumers breaking even

$$(1 + \alpha)k + 2\lambda(1 - \lambda)r^E_L(bg) + \lambda^2 r^E_L(gg) = e + \alpha k,$$

we obtain

$$r^E_L(gg) = \frac{e - k}{\lambda^2} - \frac{2(1 - \lambda)}{\lambda^2} \left( e - k - \frac{w}{2} \right).$$ \hspace{1cm} (16)

Finally, from the resource constraint when both projects succeed

$$r^L_L(gg) = A_b + \frac{w}{\lambda} - \frac{e - k}{\lambda^2} + \frac{2(1 - \lambda)}{\lambda^2} \left( e - k - \frac{w}{2} \right).$$ \hspace{1cm} (17)

Finally, replacing these results in the break even condition for each late consumer, the expected gains from depositing in the banks are exactly $e_L$.

These are the feasible payoffs that implement first best without introducing incentives to acquire information when $e > k + \frac{w}{2}$, for any $\gamma \geq 0$. Q.E.D.

The next Proposition shows that, if there is correlation across these two identical projects, it is more difficult for banks to use diversification as a way to discourage information acquisition. We assume that, with a probability $\rho$ there is a good aggregate shock where both projects always succeed and with a probability $1 - \rho$ the results of the projects are independent of each other, with a probability of success $\chi$. We redefine the ex-ante probability of success for each project as $\lambda = \rho + (1 - \rho)\chi$ to facilitate the comparison with previous propositions.
Proposition 9 It is more difficult for banks to avoid information acquisition if financing two identical projects that are correlated. Banks can implement the first best outcome if

\[ k - z \leq \frac{\gamma}{1 - \lambda} + \frac{\chi}{\lambda} w \]

where \( \frac{\chi}{\lambda} \leq 1 \). Banks can implement first best outcomes even if \( \gamma = 0 \), when \( e > k + \frac{w}{2} [2 - \frac{\chi}{\lambda}] \).

As \( \rho \to 0 \), \( \frac{\chi}{\lambda} \to 1 \), converging to the condition in Proposition 8 for two i.i.d. projects.

As \( \chi \to 0 \), \( \frac{\chi}{\lambda} \to 0 \), converging to the conditions in Proposition 3 for a single project.

Proof If the bank finances two correlated projects, there are three possible states:

- With probability \( \rho + (1 - \rho)\chi^2 \) both projects are successful (gg), and the bank’s assets at period \( t = 2 \) are \( 2[A_b + s(x)] \).

- With probability \( 2(1 - \rho)\chi(1 - \chi) \) only one projects is successful (gb or bg), and the bank’s assets at period \( t = 2 \) are \( 2A_b + s(x) \).

- With probability \( (1 - \rho)(1 - \chi)^2 \) no project is successful (bb), and the bank’s assets at period \( t = 2 \) are \( 2A_b \).

Again, in this proof we study the conditions for the bank to implement the first best. The condition for no information acquisition becomes

\[ \lambda \left( \max \{ E(r^L|g), e_L \} - E(r^L|g) \right) + (1 - \lambda) \left( \max \{ E(r^L|b), e_L \} - E(r^L|b) \right) \leq \gamma \]

where

\[ E(r^L|b) = \chi r^L_2(bg) + (1 - \chi) r^L_2(bb) \]

and

\[ E(r^L|g) = Pr(gg|g)r^L_2(gg) + (1 - Pr(gg|g))r^L_2(gb) \]

where \( Pr(gg|g) = \frac{\rho + (1 - \rho)\chi^2}{\chi} \).

When both projects fail, \( r^E_2(bb) = 0 \) and \( r^E_2(bb) = A_b \). Assume that, if only one project fails, \( r^E_2(gb) = r^E_2(bg) = 0 \). From the resource constraint when only one project fails,

\[ r^E_2(gb) = r^E_2(bg) = A_b + \frac{s(x)}{2}. \]
From the break even condition of the early consumer

\[ r^E_2(gg) = \frac{e - k}{\rho + (1 - \rho)\chi^2}. \]  

(19)

From the resource constraint when both projects succeed

\[ r^L_2(gg) = A_b + s(x) - \frac{e - k}{\rho + (1 - \rho)\chi^2}. \]  

(20)

Replacing these results in the break even condition for the late consumer, expected gains from depositing in the banks are exactly \( e_L \). This implies these promises are feasible and late consumers expected gains from depositing are

\[ E(r^L|b) = e_L + e - k - w - \frac{w}{2\lambda}. \]

If \( e < k + \frac{w}{2} \left[ 2 - \frac{1}{\lambda} \right] \), then \( E(r^L|b) < e_L \) and \( E(r^L|g) > e_L \). This implies late consumers would deposit in banks when privately observing the project succeeds and store the money if privately observing the project fails. The condition for no information acquisition is,

\[ (1 - \lambda)[e_L - E(r^L|b)] \leq \gamma \]

or

\[ k - z \leq \frac{\gamma}{1 - \lambda} + \frac{\chi w}{\lambda 2}. \]

As \( \rho \to 0, \frac{\chi}{\lambda} \to 1 \), converging to the condition in Proposition 8 for two i.i.d. projects. As \( \chi \to 0, \frac{\chi}{\lambda} \to 0 \), converging to the conditions in Proposition 3 for a single project.

