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Abstract

In an imperfect information economy with investment complementarities, market-based financial systems suffer from excessive volatility which leads to underinvestment. When financial intermediaries offer returns with low risk, intermediation improves coordination among investors, thereby enhancing efficiency and stabilizing the economy against macroeconomic shocks, entailing an *ex ante* Pareto improvement compared to the market-based allocation. However, the position of the intermediaries is fragile and competition from financial markets constrains intermediaries so that they have no incentives to improve the market allocation. Possible solutions to this problem and the optimal design of regulation are discussed. Other types of financial architecture, in which intermediation does not play a stabilizing role, are investigated.

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"What we perceived in the United States in 1998 may reflect an important general principle: Multiple alternatives to transform an economy's savings into capital investment act as backup facilities should the primary form of intermediation fail. In 1998 in the United States, banking replaced the capital markets. Far more often it has been the other way around, as it was most recently in the United Sates a decade ago."

Alan Greenspan (1999).

1 Introduction

In the early 1990s several OECD countries were adversely affected by a credit crunch. In particular, this shock had a dramatic effect on the amount of borrowing in the US. As illustrated in figure 1, the value of real loans decreased but, surprisingly, the collapse of intermediated credit did not affect the debt securities market. In 1998, during the crisis following the Russian default and leading to the failure of the hedge fund LTCM, the situation was reversed. While the real value of debt securities issued in the US fell by almost half, there was a strong turnaround in intermediate lending. Somehow the banking system was able to smooth the turbulence in the debt securities market. Looking at figure 1, there is a broad pattern of compensation by the market less severely affected by the turbulence. As a result, the US economy suffered little during these episodes.

Using these events and the examples of Sweden, Japan, Australia and the 1997 East Asian financial crisis, Alan Greenspan (1999, 2000) has suggested that multiple sources of finance help to protect economies against systemic problems affecting financial systems.

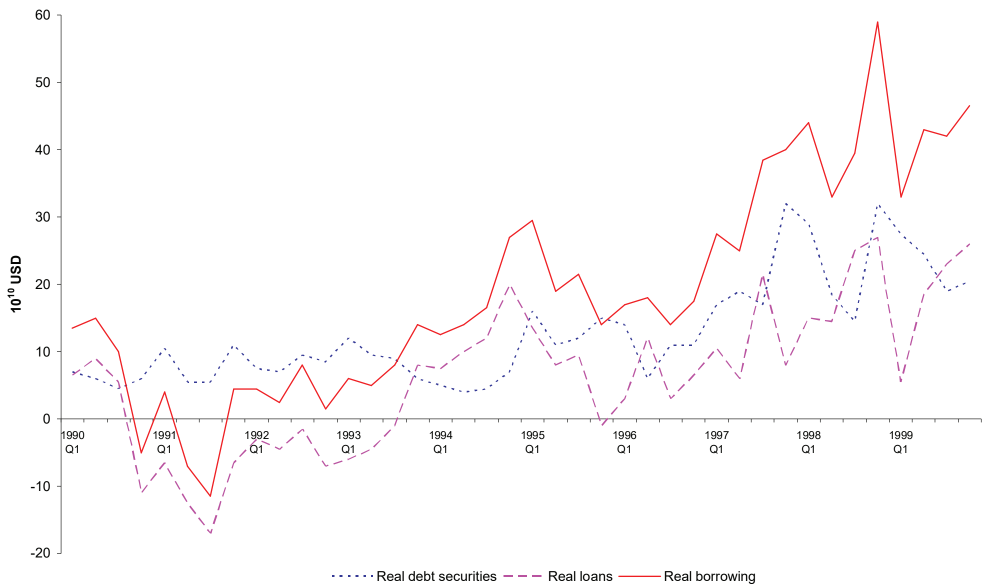

Figure 1: US corporate debt securities issuance and intermediated borrowing (1995 prices). Notes: The variable "Real debt securities" is corporate bond issuance plus commercial paper deflated by the CPI, while the variable "real loans" is bank lending, mortgages and other loans to companies, similarly deflated. "Real borrowing" is the sum of these two components. Source: Davis (2001) used quarterly data on funds raised in the credit market by non-financial corporations obtained from the "Flow of Funds Accounts of the United States" published by the Federal Reserve Board.

The purpose of this paper is to propose a framework which explains how the *architecture* of the financial system - the relative roles of banks and decentralized markets - interacts with systematic risk and affects the real sector.

This paper examines an economy with investment complementarities, where the return from investing in the real sector is determined by the state of the fundamental variables in the economy and by an externality associated with the mass of investors. This externality arises as a consequence of synergies among investment projects and, as a result, the return on investment projects improves if the number of investors is large. In the model, the mass of investors, and therefore the size of the externality, are endogenous variables. Introducing this effect seems to be a reasonable approach since it raises the issue of coordination among investors (as they take into consideration the behavior of other players when deciding whether to invest or not) which seems to be an especially relevant feature in financial markets. Were coordination perfect, any externality losses would be completely eliminated. Yet, imperfect information prevents perfect coordination and the existence of investment externalities creates feedback mechanisms through which exogenous shocks gather *momentum* from the endogenous responses of the market participants themselves. As a result, the amount of volatility of macroeconomic variables is determined endogenously together with the level of coordination among investors. For market-based financial systems, the model predicts an equilibrium characterized by underinvestment and a significant level of systematic risk.

Conventional financial theory says little about hedging *nondiversifiable* risks. It postulates that the set of assets is fixed and focuses on the efficient sharing of risks through exchange. Diversification does not eliminate aggregate shocks which affect all assets in a similar way. In an Arrow-Debreu world, risk sharing is done automatically because markets are complete and institutions play a negligible role in hedging risks. In practice, though, markets may not be complete for a variety of reasons, namely imperfect information. None of the traditional approaches provides much insight into the relationship between the institutional structure of the financial system, the stock of real assets, and asset returns. The contribution of this paper, with respect to the traditional approaches, is to consider a setup in which there is heterogeneous information and the stock of assets, as well as their returns, are endogenous. In this framework, *public information* serves as a focal point for the beliefs of the group of investors as a whole and becomes very effective in influencing the individuals' actions. As a result, the available structure of information partially determines aggregate investment and the level of systematic risk. A relative novelty of this work is that these two variables are not independent of each other.

This paper uncovers the important role of financial intermediaries for hedging *non-diversifiable* risks, thereby facilitating coordination among investors and improving efficiency. The key idea is that financial intermediation expands the available investment set beyond the frontier of investment possibilities accessible with direct finance. Intermediation can be seen as a *coordination device* that modifies the relationship between *private* and *public information* and helps investors solve the coordination problem. I compare financial systems based exclusively on direct finance with the case in which financial intermediaries offer instruments with low risk. In the former systems, imperfect information impairs coordination among agents and depresses investment. In the latter case, intermediaries provide insurance against systematic risk and alleviate the harmful effects of imperfect information. In this case, many pessimistic agents do not refrain from investing as they can choose to invest through a bank. As a result, agents anticipate high synergies which create an environment favorable to investment.

This contribution raises the possibility that financial institutions emerge endogenously. Still, competition from decentralized markets can lead to an insufficient level of intermediation as banks are unable to extract all social gains from transforming funds into productive investment in firms and may have no incentives to undertake their activity. As a consequence of *under-intermediation*, there is a role for the regulator to redistribute the efficiency gains generated by the intermediation sector. Factors determining the optimal design of regulation are the structure of information and the existence of a monitoring technology.

This analysis relates to a number of strands in the literature. On the game theoretical side, the paper builds upon recent work focusing on the mechanisms through which agents make decisions when information is imperfect and coordination is important for the final payoffs. This literature had its origin in the study of *global games* by Carlsson and van Damme (1993) and was fostered by Morris and Shin (1998). Although this literature has been extensively applied to finance, it has been less used in other fields of economics.[1] Interesting applications to macroeconomics were made by Morris and Shin

[1] Some interesting examples in finance are applications to currency markets (Morris and Shin 1998), risk management and financial crisis (Danielsson and Shin 2003), liquidity black holes in stock markets

(2001), Woodford (2002) and Angeletos and Pavan (2004). Recently, Hellwig, Mukherji and Tsyvinsky (2005) and Angeletos and Werding (2006) have underlined the importance of endogenous information, and in particular the role of asset prices as a public signal aggregating dispersed *private information*. I do not pursue this line of research, as it would unnecessarily complicate the analysis without producing new insights. Instead, I investigate whether financial institutions have incentives to modify the structure of *public information* by enlarging the investment set available to investors.

