Banks as Secret Keepers *

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PRELIMINARY AND INCOMPLETE

Abstract

Banks are optimally opaque institutions. They produce debt for use as a transaction medium (bank money), which requires that information about the backing assets not be revealed, so that bank money does not fluctuate in value, reducing 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 market 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

A defining characteristic of privately-produced money-like securities is that agents accept them at par when transacting and expect to be able to redeem them at par. The value of the money is not in doubt when transacting and it does not vary in value over time. In other words, bank money is not sensitive to information, either public or privately-produced. But, how can banks produce such money when it must be backed by risky assets, and when investment efficiency requires that information be produced to select and monitor these investments? The conundrum 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 about the backing assets secret. Without banks, information about investments comes 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 firms and to households. There is a complementarity between the production of private money and assets that minimize information leakage. Thus, the raison d'etre of banking is secret-keeping for the production of private money.

In the setting we study, a firm has two investment opportunities but no funds, while two overlapping generations of consumers ("early" and "late" consumers) live for three periods and have "liquidity" needs at an interim date. Initially the early consumer has enough endowment to cover the investment needs of the firm for the first project or its own liquidity needs in the intermediate period, but not both. If the early consumer finances the firm's needs, he can cover his liquidity needs by selling the claims in the intermediate period. The liquidity needs make consumers (effectively) risk averse to changes in the value of the claim he holds. Furthermore, he does not want the seller of goods to produce private information about the assets backing the claim, as in Gorton and Pennacchi (1990) and Dang, Gorton, and Holmström (2013).

We assume that information about the projects is socially valuable – it allows to invest more efficiently. The problem is that there is a tradeoff between socially valuable information production and its negative externality on liquidity provision. The model displays the basic problem that information is needed for investment efficiency, but not wanted for trading efficiency.

We begin by analyzing 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 projects are 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 second project and can hide this information. We assume consumers know that the correlation between the projects is perfect, while the bank does not know this correlation. When there is information about the second project and bank finances it, this does not provide any information to the bank about the whereabout of the first project

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

Then we allow agents to produce and trade on private information, potentially creating another information leakage. Now the bank may not be able to implement first best, i.e., avoid information production, and may have to force the early consumer to inefficiently bear risk, or alternatively inefficiently invest less in the initial project. These distortions may be able to prevent private information production, but may be so large that banks do not exist. Instead, firms finance in the capital markets, and money inefficiently varies in value. But, the bank can also prevent such information leakage through its choice of assets. The bank's 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 (difficult to evaluate, small, and relatively safe assets), but the reason is unrelated to any special ability of the bank to oversee these assets.

The model we analyze is related to Dang, Gorton, and Holmström (2013), 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 allows us to study why banks exist and how they optimally choose their portfolio structure

The definition of a bank depends on complementarities between the two sides of the balance sheet. 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. In Kashyap, Rajan, and Stein (2002) deposit withdrawals and loan commitment draw-downs are imperfectly correlated, and so they can be optimally combined.

Our argument for the existence of financial intermediation is very different from other explanations explored previously by the literature. The most important difference is that the bank debt is used to conduct trade; it is money. Banks are unique in producing debt used as private money. In the model, there is nothing special about the banks' activities on the asset side. However, there is still an important complementarity between bank assets and bank liabilities. In order to produce money, the banks' assets are selected to minimize information leakage, publicly or privately.

The paper is also related to the justification of financial intermediaries by Diamond and Dybvig (1983). In their paper, in the initial period the return of the illiquid asset is known but the liquidity needs of investors are stochastic, unknown and privately observed in the intermediate period. As highlighted by Jacklin (1987) and Haubrich and King (1990), if there are trading opportunities in the intermediate period, such information reduces the possibility of insurance against liquidity needs. Critically, since liquidity needs are hardwired into the preferences of investors in Diamond and Dybvig, information about those needs cannot be avoided, and the only possibility to sustain insurance is to restrict trading in the model.

In contrast, our paper assumes that in the initial period the liquidity needs of investors are known but the return of the illiquid asset is stochastic, unknown and privately observed by firms in the intermediate period. If there are trading opportunities in the intermediate period, such information also reduces the possibility of insurance against liquidity needs. However, banks are useful in hiding this information from investors, which is not feasible in the setting of Diamond and Dybvig.

An empirical literature documents that banks are opaque firms even under deposit insurance. Hirtle (2006) examines the abnormal stock returns 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, but bank holding companies 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.[1]

In the next Section 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. Finally, Section 7 concludes.

2 Model

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

[1]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).

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 as follows:

$$
\begin{aligned}
U_F &= \sum_{t=0}^{2} C_{Ft} & \omega_F &= (0,0,0)\\
U_E &= \sum_{t=0}^{2} C_{Et} + \alpha \min\{C_{E1}, k\} & \omega_E &= (e,0,0)\\
U_L &= \sum_{t=0}^{2} C_{Lt} + \alpha \min\{C_{L2}, k\} & \omega_E &= (0,e,0)\\
U_B &= \sum_{t=0}^{2} C_{Bt} & \omega_B &= (0,0,0)
\end{aligned}
$$

where C_{ht} denotes the consumption of agent $h \in \{F, E, L, B\}$ at date $t \in \{0, 1, 2\}$ and α and k are positive constants. The firm has no endowment of goods but, as we will discuss next, it has access to a productive technology; the consumers only differ on the period they born – the early consumer born in period $t = 0$ and the late consumer in $t = 1$. Both consumers have e units of goods as endowment when they born and nothing at other dates, and they both prefer to consume up to k the period after they born – in period $t = 1$ for the early consumer and in period $t = 2$ for the late consumer. This overlapping generation structure is useful to extend to more periods later and, assuming the endowment of late consumers is in expectation larger than that of early consumers, but uncertain, explore the effects of growth and volatility in the functioning of banks.

Even though the firm does not have any endowment, it has two investment opportunities. At $t = 0$ the firm can invest, at a cost w, in a *first project* that generates $x > w$ at $t = 2$ with probability λ, and zero otherwise, all in terms of the single good. At $t = 1$, the firm has another investment opportunity, a *second project*, at a cost $\widehat{w}$, which generates $\widehat{x} > \widehat{w}$ at $t = 2$ with probability $\widehat{\lambda}$ if the original investment is successful or with probability $1 - \widehat{\lambda}$ if the original investment is a failure, and zero otherwise.

We assume the original project has a positive net present value and its operation is ex-ante efficient (i.e., $\lambda x > w$). We also assume the firm observes at $t = 1$ whether the second project will be a success or a failure at $t = 2$ and can communicate this information to other agents at no cost.

We assume the firm and the consumers know $\widehat{\lambda}$ but the bank does not understand the the industry in which these two projects operate, so his best guess is that the realization of the two projects are independent of each other (i.e., $\widehat{\lambda} = 0.5$). For notation simplicity, throughout this section we assume that $\widehat{\lambda} = 1$, so there is really a perfect correlation between the two investment opportunities. This implies that if the firm or the consumers observe the second project is worthy, they infer the first project will be successful the next period. In contrast, if the bank observes the second project is worthy, they do not infer anything about the success of the first project.

We also assume that the endowment of early consumers is not enough to cover both their liquidity needs and firms' investment needs, while total endowment in the economy (the endowments of both early and late consumers) is enough to cover both liquidity and investment needs. This implies that early consumers face the risk of not consuming k in $t = 1$ if financing the original project at w, but late consumers could provide enough resources to eliminate such a risk. In summary, these restrictions are:

Assumption 1 *Projects and endowments*

1. *The first project is ex-ante efficient.*
   $\lambda x > w$.
2. *Early consumers can cover their liquidity and investment needs, but not both.*
   $e > k$, *and* $e > w$ *but* $e < k + w$.
3. *Total endowment is enough to cover both liquidity and investment needs.*
   $2e > 2k + w + \widehat{w}$.

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 way to consume k at $t = 1$ is by trading a fraction of those claims with late consumers that are born at

$t = 1$. Late consumers have enough resources to potentially finance a second project and to buy the claims from early consumers to cover their liquidity needs.