If \( e > k + \frac{w}{2} \left[ 2 - \frac{1}{\lambda} \right] \), then \( E(r^L|b) > e_L \) and \( E(r^L|g) < e_L \). In this case, there are enough resources to make promises such that \( E(r^L|g) = E(r^L|b) = e_L \), eliminating incentives to acquire information for all \( \gamma \geq 0 \). The intuitive way for banks to achieve this result is to promise \( r^E_2(bb) = 0 \) but \( r^E_2(gb) = r^E_2(bg) > 0 \), which reduces expected payoffs for late consumers in case they observe a project failing.

Since \( r^L_2(bb) = A_b \) and banks want to achieve \( E(r^L|b) = e_L \), then

\[ r^L_2(bg) = \frac{e_L - (1 - \chi)A_b}{\chi}. \]
From the resource constraint in the case only one project succeeds,

\[ r_2^E(bg) = \frac{e - k}{\chi} - \frac{w}{2\chi} \left[ 2 - \frac{\chi}{2} \right] > 0. \]

From early consumers breaking even

\[ (1 + \alpha)k + 2(1 - \rho)\chi(1 - \chi)r_2^E(gb) + [\rho + (1 - \rho)\chi^2]r_2^E(gg) = e + \alpha k \]

we obtain

\[ r_2^E(gg) = \frac{e - k}{\rho + (1 - \rho)\chi^2} - \frac{2(1 - \rho)(1 - \chi)}{\rho + (1 - \rho)\chi^2} \left( e - k - \frac{w}{2} \left[ 2 - \frac{\chi}{\lambda} \right] \right). \]

Finally, from the resource constraint when both projects succeed we obtain

\[ r_2^L(gg) = A_b + \frac{w}{\lambda} - \frac{e - k}{\rho + (1 - \rho)\chi^2} + \frac{2(1 - \rho)(1 - \chi)}{\rho + (1 - \rho)\chi^2} \left( e - k - \frac{w}{2} \left[ 2 - \frac{\chi}{\lambda} \right] \right). \]

Finally, replacing these results in the break even condition for the late consumer, expected gains from depositing in the banks are exactly \( e_L \).

These are the feasible payoffs that implement first best without introducing incentives to acquire information when \( e > k + \frac{w}{2} \left[ 2 - \frac{\chi}{\lambda} \right] \), for all \( \gamma \geq 0 \).

\[ Q.E.D. \]

### 4.3 Two Different Projects

Now assume the two projects differ in their probability of success and their costs of monitoring \((\lambda_1, \gamma_1)\) and \((\lambda_2, \gamma_2)\), but their results are independent from each other. We show that banks can cross-subsidize across projects to discourage information acquisition and implement the first best allocation. In essence, even when there may be incentives to acquire information about a single project, banks can avoid distorting risk-bearing or investment to prevent information acquisition by cross subsidizing between projects.

**Proposition 10** In the presence of two different projects, banks can discourage information acquisition and implement first best by cross subsidization rather than by distortions, charging relatively more for funds to projects for which there are relatively less incentives to acquire information.
Proof If the bank finances two different projects, there are four possible states:

- With probability $\lambda_1 \lambda_2$ both projects are successful $(gg)$, and the bank’s assets at period $t = 2$ are $2A_b + s_1(x) + s_2(x)$.
- With probability $\lambda_1 (1 - \lambda_2)$ only the first project is successful $(gb)$, and the bank’s assets at period $t = 2$ are $2A_b + s_1(x)$.
- With probability $(1 - \lambda_1) \lambda_2$ only the second project is successful $(bg)$, and the bank’s assets at period $t = 2$ are $2A_b + s_2(x)$.
- With probability $(1 - \lambda_1)(1 - \lambda_2)$ no project is successful $(bb)$, and the bank’s assets at period $t = 2$ are $2A_b$.

Again, in this proof we study the conditions for the bank to implement the first best. The condition for no information acquisition of firm 1 becomes

$$\lambda_1 \left( \max \{ E(r_L|g_1), e_L \} - E(r_L|g_1) \right) + (1 - \lambda_1) \left( \max \{ E(r_L|b_1), e_L \} - E(r_L|b_1) \right) \leq \gamma_1$$

where

$$E(r_L|g_1) = \lambda_2 r_2^L (gg) + (1 - \lambda_2) r_2^L (gb)$$

and

$$E(r_L|b_1) = \lambda_2 r_2^L (bg) + (1 - \lambda_2) r_2^L (bb),$$

where $g_1$ refers to having produced information about firm 1 and discovered firm 1’s project is successful, while $b_1$ refers to having produced information about firm 1 and discovered firm 1’s project is a failure.