I am not the first to aim at building a framework that helps to explain financial architecture. This effort adds to a small amount of recent literature concerned with the coexistence of direct and intermediated finance. Previous papers have modeled the choice between market and bank finance by considering an entrepreneurial moral hazard problem that can be ameliorated through (costly) bank monitoring. Holmstrom and Tirole (1997) and Repullo and Suarez (2000) examine the role of the net worth of firms in the distribution of external finance. Probably the most complete model explaining the demand for finance is the one by Bolton and Freixas (2000). By assuming that bank debt is easier to renegotiate and the existence of dilution costs, the authors justify why firms demand bank loans, private debt, and equity. Yet, most studies concentrate solely on the choice of finance by the firm, while I am mainly concerned with the supply of finance. Some authors offer an integrated view of the demand and supply of funds, namely Boot and Thakor (1997) and Gorton and Pennacchi (1990). For Boot and Thakor (1997),

(Morris and Shin 2004), banking system and the role of lender of last resort (Rochet and Vives 2004), pricing of debt (Shin 2008), fair value accounting and financial stability (Plantin, Sapra and Shin 2008), among others.

financial markets permit noncolluding informed agents to compete and convey valuable information to the firms. Although banks do not have any informational advantage, they coordinate uninformed traders and resolve moral hazard problems. Gorton and Pennacchi (1990) argue that informed agents collude to exploit liquidity traders. Liquidity traders break the informed traders coalition by creating a bank. Banks mitigate informational asymmetries by splitting the cash flows of the assets in the economy. I borrow from Gorton and Pennacchi (1990) the security design approach and the fact that financial intermediaries may provide safer securities to their depositors. Gersbach and Uhlig (2007) consider that banks and markets have distinct abilities when dealing with a pool of borrowers plagued simultaneously by moral hazard and adverse selection problems, with banks having a relative advantage with monitoring while markets specialize in screening entrepreneurs. In contrast with the literature that I have mentioned so far, I impose weaker requirements to justify the existence of financial intermediation. I claim that informational heterogeneity is enough to justify the existence of financial intermediation since it improves coordination among potential investors.

Another body of literature justifies the existence of financial intermediaries based on their role in liquidity creation, where liquid funds are those that can be immediately used for consumption. In this line of research, intermediaries help to solve a coordination problem related to the best allocation of resources across technologies. These models, based on Diamond and Dybvig (1983), had difficulties in explaining the coexistence between direct and indirect finance. Diamond (1997) shows that limited participation by some agents in some markets is a sufficient condition to guarantee coexistence. In his model, financial intermediaries emerge endogenously to solve the coordination problems generated by limited participation and I borrow this idea from him. My argument complements Kashyap, Rajan and Stein (2002), who emphasize the role of synergies between the deposit taking and lending activities of a bank, as long as the demands for liquidity from depositors and borrowers are not perfectly correlated. I justify endogenously this assumption because, in the model presented, financial intermediation becomes important when direct finance dries up. Unlike them, and following Gatev and Strahan (2006), I focus on systematic risk.

This paper is also related to the literature which stresses the role played by financial systems in the process of economic growth. More specifically, it is helpful to assess the relative advantages and disadvantages of bank-based financial systems *vis-à-vis* market-based systems, shedding light on the debate regarding the role of financial services for economic growth. Levine (1997), among others, stresses that financial arrangements arise to provide key financial services, suggesting that financial instruments, markets and institutions arise to mitigate the effects of information and transactions costs. Demirgüç-Kunt and Levine (1999), Demirgüç-Kunt and Maksimovic (1998), Levine (1999, 2002) and others show that differences in how well financial systems reduce information and transaction costs influence savings rates, investment decisions, technological innovation, and long-term growth. The model presented addresses these issues and encompasses the *financial services view* once we take into account that financial institutions shape the structure of information concerning the return on investments.

I borrow from Allen and Gale (1997) the idea that there are institutions which use their capital to hedge *nondiversifiable* risks. Like them, I find that financial intermediation is vulnerable to a market-based system, unless intermediaries possess special investment opportunities. Although my main concern is the role of intermediaries in financial architecture, the results presented here carry over to a more general framework with different securities (for example, debt versus equity). The role of coordination distinguishes my work from the papers dealing with models of multi-asset securities markets under heterogeneous beliefs, as in Admati (1995).

Finally, I analyze the existence of safety net guarantees for banks, which may be explicit, like deposit insurance, or implicit. Recent work has shown that, in the presence of asymmetric information, *fairly-priced* deposit insurance may be either impossible (Chan, Greenbaum and Thakor 1992), or possible but undesirable (Freixas and Rochet 1998, and Morrison and White 2004). As for implicit safety nets, the effects of the *too-big-to-fail* doctrine have been studied extensively in the literature (see Rochet and Tirole 1996). More recently, Acharya and Yorulmazer (2007, 2008) have studied the *too-many-to-fail* case, in which the regulator finds it *ex-post* optimal to bail out banks when the number of failures is large. Hoggarth, Reidhill and Sinclair (2004) study resolution policies adopted in 33 systemic banking crises over the world during the 1977-2002 period, and document that government involvement has been an important feature in the resolution process and usually has implied transfers from the government to the banking sector. The experience of episodes of systemic crises and the use of *blanket guarantees* and other alternatives are also examined by Laeven and Valencia (2008) and Kane and Klingebiel (2004). In the model presented here, and in line with Pennacchi (2006), safety nets become especially important during periods of crisis, in which there is a *flight to quality*, as investors see financial intermediaries as a safer option. Following Pennacchi (2006), this paper also alerts against the dangers of excessive expansion of safety nets. Although full deposit insurance is not optimal and creates incentives for banks to take excessive systematic risks, I argue that, as long as it allows to set the optimal level of financial intermediation, a subsidized safety net improves efficiency and stabilizes aggregate output.

The paper is organized as follows. I devote the next section to present the basic model and justify the main assumptions. I proceed by showing the resulting equilibrium and exhibit the different types of financial architecture that may emerge. Section 4 completes the description of the equilibrium and discusses the policy implications suggested by the model. The subsequent section reconciles the empirical evidence with the assumptions and results in the model and is followed by a short conclusion. The proofs of the most important results are given in the appendix.

2 The Model

The model has three types of agents:

- A continuum of households with unit mass, indexed by $i \in [0,1]$, each with one unit of funds.
- A continuum of identical firms, with unit mass, endowed with the same risky technology. This implies that there is no idiosyncratic risk in the model. Each firm has one project which requires one unit of funds. Firms have no funds of their

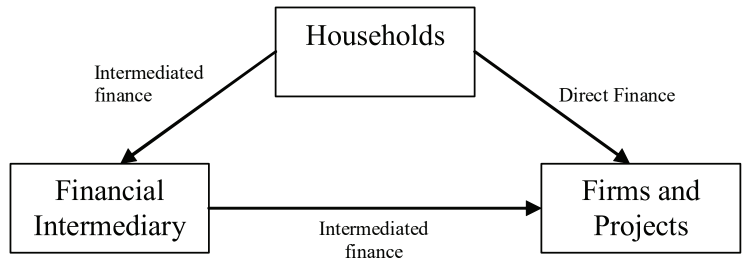

Figure 2: The Structure of the Financial System.

own and need to fully finance their project by resorting to external funds, either by issuing securities to households or resorting to financial intermediaries. Hence, the aggregate demand for funds by firms equals one.

- A representative Financial Intermediary (hereafter FI) collects funds from households and invests in firms.

The financial system is composed of direct finance and intermediated finance (see figure 2). Households must decide whether to invest their funds in the financial assets available in the economy (in which case I call them *investors*), or not to invest at all (in which case they have access to a storage technology). Investors must decide between investing their funds directly in firms or deposit their funds in the FI (in which case I call them *depositors*).[2] Figure 3 illustrates the sets of agents. All parties are risk neutral, there is no limited liability, and I assume no discounting. I do not allow for short selling.

[2] To distinguish the business of banking from pure insurance, I abstract from risk sharing motives by assuming that households are risk neutral and, therefore, end up investing exclusively in one single security. See proposition 2.

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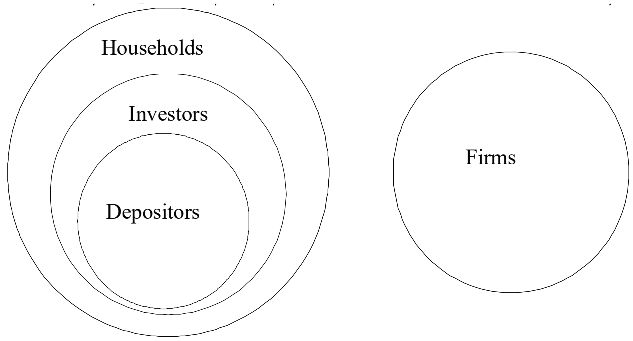

Figure 3: The sets of agents.

2.1 The Real Sector

Let n be the mass of non-investors in the economy. If $1-n$ households become investors, then each household that invests directly in the firm sector receives a net return equal to $r_D - n$. The risk factor r_D would have been the return, had every household decided to invest. Nonetheless, non-investors impose a negative externality on returns and this effect is captured by factor n. I call this effect *externality loss*.[3] I assume that factor r_D is a random variable with normal distribution $N(\overline{r}_D, 1/\sqrt{\alpha})$, where $0 < \overline{r}_D < 1$ and $1/\sqrt{\alpha}$ is the standard deviation.[4] The risk factor r_D is the single source of exogenous uncertainty in this economy and is the origin of systematic risk. Its distribution is

[3] The literature has presented justifications for such externalities based on: (i) premature liquidation of real assets as in Morris and Shin (2001) and Rochet and Vives (2004); (ii) financial assets sold at fire sale prices due to asymmetric information. An alternative explanation for such externalities concerns the existence of a production function that displays increasing returns to scale at the aggregate level (created by, for example, technological complementarities, demand spillovers or thick market externalities). In a related application to liquidity in financial markets, Morris and Shin (2004) link the externality loss with the selling of assets which tends to drive down the market-clearing price.