The trade between early and late consumers that would implement the first best, however, is hindered by information revelation about the second project at $t = 1$. Information about the type of the second project is important, since allows the second project to be financed only when it is optimal to do it. The information, however, would have a negative impact on the early consumers' ability to trade its claims on the first project, if the first project was unsuccessful. In that case the claims held by early consumers are worthless and then late consumers would not be willing to buy them. Early consumers would not be able to cover their liquidity needs.

We will show that even though the bank is a neutral agent without any endowment or special abilities – indeed the bank has inferior knowledge about the functioning of this economy and does not have any learning capabilities – it will be able to improve welfare by participating as an opaque intermediary, which uses the information to allocate investment resources optimally, while hiding that information to avoid it interfering with trade. In a sense, a clueless bank that keeps secrets can eliminate the negative externality that information imposes 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 $E(U_F^A) = E(U_B^A) = 0$ and $E(U_E^A) = E(U_L^A) = e + \alpha k$.

Clearly it is possible for the economy to do better than autarky. Consider the problem of an unconstrained social planner (that can force transfers across consumers, so it does not have to satisfy participation constraints). 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. It is also optimal for the early consumer to consume k in period $t = 1$, but the early consumer has only $z \equiv e - w < k$ remaining to consume at $t = 1$. Then it is optimal for the planner to force a transfer $k - z$ resources from the late consumer to the early consumer. It is also optimal to use $\widehat{w}$ from the late consumer to finance the second project if there is information that it will be successful.[2]

[2] Note welfare here is defined based on the true correlation between the first and the second project, not based on the uncertain belief of the bank that they are independent.

These allocations are feasible because $e > 2k - z + \widehat{w}$, from Assumption 1. Note that relaxing this assumption is not critical; it just restricts the first best outcome, introducing a trade-off between reducing investment (allocating less than w to the first project or less than $\widehat{w}$ to the second project) or distorting consumption (making consumers consume less than k when having their liquidity needs).

The next question is how to split the surplus. We choose to assign the whole 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. Define $\mu = x + \widehat{x} - \widehat{w}$ the total gains of the firm conditional on the projects succeeding. Then, under this first best allocation the ex-ante expected utilities of the agents are $E(U_B^{FB}) = 0$, $E(U_E^{FB}) = E(U_L^{FB}) = e + \alpha k$ and $E(U_F^{FB}) = \lambda\mu - w$.

The gains from trading are clear in this comparison. First, the first project gets funds always and the second project gets funds only if there is information it will succeed, in which case it generates a positive net gain $(\widehat{x} - \widehat{w})$. Then total expected gains are $\lambda\mu - w$. 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 $t = 1$, which is also feasible.

By the assumption, if both consumers were born in period $t = 0$, then it would be optimal and feasible for both to store k to consume in period $t = 1$ and to lend $\frac{w}{2}$ each to the firm. The problem of them being born in different periods is that only the early consumer can put down w completely and he then faces potentially the risk of not being able to consume k in period $t = 1$. In summary, it is optimal to finance the project at $t = 0$, and to finance the second project if good at $t = 1$. However, if the information about the second project leaks out, it may hinder the necessary trade between early and late consumers. This leakage happens in capital markets, but not with ”secret keeping” intermediaries.

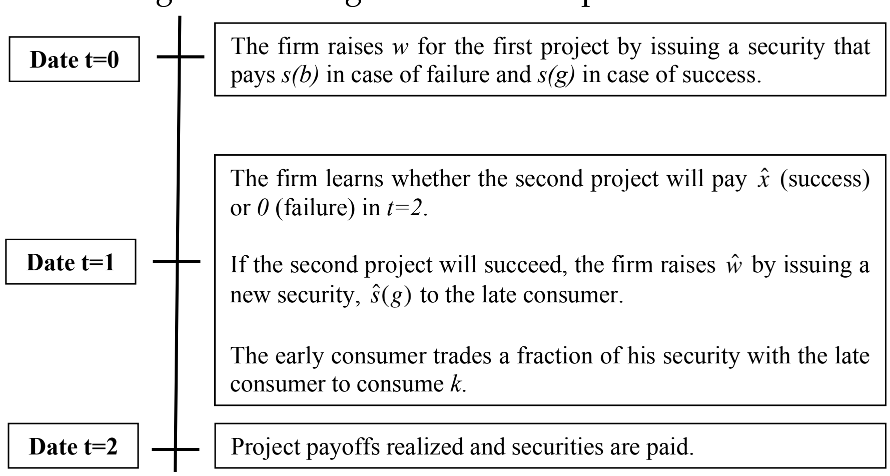
2.3 Capital markets

We now show that capital markets cannot implement the efficient allocation.

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

At $t = 1$ two transactions may occur. First, the firm may seek financing for a second project if having information that project will be successful in $t = 2$ by issuing a new security, which we denote as $\widehat{s}(g)$, 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 has $z \equiv e - w < k$ available, so 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



An important element of capital markets that we want to capture is that they communicate information about the health of financed projects. If firms have enough commitment such that they can raise funds in a way that is uninformative about the health of its previous projects, then capital markets would play the role we assign to banks here. We believe one of the main features of stock markets is the communication of information and lack of commitment. More study requires bond markets, which based on commitment by firms, can possibly be uninformative.

Since information is "hard" (can be credibly transmitted), the firm cannot lie about the project's results. In capital markets, all agents observe whether a firm is raising funds for a second project or not, so all of them infer whether the first project was successful or not. This leakage of information from the financing of the second project to the information about the first 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 proceed by backward induction. If the second project is doomed to fail, the firm does not look for finance (since it cannot prove it it is a worthy project), revealing that the first project is also doomed to fail. If there is information that the second project will succeed, the firm will seek finance by issuing a security that pays $\widehat{s}(g) = \widehat{w}$ in $t = 2$. Since the firm has hard information about the project's results, and also the bargaining power, the firm keeps the surplus $(\widehat{x} - \widehat{w})$ of the extension. In essence, by assumption, raising money in capital markets is informative about the first project.

The previous stage is critical to define the optimal choices of the late consumer. If the late consumer learns the first project is bad (because the firm never shows up asking for a loan to finance a second project), then he is better off just consuming (or storing to consume later) his full endowment e.

If the late consumer learns the first project is successful, then he chooses to finance the second project and to buy a fraction θ of the claims on the first project from the early consumer, at a price $s(g)$. 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

$$\widehat{w} + \theta s(g) \leq e.$$

This implies that

$$\theta s(g) = \min \{k - z, e - \widehat{w}\} = k - z \tag{1}$$

from Assumption 1. This means that 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 first project, he stores his endowment and obtains a certain utility of $U_{E|Store} = e + \alpha k$. In contrast, if the early consumer decides to finance the first project, then he faces a lottery because the project is risky. Then the expected utility for the early consumer when financing the project is:

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

Substituting 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 $U_{E|Finance} = U_{E|Store}$), which implies

$$(1+\alpha)z + \lambda s(g) + \lambda\alpha(k-z) = e + \alpha k,$$

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

$$s(g) = \min\left\{\frac{w}{\lambda} + \frac{\alpha(1-\lambda)}{\lambda}(k-z), x\right\}. \tag{2}$$

The first component of the first argument corresponds to the certainty equivalent cost of the loan while 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 $t=1$ (losing the additional utility α 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 $s(g) = x$, and limited commitment binds, then $U_{E|Finance} < U_{E|Store}$ and the first project 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 first project is not financed at all. Still the allocation is better than under autarky since the second project still would be financed if the firm has information that project will be a success

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:

$$E(U_F^{CM}) = \lambda x - \lambda s(g) + \lambda(\widehat{x} - \widehat{w}) < E(U_F^{FB}) = \lambda\mu - w$$

since, as is clear from equation (2), $\lambda s(g) > w$, because the firm has to compensate the early consumer for taking the risk of not consuming as much as desired in period 1. In the extreme, when $s(g) = x$ and there is no financing of the first project, then $U_F^{CM} = \lambda(\widehat{x} - \widehat{w})$.