Similarly, the condition for no information acquisition of firm 2 becomes

$$\lambda_2 \left( \max \{ E(r_L|g_2), e_L \} - E(r_L|g_2) \right) + (1 - \lambda_2) \left( \max \{ E(r_L|b_2), e_L \} - E(r_L|b_2) \right) \leq \gamma_2,$$

where

$$E(r_L|g_2) = \lambda_1 r_2^L (gg) + (1 - \lambda_1) r_2^L (bg)$$

and

$$E(r_L|b_2) = \lambda_1 r_2^L (gb) + (1 - \lambda_1) r_2^L (bb).$$

Banks want to compensate late consumers as much as possible when all projects fail. Then $r_2^E(bb) = 0$ and $r_2^E(bb) = A_b$. Assume this is also the case when only one project
fails, this is \( r_2^E(gb) = r_2^E(bg) = 0 \). Then, from the resource constraint in those situations, \( r_2^L(gb) = A_b + s_1(x)/2 \) and \( r_2^L(bg) = A_b + s_2(x)/2 \), since the two late consumers are identical and the proceedings of the single successful project are split in two.

From the break even condition of early consumers

\[
(1 + \alpha)k + \lambda_1 \lambda_2 r_2^E(gg) = e + \alpha k.
\]

Then

\[
r_2^E(gg) = \frac{e - k}{\lambda_1 \lambda_2}.
\]  
(21)

From the resource constraint when both projects succeed

\[
r_2^L(gg) = A_b + \frac{s_1(x)}{2} + \frac{s_2(x)}{2} - \frac{e - k}{\lambda_1 \lambda_2}.
\]  
(22)

The expected gains for a late consumer from depositing is

\[
\lambda_1 \lambda_2 r_2^L(gg) + \lambda_1 (1 - \lambda_2) r_2^L(gb) + (1 - \lambda_1) \lambda_2 r_2^L(bg) + (1 - \lambda_1)(1 - \lambda_2) r_2^L(bb),
\]

and replacing the promises to the late consumer derived above

\[
A_b - (e - k) + \lambda_1 \frac{s_1(x)}{2} + \lambda_2 \frac{s_2(x)}{2}.
\]

These expected gains for a late consumer from depositing are equal to \( e_L \) if

\[
\lambda_1 \frac{s_1(x)}{2} + \lambda_2 \frac{s_2(x)}{2} = w.
\]  
(23)

In the first best, \( s_1(x) = \frac{w}{\lambda_1} \) and \( s_2(x) = \frac{w}{\lambda_2} \), which implies these promises are feasible.

The expected gains for a late consumer after privately observing the result of a project \( i \in \{1, 2\} \) are

\[
E(r^L|b_i) = e_L + e - k - \frac{w}{2}
\]

and

\[
E(r^L|g_i) = e_L - \frac{(1 - \lambda_{-i})}{\lambda_{-i}} \left[ e - k - \frac{w}{2} \right].
\]

If \( e < k + \frac{w}{2} \), then \( E(r^L|b_i) < e_L \) and \( E(r^L|g_i) > e_L \). This implies late consumers, regardless of which project they investigate, would deposit in banks when privately
observing the project succeeds and store the money if privately observing the project fails. The condition for not acquiring information about none of the projects is,

$$ (1 - \lambda_i)[e_L - E(r^L|b_i)] \leq \gamma $$

or

$$ k - z \leq \frac{\gamma_i}{1 - \lambda_i} + \frac{w}{2}. $$

If this condition is fulfilled for both projects, then there are no restriction in implementing the first best, and no distortion is needed.

Without loss of generality, assume now this condition is not fulfilled for firm 1, this is $k - z > \frac{\gamma_1}{1 - \lambda_1} + \frac{w}{2}$. This implies that, in order to avoid information acquisition it is necessary a larger $E(r^L|b_1) = e_L + e - k - \lambda_2 \frac{s_2(x)}{2}$, or which is the same

$$ s_2(x) > \frac{w}{\lambda_2}, $$

which implies

$$ s_1(x) < \frac{w}{\lambda_1}, $$

from equation (23).