[4] Under the current formulation there is unlimited liability. Still, this formulation can be easily changed to incorporate limited liability. Let R_D be the (gross) rate of return. Non-investors cause a loss equal to e^{-n}. Writing $r_D \equiv \ln R_D$, the (gross) return can be written as $e^{r_D - n}$. Let r_D be distributed as described in the paper, and returns will be positive and there are no issues of unlimited liability. In this setup, utilities must be redefined: let households have the logarithmic utility function and, as a result, the payoffs are as described.

common knowledge.

2.2 The Financial Intermediation Sector

The FI raises funds by offering a security to households with a net return equal to $r_B - n$.[5] I assume that the factor r_B has mean $\overline{r}_B \in (0,1)$, standard deviation σ_B, and is perfectly correlated with the risk factor r_D, that is,[6]

$$r_B = \overline{r}_B + \sqrt{\alpha}\sigma_B \left(r_D - \overline{r}_D\right). \tag{1}$$

The distribution of r_B is common knowledge. The parameter σ_B represents the amount of risk attached to the securities issued by the FI, while $1/\sqrt{\alpha}$ is the amount of risk attached to the return on the assets of firms. A FI creates a security safer than the direct investment in firms when the value for σ_B is inferior to the risk associated with factor r_D.

Definition 1 *A safe security is a security for which $\sigma_B < 1/\sqrt{\alpha}$.*

The FI raises an amount ι_B of funds from households and transforms it into productive investment in firms. The net return received by the FI from investing one unit of funds in the firm is equal to $r_{\widetilde{D}} - n$. In the *baseline model*, $r_{\widetilde{D}} = r_D$ which means that the FI faces the same investment set as the households. Under this view, the main activity

[5] This is also related to the concept of banks as an additional security, developed in a different context by Diamond and Dybvig (1983), Jacklin (1987), Gorton and Pennacchi (1990) and Freixas and Tsomocos (2004).

[6] Perfect correlation plays no substantial role in what follows. I could allow for imperfect correlation and the results obtained would be identical. This assumption confirms the focus on systematic risk.

of the FI is to design new securities with return r_B different from r_D. For example, a bank deposit can be seen as a security for which the return $r_B - n$ is constant. When the FI offers safe securities, it acts in a way similar to a *with-profits fund*: it looses money whenever $r_B > r_D$, and makes profits whenever $r_B < r_D$. Since the FI is risk neutral and there is no limited liability, its incentive rationality condition is given by $E\left[\iota_B\left(r_D - r_B\right)\right] \geq 0$. Later, I show that, in financial systems based exclusively on intermediation, offering safe securities is profitable. Such a result provides micro-foundations for the existence of financial intermediation.

Alternatively, it is possible to build a more complete model, in which $r_{\widetilde{D}}$ differs from r_D because financial intermediaries play an active role in the management of their assets, having the ability to change the primitive payoffs available in the economy.[7] I consider the case in which the FI has access to a *monitoring technology* that modifies the return of the assets of the firm because it alleviates moral hazard problems at the firm level.[8] In order to analyze the effects of this technology, I assume that the returns on a monitored firm can be expressed as

$$r_{\widetilde{D}} = \overline{r}_{\widetilde{D}} + \sqrt{\alpha}\sigma_{\widetilde{D}}\left(r_D - \overline{r}_D\right) \tag{2}$$

where $\overline{r}_{\widetilde{D}}$ is the mean and $\sigma_{\widetilde{D}}$ is the standard deviation of the return of the investment of the FI in firms. There are two alternative frameworks:

- First, the monitoring activity reduces the uncertainty in the return of the assets of

[7] Diamond (1997) argues that small investors have limited access to financial markets which are easily accessible to FIs. This means that small investors trade in a small set of securities and FIs enlarge this set. Note that diversification is not an option available in the model.

[8] I assume that only the intermediation sector has access to this technology or it is efficient to have a FI as a *delegated monitor*.

the firm. For example, the manager of a project may have the possibility to choose between two versions of the project: one with high risk and private benefits and the other with low risk and no private benefits. Monitoring prevents the manager from choosing the riskier version. In this case $\sigma_{\widetilde{D}} < 1/\sqrt{\alpha}$ and, when $\overline{r}_{\widetilde{D}} < \overline{r}_D$, there is a cost associated with the monitoring technology.

- Another possibility is that the monitoring activity augments the mean return of the project of the firm by reducing moral hazard problems associated with private benefits enjoyed by the manager of the project, as in Holmstrom and Tirole (1997). In this case, $\overline{r}_{\widetilde{D}} > \overline{r}_D$ and $\sigma_{\widetilde{D}} = 1/\sqrt{\alpha}$.

2.3 Households and Information

There are three dates in the economy. At date 0, *public information* is revealed. *Public information* consists of probability distributions for the random variables r_D and r_B. I call α the precision of *public information*.

At date 1, *Nature* chooses the realization of the fundamentals, r_D, and households receive a piece of *private information* about the true state of the economy. Formally, each household i receives a private signal ω_i about the true value of the risk factor r_D, so that

$$\omega_i = r_D + \varepsilon_i \quad \text{with} \quad \varepsilon_i \sim N\left(0, 1/\sqrt{\beta}\right) \tag{3}$$

where ε_i is identically and independently distributed across agents and is independent of the variable r_D. I call β the precision of *private information*. The distribution of ε_i is common knowledge.

Given the information received, households update their (public) priors with their *private information*. Let $\rho_i = E[r_D|\omega_i] = (\alpha\overline{r}_D + \beta\omega_i)/(\alpha+\beta)$ be the updated belief of r_D upon observing the signal ω_i. Then the posterior distribution of r_D is $r_D|\omega_i = r_D|\rho_i \sim N\left(\rho_i, 1/\sqrt{\alpha+\beta}\right)$. Conditioning on ω_i or ρ_i is equivalent because $\rho_i = E[r_D|\rho_i] = E[r_D|\omega_i]$ and, when convenient, I condition the random variables on ρ_i. Households also use *private information* to update their expectations about the realization of factor r_B:

$$E[r_B|\rho_i] = \overline{r}_B + \sqrt{\alpha}\sigma_B(\rho_i - \overline{r}_D). \tag{4}$$

Consult Appendix A.1 for details on derivations. Intuitively, households use their information about economic conditions to infer the payoffs of the securities issued by the FI.

At date 1, after *private information* is disclosed, households make their investment decisions and financial contracts are signed. In order to state the results more economically I assume that, when investing and refraining yield the same expected payoff, households prefer to invest and, when indifferent between direct and intermediated finance, investors choose the former.

At date 2, investment returns are realized and financial claims are settled. The timing of the events is as described in Table 1.

Date 0	Date 1	Date 2
Public information is available.	1.1 Nature selects the fundamentals r_D. 1.2 Private information, ω_i, becomes available. 1.3 Investment decisions are made.	2.1 Projects are implemented. 2.2 Returns are realized and financial claims are settled.

Table 1: The time line of the baseline model.

3 Investment and Financial System Architecture

The case of an architecture based exclusively on direct finance has been studied by Morris and Shin (2001). As for the case of an architecture based exclusively on financial intermediation, the same argument proposed by Morris and Shin (2001) applies, with some minor modifications. Denote the cumulative density function of a standard normal distribution by Φ and let $\gamma = \frac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)}$.

Proposition 1 (*i*) *When $\gamma \leq 2\pi$ and direct finance is the only investment alternative available, there is a unique equilibrium. In this equilibrium, every household i refrains from investing if and only if $\rho_i < \rho'$, where ρ' is the unique solution to $\rho' = \Phi\left(\sqrt{\gamma}\left(\rho' - \overline{r}_D\right)\right)$.*

(*ii*) *When $\gamma \leq 2\pi\alpha\sigma_B^2$ and intermediated finance is the only investment alternative available, there is a unique equilibrium. In this equilibrium, every household i refrains from investing if and only if $\rho_i < \rho''$, where ρ'' is the unique solution to $\overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho'' - \overline{r}_D\right) = \Phi\left(\sqrt{\gamma}\left(\rho'' - \overline{r}_D\right)\right)$.*

The upper bounds for γ are sufficient conditions for a unique equilibrium and guarantee that the precision of *private information* is large enough when compared with the precision of *public information*. When the FI offers a safe security (that is, when $\alpha\sigma_B^2 < 1$), it has an effect similar to an improvement in the precision of *public information* and the bound on γ must change accordingly.[9]

From the *ex ante* point of view, equilibrium in market-based financial systems is characterized by underinvestment. The main innovation of this paper, with respect to the literature on global games, is raising the possibility that endogenous institutions emerge and mitigate the size of the underinvestment problem.[10]

Result 1 *Let $\gamma \leq 2\pi\alpha\sigma_B^2$ and financial intermediation be the only investment alternative available. When $r_{\widetilde{D}} = r_D$, supplying safe securities with $\overline{r}_B = \overline{r}_D$ is a profitable strategy for the FI. Additionally, if $\overline{r}_D > 1/2$, then $\rho'' < \rho'$.*

The above result shows that supplying safe securities is a profitable activity in an economy with intermediaries and no financial markets. Provided $\overline{r}_D$ is sufficiently high, this activity lowers the investment threshold, thereby raising efficiency with respect to the market allocation.