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

$$E(U_F^{FB}) - E(U_F^{CM}) = \lambda s(g) - w = \min \left\{ \alpha(1-\lambda)(k-z), \lambda x - w \right\}.$$

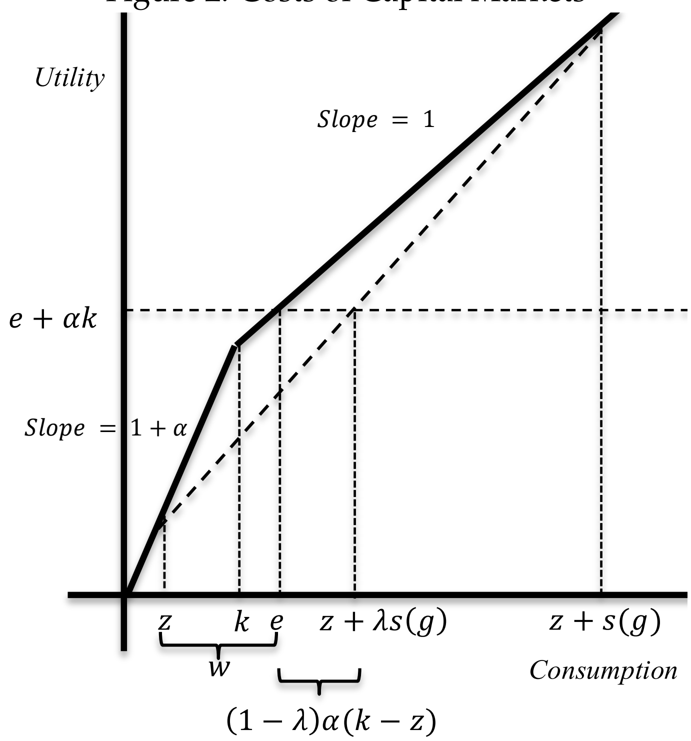
Q.E.D.

Intuitively, the securities of the early consumer are subject to information revelation about the project's result, creating the risk of bad news such that they cannot sell those securities, leaving insufficient resources to meet 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 for that risk by promising in expectation more than the loan size, w, inducing the same ex-ante utility when early consumers choose to store their endowments. 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 from financing the project.

In essence, capital markets reveal *too much* information to people who know how to interpret that 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 second projects would be financed even though they have a negative net present value or some second projects would not be financed even though they have a positive 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

Figure 2: Costs of Capital Markets



and late consumers. To compensate the early consumer 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-sharing in the economy – all the risk is faced by a single individual rather than being distributed across all individuals.

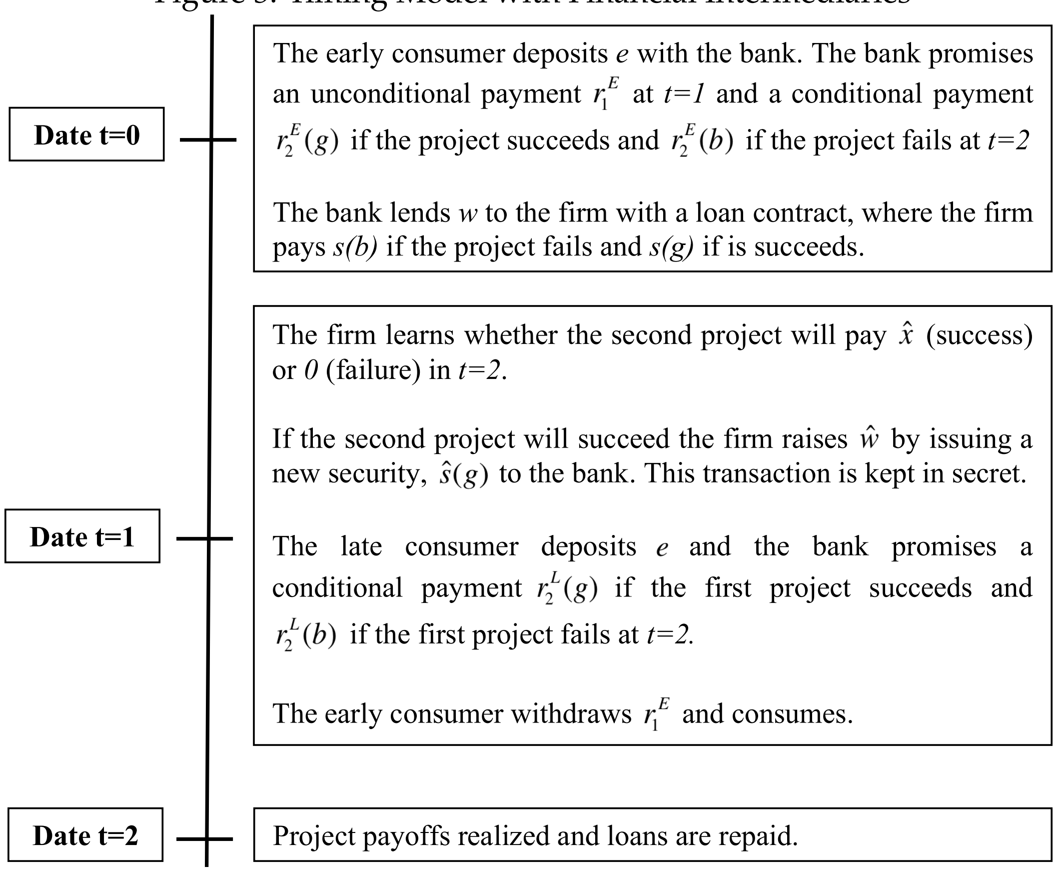
2.4 Financial intermediation

The previous analysis shows that capital markets may not implement the efficient level of investment if the early consumer cares about liquidity and, even in situations where there is efficient investment, there is inefficient risk-sharing in the economy. Now we show that intermediation by a bank that is clueless about the functioning of the economy dominates capital markets where only informed agents participate, potentially implementing the 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 that they introduce incentives for information acquisition by lenders even though banks try to hide such information. In this subsection 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 subsection we relax this restriction.

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 first project. The firm issues a contingent security that pays $s(b)$ in case of failure and $s(g)$ in case of success at $t = 2$. At the time the bank receives the deposit from the early consumer, it promises to pay $r_1^E = k$ at $t = 1$ and a contingent claim that pays $r_2^E(b)$ at $t = 2$ if the project fails and $r_2^E(g)$ at $t = 2$ if the project succeeds. The state is common information to all agents at $t = 2$.

Figure 3: Timing Model with Financial Intermediaries



At $t = 1$, the late consumer deposits e in the bank, which issues a security that promises to pay $r_2^L(b)$ if the state is bad (the first project ends up failing and the bank is liquidated) and $r_2^L(g)$ if the state is good (the first project is successful). Meanwhile, the early consumer withdraws k from the bank. If the bank determines that the firm has a good second project, then it lends $\widehat{w}$ to the firm, which issues a security that pays $\widehat{s}(g)$. If the bank determines that the firm has a bad second project, then the bank does not extend any new loan to the firm and $\widehat{w}$ 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 or not the bank has given the loan to the firm to finance a second project. The intermediary, by hiding such information, allows for efficient trade between consumers at $t = 1$ which then covers 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. At $t = 1$, if there is information that the second project will succeed the bank gives a loan $\widehat{w}$ to the firm, which issues a security that pays $\widehat{s}(g) = \widehat{w}$ in $t = 2$. In contrast, if there is information that the second project will fail, the best alternative for the bank is to not finance it and store the additional endowment $\widehat{w}$.

Since consumers are risk neutral, the bank's promises to consumers are not determined, and there are many alternatives that make the consumers indifferent. Here we assume $r_1^E = k$ and $r_2^E(b) = 0$ 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 and banks more feasible.