More precisely, $s_2(x)$ should be set at a level high enough to avoid information acquisition about firm 1. From the condition for no information acquisition this implies setting $s_2(x)$ such that

$$ (1 - \lambda_1)[e_L - (e_L - k + z + \lambda_2 \frac{s_2(x)}{2})] = \gamma_1 $$

or

$$ s_2(x) = \frac{2}{\lambda_2} \left[ k - z - \frac{\gamma_1}{1 - \lambda_1} \right] > \frac{w}{\lambda_2} $$

and from equation (23),

$$ s_1(x) = \frac{2}{\lambda_1} \left[ e - k + \frac{\gamma_1}{1 - \lambda_1} \right] < \frac{w}{\lambda_1} $$

This cross-subsidization to avoid information acquisition is feasible as long as

$$ s_2(x) \leq \frac{w + \lambda_1(k - z)}{\lambda_2}, $$
otherwise firm 2 would rather raise funds in capital markets than paying a larger rate for funds in banks. This condition can be rewritten as

$$(k - z) \left[ 1 - \frac{\alpha (1 - \lambda_2)}{2} \right] \leq \frac{\gamma_1}{1 - \lambda_1} + \frac{w}{2}.$$ 

This implies cross-subsidization is preferred and feasible as long as

$$\left[ \frac{\gamma_1}{1 - \lambda_1} + \frac{w}{2} \right] < k - z \leq \frac{2 \left[ \frac{\gamma_1}{1 - \lambda_1} + \frac{w}{2} \right]}{1 - \alpha (1 - \lambda_2)}.$$ 

Q.E.D.

5 Empirical Evidence on Bank Opacity

Banks are commonly viewed as opaque firms. Indeed, that is the rationale for regulating banks. We have argued that it is optimal for banks to be opaque. Opacity is necessary for the creation of private money and private money to be efficient in the sense of allowing for its positive allocative effects.

The empirical evidence largely supports the view that banks are opaque, and increasingly so to the extent that they make loans to small firms and consumers, who are also more complex and costly to monitor. Hirtle (2006) examines the abnormal stock return to 44 bank holding companies in response to the SEC mandate that CEOs certify the accuracy of their financial statements. This mandate resulted in no abnormal response in the case of non-financial firms, BHCs did experience positive and significant abnormal returns. Hirtle also finds that the abnormal returns are related to measures of opacity. Haggard and Howe (2007) find that banks have less firm-specific information in their equity returns than matching industrial firms. They also show that banks with higher proportions of agricultural and consumer loans are more opaque. Morgan (2002) and Iannota (2006) look at the bond ratings of banks and find that bond rating agencies are more likely to disagree on the ratings of banks compared to other firms, suggesting that banks are harder to understand. Also, see Jones, Lee, and Yeager (2012).

Flannery, Kwan, and Nimalendran (2010) examine microstructure evidence (bid-ask spreads and trading volumes) for banks and a matched non-bank control sample.
They conclude that banks are not so opaque, compared to non-banks. When they examine measures of opacity, controlling for the microstructure variables, they find evidence that loans are the contributing factor to bank opacity. That is, trading assets are not relevant. This empirical evidence is consistent with our model. Bank debt (which is rated) is opaque, but bank equity is not revealing.\footnote{There is a related literature on the potential for market discipline to complement bank supervision. The market discipline might occur via improved disclosure or mandatory subordinated debt requirements. See Flannery (1999).}

The stress tests of U.S. bank holding companies were informative to financial markets about the size of the bank capital gaps, consistent with bank opacity. See Peristian, Morgan, and Savino (2010). There is also related literature on the information value of bank examinations generally. See, e.g., Gilbert and Vaughan (1998), Berger, Davies, and Flannery (2000) and Gunther and Moore (2003).

Although the predictions of the model with respect to banks are complicated by the presence of deposit insurance, banks appear to overwhelmingly make loans to consumers and small firms borrowers without traded equity. Other forms of money very clearly rely on backing assets without traded equity, e.g., asset-backed commercial paper and repo. Money market mutual funds hold diversified portfolios of very short maturity assets, like commercial paper.

### 6 Conclusions

Banks are optimally opaque. Banks produce private money that is used as a transaction medium. An efficient transactions medium requires that the money be information-insensitive. But, the production of information is important for investment efficiency. To prevent an information externality from the production of information about investment opportunities, banks act as secret keepers. They are opaque in that the information about the investments is not revealed. Banks choose portfolios of assets to minimize information leakage.

The synergies or complementarities between loans, to small firms and households, and demand deposits (or other forms of bank debt) are not due to the need for monitoring banks, ensuring that the banks screen and monitor borrowers. Our argument is that the output of banks is debt used for trading and that this debt is efficient if it
is backed by assets that minimize information leakage. The optimal assets are precisely loans to small firms and households, but that is because these minimize the information leakage.

These results clearly have policy implications. Banks want to create opacity in order for bank money to function effectively. We argue that there is a reason for this opacity. Policies designed to enhance bank transparency reduce the ability of banks to produce (uninsured) bank money.

References