[9] I dismiss the case for a fully revealing equilibrium and assume that the representative FI is unable to derive the value of the fundamentals from the information contained in the mass of depositors. Presumably this happens because the representative FI is a useful theoretical simplification for a continuum of small financial intermediaries which do not hold a well diversified portfolio of depositors and are unable to derive the realization of the fundamentals from the mass of depositors. The model presented can accommodate the case in which the FI is able to use the mass of depositors to infer the realization of r_D, and there is imperfect aggregation of information (for example, because there are *noise traders* or unobservable supply shocks as in Grossman and Stiglitz 1976). When there is noise in the mass of depositors, the FI is not able to derive the true realization of r_D. If the FI discloses this new piece of information, it is making public information more precise. Whether we obtain multiplicity of equilibria or not, depends on the amount of aggregate noise, that is, it depends on the final precision of public information. Consult Hellwig *et al.* (2005) and Angeletos and Werding (2006) for more on this issue and, in particular, Angeletos and Werding (2006) study the case in which agents can observe one another's actions.

[10] To the extent that financial arrangements and services change the structure of information in the economy, the model offers a rationale for the *financial services view* of the finance-growth relationship.

A well known feature in global games is that the value for the investment threshold ρ' and the level of investment depend on the relative precision of *public* and *private information*. Morris and Shin (2001, 2002), Svensson (2006) and Morris, Shin and Tong (2006) have pointed out that agents use *public information* to coordinate their actions, showing that the precision of *public information* has a large disproportionate effect on the investment threshold ρ'. When *public information* is very precise and $\overline{r}_D$ is *large* (that is, above 1/2), households are confident that other households have received good private signals and are willing to invest. This reduces the expected externality loss and creates an environment favorable to investment. When the FI offers securities with low risk, the effect over aggregate confidence is similar. In this case, financial intermediation reduces the level of aggregate uncertainty in the economy, having an effect similar to augmenting the precision of *public information*. Households believe that pessimistic agents do not refrain from investing because they can invest their funds in safe securities issued by the FI. This diminishes the expected externality loss, raises expected returns, lowers the investment threshold below the level which exists in an architecture based on direct finance, induces high synergies among investors and spurs investment.

The most interesting types of architecture have intermediated finance coexisting alongside market-based finance. In these cases, households evaluate the expected net returns from investing in a portfolio composed of two assets against the payoff of not investing.

Proposition 2 (i) *When investors choose between direct and intermediated finance, each investor invests all its funds in the security with the highest expected return, given* *its updated belief ρ_i. The threshold for which investors switch from one form of finance to the other is given by $\rho^I = \frac{\overline{r}_B - \sqrt{\alpha}\sigma_B \overline{r}_D}{1-\sqrt{\alpha}\sigma_B}$.*

(ii) Provided that $\gamma \leq \min\{2\pi, 2\pi\alpha\sigma_B^2\}$, there is a unique equilibrium. In this equilibrium, every household i refrains from investing if and only if $\rho_i \leq \rho^*$, where $\rho^* = \min\{\rho', \rho''\}$.

The previous result asserts that, in financial systems with intermediated and direct finance, investors obtain the best of both worlds. They pick the more profitable alternative and may benefit from a reduction in the externality loss.

The next proposition presents four types of financial architecture according to the values taken by the key parameters that characterize financial intermediation: $\overline{r}_B$ and σ_B. Let $\widehat{r}_B$ be the threshold for $\overline{r}_B$ such that $\rho^I = \rho'$, that is

$$\widehat{r}_B = \rho' + \sqrt{\alpha}\sigma_B\left(\overline{r}_D - \rho'\right). \tag{5}$$

Proposition 3 *When parameters are such that $\gamma \leq \min\{2\pi, 2\pi\alpha\sigma_B^2\}$ and:*

(i) $\sigma_B < 1/\sqrt{\alpha}$ and $\overline{r}_B > \widehat{r}_B$, then there is coexistence between direct and intermediated finance. If $\sigma_B < 1/\sqrt{\alpha}$ and $\overline{r}_B \leq \widehat{r}_B$, then only direct finance is feasible.

(ii) $\sigma_B > 1/\sqrt{\alpha}$ and $\overline{r}_B > \widehat{r}_B$, then only intermediated finance is feasible. If $\sigma_B > 1/\sqrt{\alpha}$ and $\overline{r}_B \leq \widehat{r}_B$, then there is coexistence between direct and intermediated finance.

(iii) $\sigma_B = 1/\sqrt{\alpha}$ and $\overline{r}_B \leq \overline{r}_D$, then only direct finance is feasible. If $\sigma_B = 1/\sqrt{\alpha}$ and $\overline{r}_B > \overline{r}_D$, then only intermediated finance is feasible.

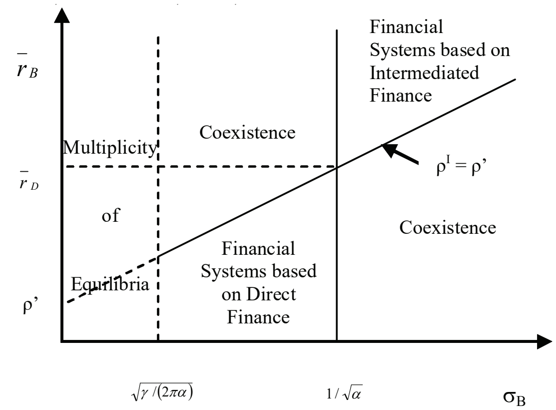

Figure 4: Classification of Financial Systems when $\gamma < 2\pi$.

When intermediaries supply safe securities, the decision to invest or not through a FI depends on the average return provided by the FI. When $\overline{r}_B > \widehat{r}_B$, households with updated beliefs belonging to the set $\left[\rho^*, \rho^I\right)$ deposit their funds in the FI and those with larger updated beliefs invest directly in the firm. When $\sigma_B > 1/\sqrt{\alpha}$, the FI issues a security with returns riskier than the returns from securities issued by firms. When $\overline{r}_B$ is sufficiently high, financial intermediation leads to an extreme reallocation of funds by absorbing all the funds from investors. When $\overline{r}_B \leq \widehat{r}_B$, households with updated beliefs belonging to the set $\left[\rho^*, \rho^I\right]$ invest directly in the firm whereas more optimistic households deposit their funds in the FI. When $\sigma_B = 1/\sqrt{\alpha}$, the only distinction between the two types of finance is the average return, and investors choose the security with the highest expected return. Investment is procyclical in all types of architecture. Figure 4 presents a classification of the different types of financial architecture, according to the values taken by the parameters $\overline{r}_B$ and σ_B.

4 Equilibrium and Regulation

As of now I restrict the study to the case in which $\gamma < 2\pi$, $\sigma_B \in \left[\sqrt{\gamma/(2\pi\alpha)}, 1/\sqrt{\alpha}\right]$ and $\overline{r}_B > \widehat{r}_B$. Arguably, in most situations, the returns on assets traded in financial markets are more volatile than the returns offered by intermediaries such as banks and insurance companies and this case shares this feature.

When the FI offers safe securities, both forms of finance coexist and, due do the beneficial effects of intermediation, the investment threshold is lower than ρ'. In this context, optimistic agents choose direct finance, while the not so optimistic agents either do not invest or obtain *insurance* through a financial intermediary.

Corollary 1 *When the FI supplies safe securities and $\overline{r}_B > \widehat{r}_B$, comparison between financial systems yields $\rho^* < \rho'$. Additionally, the effect of $\overline{r}_B$ on ρ^* is negative and, if $\overline{r}_D > 1/2$, the value of ρ^* decreases as the value of σ_B decreases.*

Increased precision on the returns offered by the intermediary (when $\overline{r}_D > 1/2$), as well as higher mean returns, make intermediation more attractive and ease the coordination problem, thus creating an environment favorable to investment.[11]

As shown in result 1, without competition from market-based finance, the FI raises the level of investment and its insurance activity is profitable. However, when intermediation coexists with financial markets, the contract issued by the FI suffers from a

[11] In order to obtain $\partial\rho^*/\partial\sigma_B > 0$, a milder condition than $\overline{r}_D > 1/2$ is needed. We only require that $\rho'' < \overline{r}_D$ and, given $\partial\rho''/\partial\overline{r}_B < 0$, there is always a sufficiently high value for $\overline{r}_B$ such that such condition is satisfied.

winner's curse. This happens because the FI ends up attracting a large portion of investors when economic fundamentals are bad and few investors when fundamentals are good. As a result, the net transfer to each depositor is positively correlated with the mass of depositors and the gains and losses from intermediation are asymmetric in good and bad states of the world so that it may not be possible to guarantee positive expected profits for the FI. As in the work by Allen and Gale (1997), financial intermediaries are vulnerable to a market-based system, which causes the *smoothing mechanism* to unravel.