In the proposed first best contract, in which the bank promises $r_1^E = k$, the assets of the bank at $t = 2$ depend on whether the first project fails or succeed. When the first project fails assets are,

$$A_b \equiv e + z - k \qquad \textit{where} \quad z = e - w.$$

When the first project succeeds, considering that $\widehat{s}(g) = \widehat{w}$, assets are

$$A_b + s(g).$$

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,

$$k < r_2^L(b) = A_b < e, \tag{4}$$

and from the indifference condition of the late consumer,

$$(1 + \alpha)k + (1 - \lambda)(A_b - k) + \lambda(r_2^L(g) - k) = e + \alpha k,$$

we can obtain the value of the last promise, which remains to be determined:

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

Finally, we have to check that these payments are feasible when the project succeeds

$$r_2^E(g) + r_2^L(g) \leq A_b + s(g).$$

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

$$s(g) \geq \frac{w}{\lambda}.$$

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

$$E(U_F^{FI}) = E(U_F^{FB}) = \lambda\mu - w.$$

Since by construction we guarantee $E(U_B^{FI}) = 0$ and $E(U_E^{FI}) = E(U_L^{FI}) = e + \alpha k$, 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 second project can implement the first best because it allows information to be used at $t = 1$ for investment purposes, but delays the revelation about the realization of the first project until $t = 2$ and prevents such information from affecting the efficient trade across consumers at $t = 1$. In this way banks allows risk-sharing between the early and late consumers. In essence banks eliminate the negative externality that information has on liquidity.

This is a stark result because we have assumed it is impossible for late consumers to learn about those secrets. We relax this assumption in the next two sections.

3 Private information acquisition

In this section we assume that late consumers can privately learn about whether the firm approached the bank for a second loan or not by exerting costly efforts γ in terms of consumption. First we study the conditions that limit the use of a banking structure to improve welfare. Basically the potential late depositors have incentives to acquire information about the quality of the second project before depositing in the bank, since that provides information about the quality of the first project. Then, we introduce a continuum of heterogeneous projects to study how the financing of firms sorts into banking or 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 cost projects), 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 γ, the benefits are given by the possibility of avoiding depositing in a bank with a failing firm in its portfolio. Specifically, if late consumers do not acquire private information about the project and deposit in the bank, their expected utility is

$$(1+\alpha)k + \lambda(r_2^L(g) - k) + (1-\lambda)(r_2^L(b) - k)$$

since, as we show before, the late consumer does not suffer any liquidity concern given $r_2^L(g) > k$ and $r_2^L(b) > k$.

In contrast, if late consumers acquire information at a cost γ and find out that the project is successful (with probability λ) then they prefer to deposit in the bank, being certain they will obtain $r_2^L(g) > e$ 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 rather than depositing and obtaining $r_2^L(b) < e$ at $t = 2$ (from equation 4). This implies the expected gains from acquiring information are

$$(1+\alpha)k + \lambda(r_2^L(g) - k) + (1-\lambda)(e - k) - \gamma.$$

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

$$(1-\lambda)[e - r_2^L(b)] \leq \gamma. \tag{6}$$

At this point, the optimality of our assumption that $r_1^E = k$ and $r_2^E(b) = 0$ is clear. Banks want to maximize the payments to late consumers when the project fails to minimize their incentives to acquire information, still providing liquidity to early consumers if possible. This leads to the following proposition.

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

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

The proof just requires replacing $r_2^L(b) = A_b = e + z - k$ from equation (4) into condition (6). Naturally, if this condition is not fulfilled, banks cannot credibly promise to pay k to the early consumer. The late consumer would have an incentive to learn about the quality of projects, not depositing in the bank if the project is a failure. In this case the bank would not always obtain 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: (i) projects have a low probability of default (high λ), (ii) they are difficult to monitor (high γ), (iii) they are relatively small (low w), (iv) the liquidity needs are relatively small (low k) or (v) the early consumer is relatively rich (high e). That is, relatively safe, small and complex projects are more likely to be observed in the portfolios of banks.

The natural question is, can the bank still improve welfare if this condition is not fulfilled? We show that the bank can improve welfare but it cannot achieve the first best allocation. When condition (6) binds, banks need to either distort risk-sharing or distort 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-sharing in the economy and then if they distort investment. Then, we discuss the condition under which banks prefer distorting risk-sharing instead of distorting investment.

3.1 Distorting risk-sharing

If late consumers have incentives to acquire information about the banks' assets (or the quality of the second project) when the bank offers the contract that implements the first best, banks can distort risk-sharing (or the provision of private money) in a way such 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-sharing in the economy, promising early consumers a certain return $r_1^E < k$ in $t = 1$.

Proof How can banks distort risk-sharing to avoid information acquisition? Since the expected benefits for late consumers to acquiring information are given by $(1 - \lambda)[e -$

$r_2^L(b)]$, and their costs are γ, a way for banks to discourage information acquisition is to promise late consumers no less than

$$r_2^L(b) = e - \frac{\gamma}{1-\lambda}, \tag{7}$$

in case the project is a failure.

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

$$A_b \equiv e + z - k < e - \frac{\gamma}{1-\lambda}.$$

The only possibility to guarantee the resource constraint and avoid information acquisition is to promise early consumers $r_1^E < k$. From the inequality above,

$$r_1^E = z + \frac{\gamma}{1-\lambda} < k. \tag{8}$$

Since the second loan does not provide information to the bank about the quality of the first project, the bank can only to distort risk-sharing by offering a non-contingent payment less than k to early consumers. Since the bank promises a lower payment at $t = 1$ to early consumers, it has to to offer them a larger payment at $t = 2$ in case the project succeeds, which compensates for not completely covering their liquidity needs, but making them indifferent between storing or depositing. This condition 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,

$$(1+\alpha)k + \lambda(r_2^L(g) - k) + (1-\lambda)(r_2^L(b) - k) = e + \alpha k.$$

Recall, from equation (7), that the promise for the late consumer in the bad state should be larger than without distortions, this is $r_2^L(b) = e - \frac{\gamma}{1-\lambda} > A_b > k$. Then,

$$r_2^L(g) = e + \frac{\gamma}{\lambda}. \tag{10}$$

Now, we have to check that these payments are feasible when the project succeeds, this is, the banks' assets when the project succeeds are enough to cover the promises,

$$r_2^E(g) + r_2^L(g) \leq e + z - r_1^E + s(g).$$

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

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

Note that in the first best $s(g) = \frac{w}{\lambda}$. When risk-sharing is distorted, banks have to charge the firm the gap $k - z - \frac{\gamma}{1-\lambda}$ adjusted by making the early consumer consume in period $t = 2$ rather than in $t = 1$ (adjusted by $\frac{\alpha}{\lambda}$). This is not feasible if $s(g) > x$.

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-sharing is distorted is

$$E(U_F^{Dist}) = \lambda(x - s(g)) + \lambda(\widehat{x} - \widehat{w}) = E(U_F^{FB}) - \alpha\left[k - z - \frac{\gamma}{1-\lambda}\right].$$

Assuming it is feasible for firms to raise funds in capital markets, comparing the firm's utility when risk-sharing is distorted with the firm's utility when raising funds in capital markets, banks can still implement higher welfare if:

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

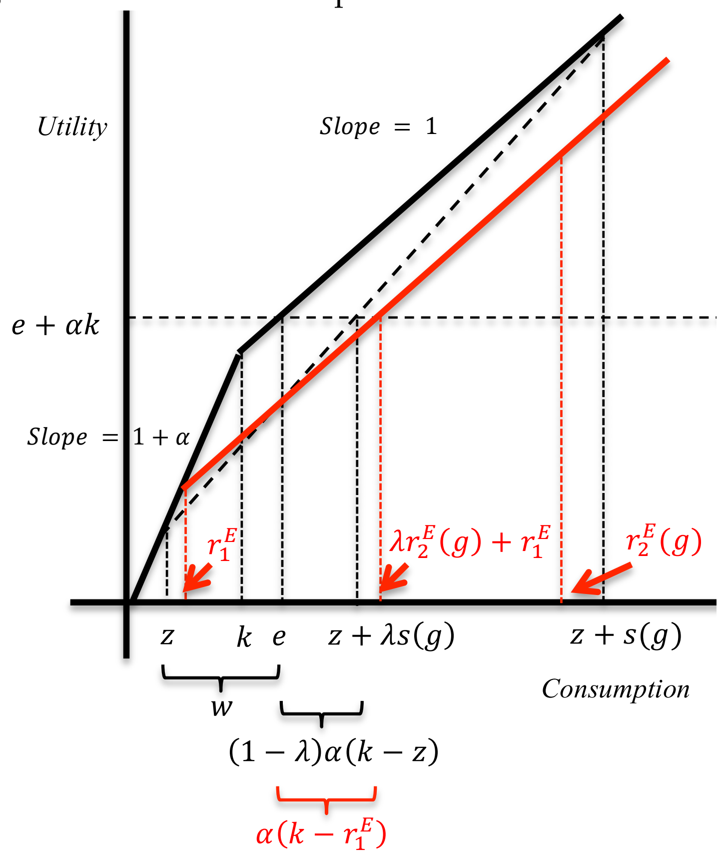
or

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

Q.E.D.