Yet, if the FI has access to a monitoring technology which reduces the dispersion of the returns in the firm, then it is possible to have profitable intermediation coexisting alongside financial markets.

Proposition 4 *When monitoring reduces dispersion in the returns of firms and* $\overline{r}_{\widetilde{D}} > \widehat{r}_B$*, financial intermediation is profitable.*

Proof. Let $\sigma_B = \sigma_{\widetilde{D}}$ and $\overline{r}_B = \overline{r}_{\widetilde{D}} + \left(\overline{r}_{\widetilde{D}} - \widehat{r}_B\right)/2$. Then $\rho^* < \rho'$, the size of the intermediation sector is non-zero and $E\left[\iota_B\left(r_{\widetilde{D}} - r_B\right)\right] = \left(\overline{r}_{\widetilde{D}} - \widehat{r}_B\right)E\left[\iota_B\right]/2 > 0$. ∎

A second reason for the beneficial effects of financial intermediation is that, for some parameters, the existence of financial intermediation stabilizes the behavior of investment. After a bad shock, some of the pessimistic investors abandon decentralized financial markets and invest through a FI, whereas in systems based on direct finance these households would not invest at all. This result is coherent with Greenspan (1999, 2000)'s view about the functioning of the financial system. For the purpose of illustrating the main features of the model, in this section and following subsections, I consider specific

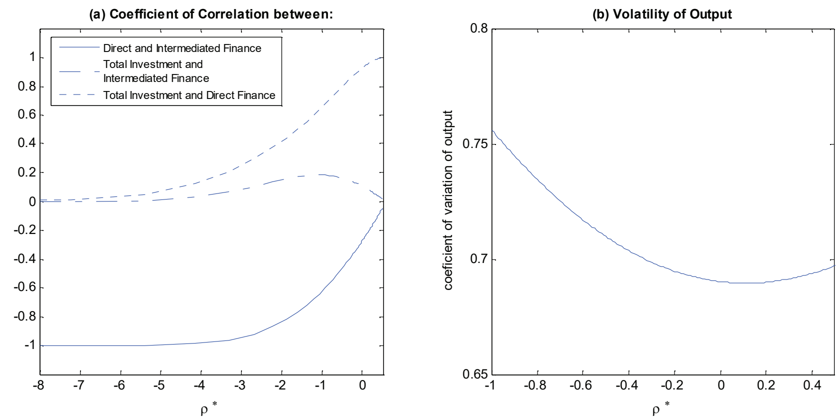

Figure 5: Investment threshold and coefficients of correlation and variation. Notes: The values used for the parameters were $\alpha = 0.25, \beta = 4$ and $\overline{r}_D = 0.6$ such that $\rho' = 0.4963$. I considered that $\rho^* = \rho''$. The coefficient of variation is the standard deviation divided by the mean.

values for the parameters. The values chosen were $\alpha = 0.25, \beta = 4$ and $\overline{r}_D = 0.6$. For these parameters, the value of ρ' equals 0.4963.[12]

Figures 5(a) and 5(b) plot the relationships between the investment threshold and the correlations between financial flows and a measure of stability, with the purpose of illustrating the role of intermediaries in the determination of aggregate risk. Figure 5(a) reports the correlations between the available investment alternatives and shows that direct and intermediated finance are negatively correlated, implying imperfect correlation between total investment and the size of direct and intermediated finance. These predictions are broadly consistent with the results presented by Davis (2001) (and partially

[12] I consider $\overline{r}_D > 1/2$ because, in the setup presented here, intermediation with safe securities is impossible with $\overline{r}_B = \overline{r}_D$ and $\overline{r}_D < 1/2$. Unless stated otherwise, the values used for the parameters were $\alpha = 0.25, \beta = 4$ and $\overline{r}_D = 0.6$ such that $\rho' = 0.4963$ and, when direct finance is the only investment alternative available, the *ex ante* expected net return, $E\left[r_D - n\left(\rho'\right)\right]$, equals 12.1%. Later, I consider different levels of relative precision of public and private information. Results shown are robust to alternative parameterizations.

reported in table 2). Figure 5(b) plots the coefficient of variation of output, which is seen as a measure of stability, against the value of the investment threshold. The relation is non-monotone and shows that maximum stability is obtained for values of ρ^* below ρ'.

4.1 Policy and Regulatory Implications for the Baseline Model

The model described has implications regarding two criteria relevant for economic policy: efficiency and stability.[13] With respect to efficiency, I analyze first the *baseline model* $\left(r_{\widetilde{D}} = r_D\right)$. The optimal outcome under perfect information would have all households investing whenever $r_D \geq 0$ and no one investing otherwise. Due to imperfect information inefficiencies are unavoidable in equilibrium, and it remains to know how large are such inefficiencies and how to achieve a *second-best*, by choosing the optimal level for ρ^*. As mentioned before, financial intermediaries have the ability to reduce the value of ρ^* below the level of ρ'. Yet, intermediation may not be profitable and, if profitable, a profit maximizing FI may not be willing to set ρ^* at the most efficient level. These issues provide the foundations for the existence of regulation.

In order to assess the merits of regulation, I conduct an *ex ante* evaluation of expected social welfare. When I refer to *ex ante* analysis, I am referring to the analysis made at date zero. I define social welfare as the gross return of the funds available in the economy or, equivalently, the value of aggregate output. Specifically, when all households use an investment threshold equal to ρ^T, social welfare equals $W\left(\rho^T, r_D\right) =$

[13] Note that the two dimensions are correlated. Stable economies tend to be more efficient as they favour coordination among investors.

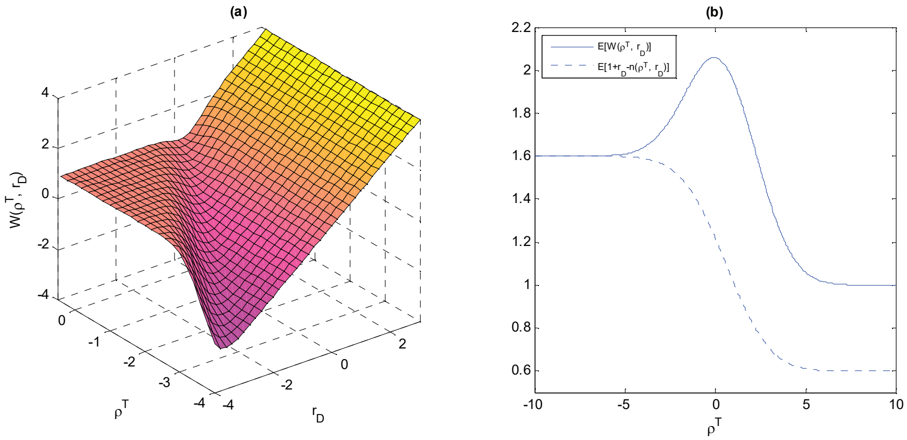

Figure 6: Investment threshold, social welfare and expected social welfare. Notes: The values used for the parameters were $\alpha = 0.25, \beta = 4$ and $\overline{r}_D = 0.6$ such that $\rho' = 0.4963$.

$\left[1 - n\left(\rho^T, r_D\right)\right]\left[1 + r_D - n\left(\rho^T, r_D\right)\right] + n\left(\rho^T, r_D\right)$, where the mass of agents that chooses storage equals $n\left(\rho^T, r_D\right) = 1 - \Phi\left(\sqrt{\beta}\left(r_D - \frac{\alpha+\beta}{\beta}\rho^T + \frac{\alpha}{\beta}\overline{r}_D\right)\right)$. Figure 6(a) describes how *ex post* social welfare, $W\left(\rho^T, r_D\right)$, evolves with the realization of the fundamentals, r_D, and the value of the investment threshold, ρ^T. Obviously, the fundamentals have a positive effect on welfare. As for the investment threshold, ρ^T, its choice has important effects on welfare. A high (positive) value for the investment threshold reduces the level of investment as fewer households have $\rho_i \geq \rho^T$. This is bad when the realization of the fundamentals, r_D, is positive, but limits the welfare loss whenever r_D is negative since many households refrain from investing. On the one hand, these features suggest that, *ex ante*, it may not be optimal to set the value of of the investment threshold too low, as it would imply overinvestment when fundamentals are bad. On the other hand, setting the investment threshold too high, implies loosing many good investment opportunities when fundamentals are good.

Define *ex ante* expected social welfare by $E\left[W\left(\rho^T, r_D\right)\right]$, where the expectation is taken with respect to the random variable r_D. Figure 6(b) plots the relationship between this variable and the level of the investment threshold ρ^T. For extremely low values of ρ^T households always invest, regardless of the signals received, thus eliminating the externality losses and the *ex ante* expected gross return equals $1+\overline{r}_D$. For extremely high levels of ρ^T, everyone chooses the storage technology, for which the net rate of return is zero. The relationship between expected social welfare and ρ^T is non monotonic because low values of the investment threshold generate overinvestment while high values generate underinvestment. From the social point of view, it is desirable to have an intermediate value for the investment threshold.[14] Figure 6(b) also shows that expected returns on investment are imperfectly correlated with expected social welfare.