In Figure 4 we show graphically that, if $\lambda(k - z) > \frac{\gamma}{1-\lambda}$ (a violation of the condition in Proposition 4), firms finance the project in capital markets and not through distortionary intermediaries. When intermediaries distort risk-sharing the utility function effectively changes. The reason is that the bank pays $r_1^E = z + \frac{\gamma}{1-\lambda} < k$ with certainty in the first period (delivering marginal utility $1+\alpha$) and then provides a lottery that pays in the second period (delivering a marginal utility of just 1). The utility function then becomes as depicted in red, with a kink located at r_1^E.

Figure 4: Case in which Capital Markets Dominate Banks



In both cases the welfare loss is given by $\lambda s(g) - w$. In capital markets, $s(g) = \frac{w}{\lambda} + \frac{\alpha(1-\lambda)}{\lambda}(k-z)$ and the loss is given by $\alpha(1-\lambda)(k-z)$. With distorting financial intermediaries $s(g) = \frac{w}{\lambda} + \frac{\alpha}{\lambda}\left[k - z - \frac{\gamma}{1-\lambda}\right]$ and the loss is given by $\alpha(k - r_1^E)$. 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 at a lower rate in capital markets.

3.2 Distorting investment

Assume now that the project is divisible and it is possible for the bank to invest in just a fraction η of the project and to store the rest of the deposits (for example in Treasury bonds or other safe assets).[3] An alternative view is that a bank finances the project only with probability η, which can be interpreted as credit rationing. We show banks can distort investment in order to discourage information acquisition.

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

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

where $\psi \equiv \left(1 - \frac{\alpha w(1-\lambda)}{\lambda x - w}\right)$, which is implemented by providing funds for only a fraction η of the original project.

Proof How can the bank distort investment in the project to avoid information acquisition? Since the expected benefits for late consumers from acquiring information are given by $(1-\lambda)[e - r_2^L(b)]$, and their costs are γ, banks can discourage information acquisition by promising late consumers $e - \frac{\gamma}{1-\lambda}$ or more, as in equation (7).

Banks can publicly store a fraction $(1-\eta)$ of the endowment e of early consumers, or invest in the whole first project just with probability η, even when it is ex-ante efficient to always invest in the project.

Since in this section we allow for efficient risk-sharing, the bank promises to pay k at $t = 1$ to the early consumer, what remains for the late consumer in case of a bad shock is $r_2^L(b) = \eta(e+z-k) + (1-\eta)(e+z-k+w) = e+z-k+(1-\eta)w$ (with probability η we have the same situation as above, and with probability $(1-\eta)$ the bank stores the endowment of early consumers without spending w on 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

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

[3] This analysis is isomorphic to imposing capital requirements under which banks are mandated by regulation to invest a fraction of deposits in safe assets.

and then the investment distortion that allows for optimal risk-sharing when $k - z > \frac{\gamma}{1-\lambda}$ and there are otherwise incentives for late consumers to acquire information is

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

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

$$E(U_F^{Dist}) = E(U_F^{FB}) - (1-\eta)(\lambda x - w).$$

This implies that the loss from distorting investment is

$$(1-\eta)(\lambda x - w) = \left(\frac{k-z}{w} - \frac{\gamma}{w(1-\lambda)}\right)(\lambda x - w).$$

Banks that distort investment dominate capital markets if

$$\left(k - z - \frac{\gamma}{1-\lambda}\right)\frac{\lambda x - w}{w} < \alpha(1-\lambda)(k-z).$$

Then

$$\left(1 - \frac{\alpha w(1-\lambda)}{\lambda x - w}\right)(k-z) < \frac{\gamma}{1-\lambda},$$

Q.E.D.

Finally, we obtain the conditions under which it is better to distort risk-sharing than to distort investment, just from comparing λ and ψ from Propositions 4 and 5.

Proposition 6 *Banks prefer to distort risk-bearing rather than investment if*

$$\lambda x > (1+\alpha)w.$$

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

$$\alpha\left[k - z - \frac{\gamma}{1-\lambda}\right] < \frac{\lambda x - w}{w}\left[k - z - \frac{\gamma}{1-\lambda}\right].$$

Q.E.D.

Intuitively, banks distort risk-sharing rather than investment when the welfare costs of risk-sharing (captured by $(1+\alpha)w$) are lower than the welfare costs of not financing the first project (captured by the gains per unit of investment x times the probability of success λ). Then, it is clear that banks are more likely to distort risk-sharing when liquidity needs are small (low α), when the relative cost of the projects is small (low w), or when projects are very likely to succeed and pay a lot in case of success (high λ and high x).

4 Coexistence of banks and capital markets

In this section we assume there are many, potentially heterogenous, projects that need financing in the economy and characterize which projects are financed by banks that replicate first best, which ones are financed by banks that have to distort risk-sharing or investment (not implementing the first best because they need to avoid information acquisition) and which ones are financed by capital markets.

We replicate the previous analysis performed for a single early consumer, a single late consumer, a single bank and a single project in an economy with a continuum of early consumers, a continuum of late consumers, a continuum of banks and a continuum of projects i characterized by pairs (λ_i, γ_i), their probability of success and monitoring costs.

Assume a mass 1 of each agent's type and assume that each bank forms a match with a single early and a single late consumer and finances a single project. The cost of financing each project is w; each early consumer has endowment e at $t = 0$, and each late consumer has endowment e at $t = 1$. Preferences, technologies, information and the problem for each single individual are exactly the same as specified in the case for a single project. Since we assume the realization of projects are i.i.d., then effectively financing each project has exactly the same characterization as in the previous analysis.

The following proposition show how projects are sorted in their financing.

Proposition 7 *Coexistence of Banks and Capital Markets*

First projects are not financed if $\lambda_i < \frac{w}{x}$ (and first projects are ex-ante inefficient).

First 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-sharing if

$$\lambda_i \leq \frac{\gamma_i}{(1-\lambda_i)(k-z)} < 1 \qquad \textit{and} \qquad \lambda_i x \geq (1+\alpha)w$$

and they are financed by banks that distort investment if

$$\psi_i \leq \frac{\gamma_i}{(1-\lambda_i)(k-z)} < 1 \qquad \textit{and} \qquad w \leq \lambda_i x < (1+\alpha)w.$$

Finally, first projects are financed in capital markets if

$$\frac{\gamma_i}{(1-\lambda_i)(k-z)} < \lambda_i \qquad \textit{and} \qquad \lambda_i x \geq (1+\alpha)w$$

or

$$\frac{\gamma_i}{(1-\lambda_i)(k-z)} < \psi_i \qquad \textit{and} \qquad w \leq \lambda_i x < (1+\alpha)w.$$