In the context of the *baseline model*, decentralized markets do not guarantee maximum welfare because they suffer from coordination problems, leading to a high investment threshold which causes a significant underinvestment problem. For the calibration shown in figure 6(b) the value of ρ' equals 0.4963 yielding an *ex ante* social welfare equal to 2.031 which is inferior to the maximum value of welfare (2.0587) obtained for a value of the investment threshold equal to -0.0462.[15] As a result, there is scope for the

[14] In the simulations performed, the optimal value for ρ^T was very close to zero. To see the reason why this happens note that, under perfect information, investment should be undertaken if and only if $r_D \geq 0$. Under imperfect information, r_D is non observable and the optimal investment threshold is also close to zero. Interestingly, the optimal value for ρ^T is decreasing in $\overline{r}_D$ and α (results not shown). This happens because large values for these parameters make the realization of low fundamentals more unlikely, and the underinvestment problem more probable.

[15] In the simulations performed, the optimal value for ρ^T was negative. To see the reason why this happens note that $\overline{r}_D$ is positive and fundamentals take positive values more often than negative. When the investment threshold is positive, most of the time there is underinvestment. Hence, under imperfect information, it is optimal to set the investment threshold below zero.

creation of institutions which reduce the value of the investment threshold and provide incentives to invest. The institutional framework considered in this and the following subsections is the creation of a FI, together with a safety net which guarantees transfers to the FI (and depositors) in the bad states of the world. The goal is to allow the FI to create a safe security, thereby reducing the value for the investment threshold ρ^* to more efficient levels. In order to give a qualitative characterization of the optimal design of regulation, let τ be the net transfers from the safety net to the FI, and

$$\tau = \overline{\tau} - \sigma_\tau \sqrt{\alpha} \left(r_D - \overline{r}_D \right) \tag{6}$$

wherein $\overline{\tau}$ and $\sigma_\tau \geq 0$ represent the mean and dispersion in net transfers. Note that, when $\sigma_\tau > 0$, transfers are (perfectly) negatively correlated with the fundamentals. Additionally, assume that transfers to and from the regulator must be delivered to depositors, that is $r_B = r_D + \tau$. In this setup, $\overline{r}_B = \overline{r}_D + \overline{\tau}$, $\sigma_B = 1/\sqrt{\alpha} - \sigma_\tau$ and the regulator has two instruments available: setting $\overline{\tau}$ and σ_τ. I interpret the case in which $\sigma_\tau > 0$ as the existence of a safety net and, when $\overline{\tau} > 0$ and $\sigma_\tau = 0$, the regulator makes a lump sum transfer to each depositor. When $E\left[\iota_B \tau\right] > 0$, the regulator subsidizes the safety net.[16]

The first result is that, in general, the creation of institutions which guarantee full deposit insurance is not optimal. Full deposit insurance amounts to setting ρ^* at an infinitely low level, in which case households disregard valuable *private information* to make

[16] In the model, *depositors* have a broad interpretation. They can be investors in bank deposits, wholesale creditors, etc. Still, the model is opened to extensions and it allows for including equity in a portfolio of securities issued by the representative financial intermediary. In this case, insurance for shareholders is obtained either through the government (presumably through implicit guarantees where shareholders are also bailed out) or through monitoring (which will be analyzed in the next subsection).

their decisions, thereby generating overinvestment. A mechanism which incorporates uncertainty about the final returns is better than a completely safe scheme, because it allows to set ρ^* at the efficient level. In the example shown in figure 6(b), the optimal design of a safety net implies an investment threshold close to zero, which can be achieved with random transfers and strictly positive σ_τ. In this context, the effects of *too-big-to-fail* and *too-many-to-fail* guarantees can be analyzed in the light of the current framework.[17] Interestingly, and in contrast with the studies by Acharya and Yorulmazer (2007, 2008) on the *too-many-too-fail* effect and the results in the *too-big-to-fail* literature, there is no time-inconsistency in closure policies.

Results on alternative parameterizations suggest that, when the relative precision of *public information* is high (α is high and β is low), full deposit insurance is almost optimal because the expected social welfare for extremely low values of the investment threshold is very close to the maximum of expected social welfare. This happens for two reasons. First, when α is high, the dispersion of r_D around its mean is low and the value of r_D is seldom negative (given that $\overline{r}_D > 0$). Hence, the extent of the overinvestment problem is limited and setting the investment threshold too low does not cause significant welfare losses.[18] Second, when β is low, *private information* is not

[17] Implicit guarantees incorporate a degree of discretion by the authorities and the presented framework allows to discuss the strategies of *constructive ambiguity* followed by central banks, which are supposed to maintain some uncertainty about the criteria actually used for deciding whether to bail out a failing bank. So far I have restricted the study to cases in which τ is perfectly correlated with r_D. Yet, due to risk neutrality, the same results would obtain with imperfect correlation since the relevant parameter is the covariance and not the coefficient of correlation between τ and r_D. Ambiguity about whether the regulator of the financial intermediation sector will make transfers in the bad states of the world prevents households with bad signals from investing, reducing investment in these states. Arguably, strategies of *constructive ambiguity* can be seen as ideal to minimize the overinvestment problem.

[18] Such result suggests that in the period known as the *Great Moderation*, in which there was a substantial decline in macroeconomic volatility, full deposit insurance was (almost) optimal. However, during periods of economic instability, the existence of unconditional *blanket guarantees* may reduce

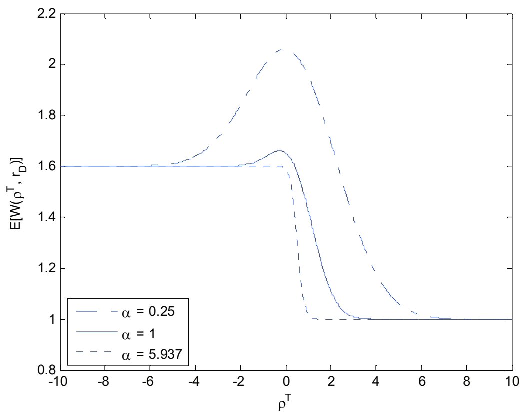

Figure 7: Investment threshold and expected social welfare. Notes: The values used for the parameters were $\beta = 4$ and $\overline{r}_D = 0.6$.

particularly valuable and disregarding it does not penalize welfare significantly. Such results are illustrated in figure 7 which plots the relationship between the investment threshold and expected social welfare for different levels of relative precision between *private* and *public information*. Finally, note that the optimal level of uncertainty in the protection of depositors is conditioned by the multiplicity of equilibria issue. A random mechanism with too little uncertainty (that is, with $\sigma_B^2 < \gamma/(2\pi\alpha)$) would generate multiple equilibria and could prove to be destabilizing for the financial sector, an issue already discussed by Rochet and Vives (2004).

The second set of results on regulation relates to setting the level for $\overline{\tau}$. This raises an important policy question about whether the safety net should be subsidized or not. Simulations in the *baseline model* suggest that financial intermediation is profitable if, and only if, $E[\iota_B \tau] > 0$, that is only if the safety net is funded through general taxation

social welfare.

does it have any beneficial effect. As in Morrison and White (2004), it is the tax levied on agents outside the banking system that provides a net subsidy to the system and guarantees profitable intermediation.

The model can be used to find the optimal regulation that weights the cost of under-investment versus the cost of safety nets. The first result on taxation is that the date in which taxes are collected is relevant for social welfare. Preliminary analysis suggests that, if taxes are collected at date 0 and the relative precision of *private information* is high, it may not be possible to improve expected social welfare. To see this, note that the regulator has less information than households because it does not receive a private signal and therefore, when taking investment decisions, it dispenses with valuable *private information* held by households. Consequently, when investing the funds collected through taxes at the initial date, the regulator bases its decision on less information than households, thereby distorting the allocation of resources.[19]

Taxation at date 2 is non-distortionary and is unequivocally welfare improving. In this case, the regulator does not interfere with the allocation of resources at date zero, and households make the best use of *private information* (not available to the regulator) to take their investment decisions at the initial date. As of now I assume that the regulator collects lump sum taxes from all households at date 2 and transfers these funds to investors.[20] The funds collected can be used in two different ways. The first alternative

[19] The funds collected through taxes are redistributed at date two and, therefore, it remains to know what is done to funds collected at date zero. Suppose that the resources collected are used for investment (which mitigates the underinvestment problem). When $r_D < 0$, many households, using their private information find $\rho_i < \rho^*$ and refrain from investing. Yet, the regulator does not receive any private signal and will invest the funds regardless of the fundamentals, thus generating overinvestment.

[20] There is an alternative policy which consists of taxing only non-investors *ex post*. The main virtues

consists of financing a safety net which sets σ_τ at the socially optimal level. The second alternative amounts to transferring lump sum subsidies, equal to $\overline{\tau}$, to investors. For the calibration that has been considered so far, both policies allow the economy to achieve the maximum level of welfare under imperfect information (results not shown).