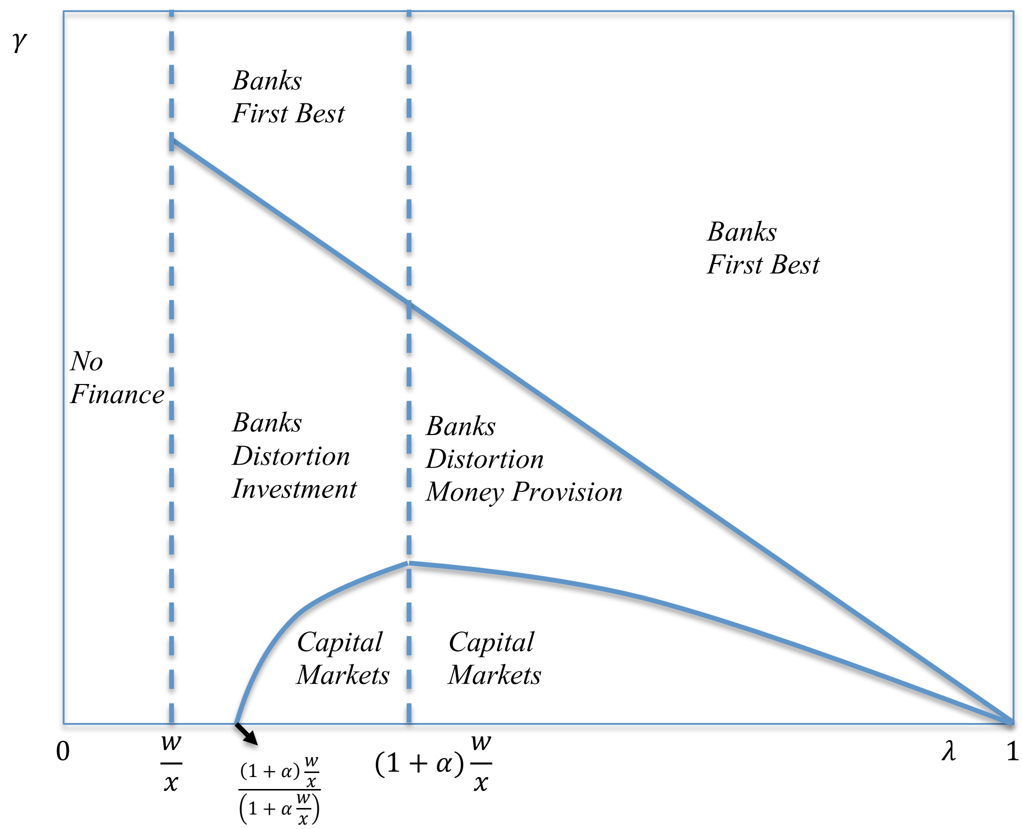
These regions arise trivially from combining Propositions 4-6 for a single project. The Proposition is displayed in Figure 5.

The assumption of i.i.d. projects is critical to sort projects as described above. As an illustration, take the extreme opposite case of perfect correlation across projects (if one succeeds, all succeed). In this case, it is easy to see that if a late consumer observes that a firm financing the first project in capital markets does not try to finance a second project also in capital markets, then no late consumer would be willing to deposit in the bank because they can infer that all other first projects in the economy have failed. In this extreme case, then, correlation destroys the possibility of using banks at all to improve welfare.

5 Optimal portfolio and bank capital

In this section we assume that a single bank finances two projects using the funds from two identical early consumers and two identical late consumers. This is enough to capture how the bank can exploit a combination of projects to avoid information acquisition. We also assume each late consumer can choose to privately learn about the quality of one, and only one, project at a cost γ. As will become clear later, intro-

Figure 5: Regions of Financing



ducing more projects just complicates the analysis without adding any new insight to the main conclusions derived with just two projects.

5.1 Optimal portfolio

We state three propositions, the proof of which are in the Appendix. First, if the two projects are identical and independent of each other, financing both discourage information acquisition more than financing just one, justifying economies of scale in the banking sector.

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*

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

Hence, banks can implement first best outcomes even if $\gamma = 0$ since $e > k + \frac{w}{2}$.

Second, if there is correlation across two identical projects, it is more difficult for banks to discourage information acquisition. We assume that, with a probability ρ 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 χ. We redefine the ex-ante probability of success for each project as $\lambda = \rho + (1 - \rho)\chi$ to facilitate the comparison with the previous proposition. This suggests the optimal portfolio of banks should be composed by projects that are uncorrelated.

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*

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

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

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.

Finally, assume the two projects differ in their probability of success and their costs of monitoring (λ_1, γ_1) and (λ_2, γ_2), but their results are independent of 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 across 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. Given the assumption that $e > k + \frac{w}{2}$ it is not necessary to rely on cross subsidization to avoid information acquisition, even for $\gamma = 0$.*

5.2 Bank capital

Assume now that agent B, who serves as a banker, receives a deterministic endowment e_B at $t = 2$ and it is able to issue a claim against those cash flows, committing to use them as "bank capital". Access to this endowment is important in reducing incentives for late consumers to acquire information during the intermediate period. The following Proposition formalizes this result, proved in the Appendix.

Proposition 11 *It is easier for banks to avoid information acquisition if they have an endowment e_B at $t = 2$ that can be used as "bank capital". Banks can implement the first best outcome if*

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

Banks can implement first best outcomes even if $\gamma = 0$ when $e > k + w - e_B$.

Intuitively, if the banker can ex-ante commit some of its own endowment in the last period to compensate late consumers in case the first project fails, then he can avoid information acquisition and still implement the first best by providing a buffer on the losses of the late consumers that discourage their information acquisition. The bank compensates for providing this buffer by promising less payments to late consumers in case the project succeeds. Even though we have assumed for simplicity that all the surplus goes to the firm, it is natural to think that part of the surplus goes to the bank, having positive incentives to participate in this arrangement and putting its own endowment at stake as bank capital.

6 Overlapping generations

In this section we extend the previous developing an overlapping generations structure where the firm has the same investment opportunities as before in periods $t = 0$ and $t = 1$, but the projects mature and pay out at an arbitrary date $T \geq 2$, which is unknown ex-ante. More specifically, conditional on the projects not having paid out in a given period t, the probability the projects pay out during the next period, $t + 1$, is a positive constant ν.

This extension just introduces a longer gap between the time projects are financed and the time projects pays out, which is filled by the participation of generations that only live for three periods and overlap over time. The main goal of this extension is to show that, when considering more than three periods, the banking contract for all generations, except the two involved with the bank at the time the projects mature, is unconditional on the projects' results, then corresponding more closely to standard demand deposits whose payments are independent of the performance of the bank portfolio. Only when projects mature payments are conditional on results and hence those two generations effectively operate as bank holders.

The next proposition shows that the contract indeed looks identical to the one we study in our benchmark above, and independent of the probability projects mature.

Proposition 12 *When the time T at which projects mature is uncertain, all generations participating during $t < T$ obtain non-contingent payments, while generations participating at $t = T$ receive the same contingent payments as in the benchmark. None of these payments depend on the probability of projects maturing ν.*

Proof We start with consumers who born at $t = 0$. This initial generation faces the possibility (with probability ν) that the projects mature in $T = 2$, in which case the problem is identical to the one in the benchmark, receiving k in $t = 1$ (to implement the first best) and $r_2^E(g)$ or $r_2^E(b) = 0$, depending on the result of the project, in $t = 2$.

However, in this setting, with the complementary probability $1 - \nu$, the projects do not mature in period $T = 2$, in which case the payment to these consumers in $t = 2$ should be non-contingent on the realization of the project, which is information the bank does not have. Since the consumer obtained k in period $t = 1$, then in this situation when the projects do not mature the bank has to compensate the consumer with $e - k$ in $t = 2$.

Is this feasible? When projects do not mature in period $t = 2$, conditional on consumer who borns in $t = 2$ depositing e (we check next this is the case), the bank can always pay $e - k$ to consumers who deposited in $t = 0$ and k to consumers who deposited in $t = 1$. In this sense, when projects do not mature, the bank that keeps secrets allows for overlapping generations to just transfer funds optimally across them.

Now we show that the promise $r_2^E(g)$ that banks have to make to induce consumers who born in period $t = 0$ to deposit is identical to the promise to late consumers in the benchmark. Assuming $r_2^E(b) = 0$, which is the payment that minimizes the incentives to acquire information about the bank's secrets, consumers who born in period $t = 0$ are indifferent between depositing or not when

$$\nu\left[(1+\alpha)k + \lambda r_2^E(g)\right] + (1-\nu)\left[(1+\alpha)k + e - k\right] = e + \alpha k$$

or similarly, when

$$\nu\left[(1+\alpha)k + \lambda r_2^E(g)\right] = \nu[e + \alpha k]$$

which is exactly the equation that determines $r_2^E(g) = \frac{e-k}{\lambda}$ in the benchmark model. Recall this result is independent of the probability projects mature in $T = 2$.

Now we can focus on all other consumers, who born at $t > 0$. These consumers face the probability the projects mature in $t+1$ and, if not, that they mature in $t+2$. If projects mature in $t+1$, consumers' problem becomes that of late consumers in the benchmark as they immediate receive either $r_{t+1}^L(g)$ or $r_{t+1}^L(b)$, depending on the realization of the first project. If projects mature in $t+2$, consumers' problem becomes that of early consumers as we described above – they receive k in $t+1$ and either $r_{t+2}^E(g)$ or $r_{t+2}^E(b) = 0$, depending on the realization of the projects. Finally, if projects do not mature in neither $t+1$ nor $t+2$ consumers receive non contingent payments k in $t+1$ and $e-k$ in $t+2$, which is feasible as previously discussed.

At the moment T projects mature there are always two generations participating in the banking contract. Generation $T-1$ takes the place of "late" consumers, then we denote their payments as $r_t^L(i)$, while generation $T-2$ takes the place of "early" consumers, then we denote their payments as $r_t^E(i)$, with $i \in \{b, g\}$.

Now we show that the promises that banks have to make to induce consumers who born in period $t > 0$ to deposit are identical to the promises to early and late consumers in the benchmark. Assuming $r_{t+1}^E(b) = 0$, by resource constraints $r_{t+1}^L(b) = A_b$. Then, consumers that born in period $t > 0$ are indifferent between depositing or not when

$$\begin{aligned}
&\nu\left[(1+\alpha)k + \lambda(r_{t+1}^L(g) - k) + (1-\lambda)(A_b - k)\right] + \\
&(1-\nu)\left[(1+\alpha)k + \left(\nu\lambda r_{t+2}^E(g) + (1-\nu)(e-k)\right)\right] = e + \alpha k
\end{aligned}$$

From the previous analysis $r_{t+2}^E(g) = \frac{e-k}{\lambda}$, and then this condition is simply

$$\nu\left[(1+\alpha)k + \lambda(r_{t+1}^L(g) - k) + (1-\lambda)(A_b - k)\right] = \nu[e + \alpha k]$$

which determines

$$r_{t+1}^L(g) = e + \frac{(1-\lambda)}{\lambda}[w + k - e] > e, \tag{12}$$

exactly as $r_2^L(g)$ in the benchmark model. Recall this result is also independent of the probability ν projects mature in future periods. Q.E.D.

Even though the promises that implement first best allocations do not depend on the probability that projects mature during the next period, ν, depositors' incentives to acquire information about the bank's portfolio do depend on that probability. Given the promises obtained above, the expected gains for a consumer to deposit his endowment in the bank at time t without producing information is

$$\begin{aligned} &\nu \left[(1+\alpha)k + \lambda(r_{t+1}^L(g) - k) + (1-\lambda)(A_b - k)\right] + \\ &(1-\nu)\left[(1+\alpha)k + \nu\lambda r_{t+2}^E(g) + (1-\nu)(e-k)\right] = e + \alpha k. \end{aligned}$$

In contrast, the net expected gains from producing information about the portfolio of the bank at a cost γ is

$$\begin{aligned} &\nu \left[(1+\alpha)k + \lambda(r_{t+1}^L(g) - k) + (1-\lambda)(e - k)\right] + \\ &(1-\nu)\left[(1+\alpha)k + \nu\left(\lambda r_{t+2}^E(g) + (1-\lambda)(e-k)\right) + (1-\nu)(e-k)\right] - \gamma \end{aligned}$$

Hence, there are no incentives to acquire information (the first expression is larger than the second) as long as

$$\nu(1-\lambda)\left[(e - A_b) + (1-\nu)(e-k)\right] < \gamma.$$

This leads to the next Proposition.

Proposition 13 *When consumers are able to learn privately about the quality of projects at a cost γ, banks can implement the first best allocation only if*

$$\nu\left[(k - z) + (1-\nu)(e-k)\right] \leq \frac{\gamma}{1-\lambda}$$

This condition for information acquisition when we allow for the possibility of projects not maturing in the future differs from the benchmark in Proposition 3. In the benchmark only late consumers had the potential to acquire information because the information accrues in $t = 1$, while in this extension consumers act potentially both as late consumers (if projects mature the period after depositing, with probability ν) and as early consumers (if projects mature two periods after depositing, with probability ν^2). Both possibilities introduce incentives to learn about the bank's portfolio, depositing when projects are good and not depositing when projects are bad.

The incentives to acquire information increase with the probability the projects mature in the foreseeable future. Furthermore, there is a low enough $\bar{\nu} > 0$ such that for all $\nu < \bar{\nu}$ there is no information acquisition and the first best allocation is implementable. Interestingly, since the payments that sustain the first best allocation do not depend on ν, the perceptions about the likelihood that projects mature can vary over time, only affecting the incentives to acquire information over time and then the needs for distortions.

7 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.

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A Appendix

A.1 Proof Proposition 8.

If the bank finances two original projects, with funds from two early consumers, there are three possible states:

- With probability λ^2 both original projects are successful (gg), and the bank's assets at $t = 2$ are $2[A_b + s(g)]$.
- With probability $2\lambda(1 - \lambda)$ only one original project is successful (gb or bg), and the bank's assets at $t = 2$ are $2A_b + s(g)$.
- With probability $(1-\lambda)^2$ neither original project is successful (bb), and the bank's assets at $t = 2$ are $2A_b$.

In this proof we study the conditions for the bank to implement the first best, hence we require banks to pay each early consumer $r_1^E = k$ at $t = 1$ and to charge firms $s(g) = \frac{w}{\lambda}$, which we know maximizes 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

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

where

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

are the expected payoffs of a late consumer who finds out that 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 who finds out that 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 $r_2^L(bb) = A_b$. Assume this is also the case when one project fails, that is $r_2^E(gb) = r_2^E(bg) = 0$. Then, from the resource constraint when one project fails, $r_2^L(gb) = r_2^L(bg) = A_b + s(g)/2$, since the two late consumers are identical and the proceeds 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

$$r_2^E(gg) = \frac{e-k}{\lambda^2}. \tag{13}$$

Using this result in the resource constraint when both projects succeed:

$$r_2^L(gg) = A_b + s(g) - \frac{e-k}{\lambda^2}. \tag{14}$$

Using these results in the break-even condition for the late consumer it is clear that the expected utility from depositing in a bank should be exactly $e + \alpha k$:

$$(1+\alpha)k + \lambda^2(r_2^L(gg) - k) + 2\lambda(1-\lambda)(r_2^L(gb) - k) + (1-\lambda)^2(r_2^L(bb) - k) = e + \alpha k.$$

or alternatively, simply

$$\lambda^2 r_2^L(gg) + 2\lambda(1-\lambda) r_2^L(gb) + (1-\lambda)^2 r_2^L(bb) = e.$$

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

$$E(r^L|b) = 2e - k - \frac{w}{2},$$

while the expected gains for late consumers from depositing when observing a project succeeding are

$$E(r^L|g) = e - \frac{(1-\lambda)}{\lambda}\left[e - k - \frac{w}{2}\right].$$

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

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

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 $e > k + \frac{w}{2}$, $E(r^L|b) > e$ and $E(r^L|g) < e$, then 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 $E(r^L|g) = E(r^L|b) = e$, eliminating the incentives to acquire information regardless of information costs. The intuitive way for banks to achieve this result is to still pay $r_2^E(bb) = 0$ but $r_2^E(bg) = r_2^E(gb) > 0$, 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 $r_2^L(bb) = A_b$ and we want to achieve $E(r^L|b) = e$, then

$$r_2^L(bg) = r_2^L(gb) = \frac{e - (1-\lambda)A_b}{\lambda}. \tag{15}$$

From the resource constraint in the case where only one project succeeds

$$r_2^E(bg) = r_2^E(gb) = \frac{e-k}{\lambda} - \frac{w}{2\lambda} > 0. \tag{16}$$

From early consumers breaking even

$$(1+\alpha)k + 2\lambda(1-\lambda)r_2^E(bg) + \lambda^2 r_2^E(gg) = e + \alpha k,$$

we obtain

$$r_2^E(gg) = \frac{e-k}{\lambda^2} - \frac{2(1-\lambda)}{\lambda^2}\left(e - k - \frac{w}{2}\right). \tag{17}$$

Finally, from the resource constraint when both projects succeed

$$r_2^L(gg) = A_b + \frac{w}{\lambda} - \frac{e-k}{\lambda^2} + \frac{2(1-\lambda)}{\lambda^2}\left(e - k - \frac{w}{2}\right). \tag{18}$$

Finally, substituting these results into the break even condition for each late consumer, the expected gains from depositing in the banks are exactly $e + \alpha k$.