4.2 Policy and Regulatory Implications with Monitoring Technology

When we abandon the *baseline model*, and consider the case in which banks have access to a monitoring technology, there are effectively two technologies competing and social welfare depends on the relative size of the intermediation sector. In this case, the *ex ante* expected social welfare depends on the investment threshold ρ^T and the switching threshold ρ^I. Formally, $W\left(\rho^T, \rho^I, r_D\right) = \iota_B\left(1 + r_{\widetilde{D}} - n\left(\rho^T, r_D\right)\right) + \iota_D\left(1 + r_D - n\left(\rho^T, r_D\right)\right) + n\left(\rho^T, r_D\right)$, where ι_D is the amount of direct investment in firms.

When the monitoring activity reduces the uncertainty in the return of the assets of the firm $\left(\sigma_{\widetilde{D}} < 1/\sqrt{\alpha}\right)$, optimal regulation involves a *policy-mix*. In this case, welfare depends on the values taken by ρ^T and ρ^I and the two instruments available, $\overline{\tau}$ and σ_τ, must be used simultaneously to maximize social welfare. When monitoring augments the mean return of investment, then financial intermediation dominates direct finance. Hence, the best regulatory practices involve setting the threshold ρ^* at its optimal level using exclusively the instrument $\overline{\tau}$. This is because the existence of a safety net with

of this policy are that it does not interfere with the use of private information and allows to tax directly the source of the externality loss.

$\sigma_\tau > 0$ implies negative transfers in the good states of the world, thereby inducing optimistic investors to evade the *smoothing mechanism* and choose direct finance (thus creating inefficiencies).

4.3 Policy and Regulatory Implications for Stability

The second dimension of potential concern for the regulator is systematic risk and the stability of aggregate output. Since output and investment are positively correlated, the pursuit of output stability amounts to promoting a stable investment. Results in figure 5(b) allow to infer that, for the parameters considered, lowering the level of ρ^* below ρ' reduces the variance of aggregate investment. It has often been suggested that the apparent resilience of most continental European financial systems lies in the existence of implicit or explicit safety net guarantees (see, e.g., Greenspan 1999). Still, by looking at figure 8, it can be seen that full deposit insurance would create incentives for the FI to take excessive systematic risks, a concern highlighted by Pennacchi (2006).

5 Empirical evidence

Although testing the predictions of the model is outside the scope of this contribution, it is interesting to relate the results with the ones obtained in the literature. Table 2 reports descriptive statistics for variables regarding credit-market financing by non-financial corporations for the US, UK, Japan and Canada over the 1970-1999 period. The variables are "real debt securities", used as a proxy for market-based finance, "real loans", used as a proxy for intermediated finance, and "real borrowing" which is just a

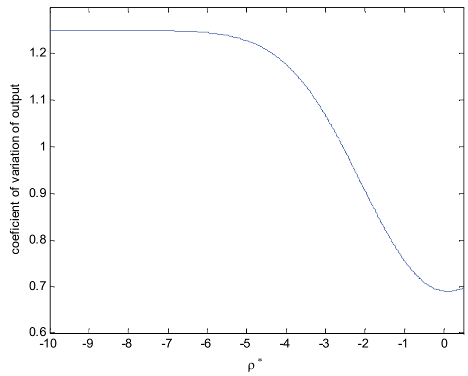

Figure 8: Investment threshold and volatility of output. Notes: The values used for the parameters were $\alpha = 0.25, \beta = 4$ and $\overline{r}_D = 0.6$ such that $\rho' = 0.4963$. I have considered that $\rho^* = \rho''$.

	Percent of GDP	Coefficient of Variation	Correlations: Real borrowing	Real debt securities	Real loans
United States					
Real borrowing	3.15	0.59	1		
Real debt securities	1.65	0.56	0.64	1	
Real loans	1.50	1.01	0.86	0.16	1
United Kingdom					
Real borrowing	3.57	1.03	1		
Real debt securities	0.67	1.72	0.60	1	
Real loans	2.90	1.10	0.94	0.28	1
Japan					
Real borrowing	4.94	1.03	1		
Real debt securities	0.54	2.04	0.64	1	
Real loans	4.40	1.01	0.97	0.45	1
Canada					
Real borrowing	4.31	0.61	1		
Real debt securities	2.01	0.77	0.45	1	
Real loans	2.30	1.04	0.81	-0.15	1

Table 2: Volatility and Correlation of Real Corporate Debt Financing Flows during the 1970-1999 period. Notes: Results based on Tables 1 and 2 of Davis (2001). Quarterly data on funds raised in the credit market by non-financial corporations obtained from the US Flow of Funds (Federal Reserve Board), UK Financial Statistics (Office of National Statistics), Canadian National Income and Expenditure data (Statistics Canada) and Japanese flow of funds data (Bank of Japan). The variable "Real debt securities" comprises corporate bond issuance plus commercial paper (except for the UK and Japan where commercial paper data was not consistently available) at market value, the variable "real loans" is bank lending, mortgages, and other loans to companies. All variables are deflated by the CPI. "Real Borrowing" is the sum of these two sub-components.

sum of the two previous sub-components. The shares of bank loans and securities and the measure of volatility show that countries with more equilibrated financial systems are those where aggregate borrowing is more stable. Correlations suggest that bank lending and securities move to balance each other out on average, although the effectiveness of this varies across countries.[21] Overall credit market financing tends to be more closely correlated with loans than security issuance, while the correlation between securities and loans is low, suggesting a relative advantage of an architecture based on decentralized markets to smooth overall credit flows over the cycle.[22] Yet, Allen and Gale (1997) highlight the relative advantages of intermediation-based systems, when compared with market-based systems, to weather systemic shocks. The authors argue that, during the sharp rise in oil prices in the 1970s, German investors did not suffer a fall in their returns like the US investors because, in Germany, savings are mostly placed with intermediaries and assets were not priced according to the market. Yet, since claims on intermediaries were fixed in nominal terms, German investors did less well than their counterparts in the US during the 1980s' good economic performance.[23] This evidence, although circumstantial, is consistent with the assumptions and results expressed in this paper.

In a number of ways, the behavior of the economy presented in section 4 and shown in figure 5 is corroborated by the results obtained in conventional analysis of the business

[21] Sharpe (1995) reports similar findings for the US economy.

[22] Recent literature, such as Holmstrom and Tirole (1997), highlights the role of "complementarity" (as opposed to "substitutability") between informed (bank) and uninformed capital (securities) for firms. Ioannidis and Davis (2003) find evidence favorable to this hypothesis. Interestingly, these authors find that the effects are asymmetric, implying that "multiple avenues" may not be effective as a buffer when a bank credit crunch occurs.

[23] Interestingly, Plantin, Sapra and Shin (2008) highlight the coordination issues mentioned in this contribution to relate fair value accounting and financial stability.

cycle. Investment is strongly procyclical, although its most volatile component - inventories - is not being analyzed in this paper. The financial system is also procyclical, that is, measures on financial activity such as new bond issues and total bank lending tend to increase more during economic booms than during downturns (for example, Adrian and Shin 2007, document that *marked-to-market* leverage is strongly procyclical).[24] Additionally, Bernanke, Gertler and Gilchrist (1996) cite diverse evidence for the *flight to quality* effect in credit markets during downturns, which confirms the predictions in the model: following an adverse (macroeconomic) shock in r_D a larger fraction of investors choose the safest form of finance.

Regarding financial crisis periods, Davis (2001) documents a broad pattern of equilibration by the market less severely affected by the turbulence, although overall financing tended to be most severely affected in banking crises (suggesting that banks may be better able to offset securities market crises than vice versa). Gatev, Schuermann and Strahan (2004) show that funding supply to banks increased as the availability of market liquidity declined during the Russia/LTCM crisis. In this way, banks were able to withstand the crisis because deposit funding flowed in just as it was needed by borrowers.

There are several pieces of evidence suggesting a powerful deposit-lending synergy related to liquidity risk management that operates within the banking industry. Using data for the commercial paper market, Gatev and Strahan (2006) document that banks provide firms with insurance against systematic liquidity shocks because deposit inflows

[24] Much of this procyclicality has been attributed to financial accelerator effects, such as the one in Bernanke and Gertler (1989) and Bernanke, Gertler and Gilchrist (1996, 1999).

offer a hedge for loan demand shocks. The authors provide evidence that funding supply to banks and bank asset growth increase as the availability of market liquidity declines. Gatev, Schuermann and Strahan (2008) find that asset-side and liability-side liquidity risks are offsetting rather than reinforcing, meaning that combining deposits and commitment lending provide a liquidity-risk hedge for banks. Arguably, banks enjoy funding inflows when market liquidity becomes scarce because banks are rationally viewed as explicitly or implicitly insured by governments. Consistent with this notion, Pennacchi (2006) finds that during the years before the introduction of federal deposit insurance, bank funding supply did not increase during market pullback. Hence, today's banks seem to have the ability to supply financial instruments different from the ones offered by decentralized markets. In conformity with the predictions of the model, negative aggregate shocks lead investors to divert their funds away from direct finance and invest their funds in financial intermediaries, augmenting the relative weight of intermediated finance in the economy.