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

A.2 Proof Proposition 9.

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

- With probability $\rho + (1-\rho)\chi^2$ both projects are successful (gg), and the bank's assets at $t = 2$ are $2[A_b + s(g)]$.
- With probability $2(1-\rho)\chi(1-\chi)$ only one project is successful (gb or bg), and the bank's assets at $t = 2$ are $2A_b + s(g)$.
- With probability $(1-\rho)(1-\chi)^2$ no project is successful (bb), and the bank's assets at $t = 2$ 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:

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

where

$$E(r^L|b) = \chi r_2^L(bg) + (1-\chi) r_2^L(bb),$$

and

$$E(r^L|g) = Pr(gg|g) r_2^L(gg) + (1 - Pr(gg|g)) r_2^L(gb),$$

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

When both projects fail, $r_2^E(bb) = 0$ and $r_2^L(bb) = A_b$. Assume that, if only one project fails, $r_2^E(gb) = r_2^E(bg) = 0$. From the resource constraint when only one project fails,

$$r_2^L(gb) = r_2^L(bg) = A_b + \frac{s(g)}{2}. \tag{19}$$

From the break even condition of the early consumer

$$r_2^E(gg) = \frac{e-k}{\rho + (1-\rho)\chi^2}. \tag{20}$$

From the resource constraint when both projects succeed

$$r_2^L(gg) = A_b + s(g) - \frac{e-k}{\rho + (1-\rho)\chi^2}. \tag{21}$$

Substituting these results into the break-even condition for the late consumer, the expected gains from depositing in the banks are exactly $e + \alpha k$. This implies that these promises are feasible and late consumers' expected gains from depositing are

$$E(r^L|b) = 2e - k - w - \chi\frac{w}{2\lambda}.$$

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

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

or

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

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 $e > k + \frac{w}{2}\left[2 - \frac{\chi}{\lambda}\right]$, then $E(r^L|b) > e$ and $E(r^L|g) < e$. In this case, there are enough resources to make promises such that $E(r^L|g) = E(r^L|b) = e$, eliminating incentives to acquire information for all $\gamma \geq 0$. The intuitive way for banks to achieve this result is to promise $r_2^E(bb) = 0$ but $r_2^E(gb) = r_2^E(bg) > 0$, which reduces expected payoffs for late consumers in case they observe a project fail.

Since $r_2^L(bb) = A_b$ and banks want to achieve $E(r^L|b) = e$,

$$r_2^L(bg) = \frac{e - (1-\chi)A_b}{\chi}.$$

From the resource constraint in the case only one project succeeds,

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

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, substituting these results into the break-even condition for the late consumer, expected gains from depositing in the banks are exactly $e+\alpha k$.

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 $\gamma \geq 0$.

A.3 Proof Proposition 10.

If the bank finances two different original projects, there are four possible states:

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

$$\lambda_1\left(\max\{E(r^L|g_1),e\} - E(r^L|g_1)\right) + (1-\lambda_1)\left(\max\{E(r^L|b_1),e\} - E(r^L|b_1)\right) \leq \gamma_1$$

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 that 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 is:

$$\lambda_2\left(\max\{E(r^L|g_2),e\} - E(r^L|g_2)\right) + (1-\lambda_2)\left(\max\{E(r^L|b_2),e\} - E(r^L|b_2)\right) \leq \gamma_2,$$

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 $r_2^L(bb) = A_b$. Assume this is also the case when only one project fails, this is $r_2^E(gb) = r^E(bg) = 0$. Then, from the resource constraint in those situations, $r_2^L(gb) = A_b + s_1(g)/2$ and $r_2^L(bg) = A_b + s_2(g)/2$, since the two late consumers are identical and the proceeds 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

$$r_2^E(gg) = \frac{e-k}{\lambda_1\lambda_2}. \tag{22}$$

From the resource constraint when both projects succeed

$$r_2^L(gg) = A_b + \frac{s_1(g)}{2} + \frac{s_2(g)}{2} - \frac{e-k}{\lambda_1\lambda_2}. \tag{23}$$

The expected gains for a late consumer from depositing are:

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

and replacing the promises to the late consumer derived above

$$A_b - (e-k) + \lambda_1 \frac{s_1(g)}{2} + \lambda_2 \frac{s_2(g)}{2}.$$

These expected gains for a late consumer from depositing are equal to $e + \alpha k$ if

$$\lambda_1 \frac{s_1(g)}{2} + \lambda_2 \frac{s_2(g)}{2} = w. \tag{24}$$

In the first best, $s_1(g) = \frac{w}{\lambda_1}$ and $s_2(g) = \frac{w}{\lambda_2}$, which implies that these promises are feasible. The expected gains for a late consumer after privately observing the result of a project $i \in \{1, 2\}$ are:

$$E(r^L|b_i) = 2e - k - \frac{w}{2}$$

and

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

If $e < k + \frac{w}{2}$, then $E(r^L|b_i) < e$ and $E(r^L|g_i) > e$. This implies that late consumers, regardless of which project they investigate, would deposit in banks when privately observing the project succeed and store the money if privately observing the project fail. The condition for not acquiring information about any of the projects is,

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

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 restrictions to implementing the first best, and no distortion is needed.

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

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

which implies

$$s_1(g) < \frac{w}{\lambda_1}$$

from equation (24).

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

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

or

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

and from equation (24),

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

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

$$s_2(g) \leq \frac{w + \alpha(1-\lambda_2)(k-z)}{\lambda_2},$$

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

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

Given our assumption that $e > k+\frac{w}{2}$, then $E(r^L|b_i) > e$ and $E(r^L|g_i) < e$ and then cross subsidization is not even needed to avoid information acquisitions as shown in the previous proposition.

A.4 Proof Proposition 11.

Assume the bank has an observable endowment e_B at $t=2$, and it is able to commit to use it as capital when issuing claims. We study the conditions for the bank to implement the first best allocation, paying the early consumer $r_1^E = k$ at $t=1$ and charging the firm $s(g) = \frac{w}{\lambda}$ for the original project, while still breaking-even and generating in expectation $E(U_B) = e_B$. Under what conditions is this contract feasible and implementable (no incentives for information acquisition).

Assume a project that induces late consumers to acquire information, i.e.,

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

To avoid information acquisition, from equation (6), the bank has to promise late consumers

$$r_2^L(b) = e - \frac{\gamma}{1-\lambda} > e-k+z$$

in case the project fails.

To cover the difference between the maximum the bank can promise to the late consumer only using firm's funds and paying k to early consumers and the amount that prevents information acquisition, the bank should contribute, as bank capital

$$e_B^k = \min\left\{k-z-\frac{\gamma}{1-\lambda}, e_B\right\}.$$

If

$$k-z-\frac{\gamma}{1-\lambda} < e_B,$$

which is the condition in the proposition, the bank has enough resources to implement the first best allocation. Assume this is the case. Are the promises feasible to make the bank willing to post its own endowment as capital?

When paying late consumers $r_2^L(b)$ as above to avoid information acquisition, they are indifferent between depositing in the bank or not if:

$$\lambda r_2^L(g) + (1-\lambda)\left[e - \frac{\gamma}{1-\lambda}\right] = e,$$

which implies

$$r_2^L(g) = e + \frac{\gamma}{\lambda}.$$

In the first best allocation, $r_1^E = k$ and $r_2^E(g) = \frac{e-k}{\lambda}$. Then, from resource constraints in the case the project is successful,

$$e + z + \frac{w}{\lambda} + e_B^k = k + \frac{e-k}{\lambda} + e + \frac{\gamma}{\lambda} + r_2^B(g),$$

which implies

$$r_2^B(g) = \frac{e_B^k}{\lambda}.$$

It is clear that there are enough resources to make the banker indifferent between not setting up a bank or setting up a bank and committing capital e_B^k, obtaining $r_2^B(b) = 0$ if the project is a failure and $r_2^B(g)$ if the project is a success.

Bank capital can implement the first best allocation if $e_B^k \leq e_B$. If $e_B^k > e_B$, the first best cannot be implemented, but welfare can still be improved through the distortions analyzed above.