Several empirical studies find that banking and stock market development are strongly related with the process of economic growth (for example, Levine and Zervos 1998), although the strength and sign of such relationships might vary with the development of the financial sector, size of firms, legal and institutional conditions and other country specific factors (see Tadesse 2001). Many historians, among whom Cottrell (1980), agree that, in the early days of the industrial revolution, banks played an important coordinating role, collecting and reinvesting idle funds from small and uninformed investors. This idea is supported by the fact that commercial banking was the main form of intermediation during the initial stages of the industrial revolution in the UK. Sylla (1998) emphasizes the mutual support between the banking system, and securities markets for the US economy from 1790 to 1840. Song and Thakor (2007) mention, using data from The World Bank Group, that the evolution of banks and capital markets in the US, UK, Germany and Japan during the 1960-2003 period shows complementarity between banks and markets most of the time. Overall results broadly confirm the assumptions and results in the model and support the coordination role played by financial intermediaries.

6 Conclusion

The role of financial intermediation in financial architecture is twofold: it affects the levels of aggregate output and systematic risk. When financial intermediaries insure aggregate risk, intermediation is beneficial to the economy since, on the one hand, it lowers the *investment threshold*, reduces the externality loss and increases efficiency and, on the other hand, intermediation stabilizes aggregate output, reducing systematic risk. Yet, such activity might be difficult to be profitably performed and, in order to exist, either financial intermediaries have access to a new investment set or must be subsidized. I conclude that the regulator should consider the value of the investment threshold as an intermediate goal for economic policy.

There are several interesting extensions for the present work. First, it would be interesting to consider explicitly the role of prices as a source of *public information*. Alternatively, one could consider the case in which the amount of deposits conveys information about the realization of the fundamentals.

Second, I have assumed that the mass of non-investors, n, has a common effect on all available securities which implies that the externality loss does not depend on the type of investment made. One interesting extension of the model is to consider explicitly different externality losses generated by non-investors for each of the securities in the economy. On the one hand, intermediated finance diverts resources from markets for direct finance, diminishing their liquidity. On the other hand, when markets for direct finance are incipient, financial intermediation might reveal itself as the most efficient mechanism to channel funds from agents into the productive activity. As a consequence, encompassing these features in the model would indicate both the virtues of financial intermediaries when markets are illiquid (as in the Japanese and German types of financial architecture) and the virtues of fully fledged security markets when externalities are limited and liquidity is high. Again, my ideas run close to the arguments expressed by Allen and Gale (1997).

Finally, it would be interesting to apply the framework presented in this paper to examine explicitly the role of financial services for economic growth. In this line of research, note that the implications of competition for the equilibrium were not studied in this contribution.

A Appendix

A.1 Derivation of Expression (4)

The joint distribution of the variables in the model is

$$\begin{pmatrix} r_D \\ \varepsilon_i \\ \omega_i \\ r_B \\ \omega_{-i} \end{pmatrix} \sim N\left(\begin{pmatrix} \overline{r}_D \\ 0 \\ \overline{r}_D \\ \overline{r}_B \\ 0 \end{pmatrix}, \begin{pmatrix} \frac{1}{\alpha} & 0 & \frac{1}{\alpha} & \sqrt{\frac{1}{\alpha}}\sigma_B & \frac{1}{\alpha} \\ 0 & \frac{1}{\beta} & \frac{1}{\beta} & 0 & 0 \\ \frac{1}{\alpha} & \frac{1}{\beta} & \frac{1}{\alpha}+\frac{1}{\beta} & \sqrt{\frac{1}{\alpha}}\sigma_B & \frac{1}{\alpha} \\ \sqrt{\frac{1}{\alpha}}\sigma_B & 0 & \sqrt{\frac{1}{\alpha}}\sigma_B & \sigma_B^2 & \sqrt{\frac{1}{\alpha}}\sigma_B \\ \frac{1}{\alpha} & 0 & \frac{1}{\alpha} & \sqrt{\frac{1}{\alpha}}\sigma_B & \frac{1}{\alpha}+\frac{1}{\beta} \end{pmatrix}\right)$$

where ω_{-i} is the distribution of the signal of a player different from player i. We can compute

$$E\left[r_B|\omega_i\right] = \overline{r}_B + \frac{\sqrt{\frac{1}{\alpha}}\sigma_B}{\frac{1}{\alpha}+\frac{1}{\beta}}\left(\omega_i - \overline{r}_D\right)$$

and, using the definition of ρ_i, we obtain $E\left[r_B|\omega_i\right] = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ which yields expression (4).

A.2 Proof of Proposition 1

The proof for the direct finance case is as in Morris and Shin (2001), while the proof for the second case is an extension of the same proof. In their contribution, the gross return on investment conditional on ρ_i is a function equal to ρ_i. Yet, their argument applies to more general continuous piecewise linear functions g, as long as $g' \geq \sqrt{\gamma/\left(2\pi\right)}$ for all subintervals of g. The proof follows the same steps proposed by Morris and Shin

(2001) and we obtain, as an equilibrium, a switching strategy around ρ^*, where ρ^* solves $g(\rho^*) = \Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right)$. In the case of financial intermediation, the gross return equals $\overline{r}_B + \sqrt{\alpha}\sigma_B\left(r_D - \overline{r}_D\right)$, $g(\rho_i) = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ and the uniqueness condition becomes $\sqrt{\gamma/(2\pi)} \leq \sqrt{\alpha}\sigma_B$.■

A.3 Proof of Result 1

The proof starts with the computation of the level of investment.

Result *The level of investment, $1-n$, in an economy with investment threshold equal to ρ^T, equals $\iota\left(r_D;\rho^T\right) = \Phi\left(\sqrt{\beta}\left(r_D - \frac{\alpha+\beta}{\beta}\rho^T + \frac{\alpha}{\beta}\overline{r}_D\right)\right)$.*

Proof. The mass of investors is equal to the probability that any particular household invests. Given the realization of the factor r_D, this is the probability that the household's updated belief falls above ρ^T. Since $\rho_i|r_D \sim N\left(\frac{\alpha\overline{r}_D+\beta r_D}{\alpha+\beta}, \frac{\sqrt{\beta}}{\alpha+\beta}\right)$, then $\iota\left(r_D;\rho^T\right) = prob\left[\rho_i > \rho^T|r_D\right] = 1-\Phi\left(\sqrt{\beta}\left(\frac{\alpha+\beta}{\beta}\rho^T - \frac{\alpha}{\beta}\overline{r}_D - r_D\right)\right) = \Phi\left(\sqrt{\beta}\left(r_D - \frac{\alpha+\beta}{\beta}\rho^T + \frac{\alpha}{\beta}\overline{r}_D\right)\right)$.■

The expected profit of the FI equals $E\left[\iota_B\left(r_D - r_B\right)\right] = E\left[\iota_B\left(r_D - \overline{r}_D\right)\right]\left(1 - \sqrt{\alpha}\sigma_B\right) + E\left[\iota_B\right]\left(\overline{r}_D - \overline{r}_B\right)$ with $\iota_B = \iota\left(r_D;\rho''\right)$. Applying Stein's lemma, the expression for expected profit becomes $E\left[\phi\left(\sqrt{\beta}\left(r_D - \frac{\alpha+\beta}{\beta}\rho^T + \frac{\alpha}{\beta}\overline{r}_D\right)\right)\right]\sqrt{\beta}/\alpha\left(1 - \sqrt{\alpha}\sigma_B\right) + E\left[\iota_B\right]\left(\overline{r}_D - \overline{r}_B\right) > 0$.

Finally we prove that $\rho'' < \rho'$. We start with an intermediate result.

Result *When $\overline{r}_D > 1/2$, then $\rho' < 1/2$.*

Proof. If $\overline{r}_D = 1/2$, then $\rho' = 1/2$. Since $1 > \phi\left(\sqrt{\gamma}\left(\rho_i - \overline{r}_D\right)\right)\sqrt{\gamma}$ for all $\rho_i \neq 1/2$, by the method of implicit differentiation applied to $\rho' = \Phi\left(\sqrt{\gamma}\left(\rho' - \overline{r}_D\right)\right)$, we obtain $\frac{d\rho'}{d\overline{r}_D} < 0$ and the result follows.■

When $\overline{r}_B = \overline{r}_D$, $g(\rho_i) = (1 - \sqrt{\alpha}\sigma_B)\overline{r}_D + \sqrt{\alpha}\sigma_B\rho_i \equiv \widehat{g}(\rho_i)$. When $\sqrt{\alpha}\sigma_B < 1$ and $\rho' < \overline{r}_D$, then $\widehat{g}(\rho') > \rho'$ and $\widehat{g}(\rho') - \Phi\left(\sqrt{\gamma}(\rho' - \overline{r}_D)\right) > 0$. Since $\gamma \leq 2\pi\alpha\sigma_B^2$, the function $\widehat{g}(\rho_i) - \Phi\left(\sqrt{\gamma}(\rho_i - \overline{r}_D)\right)$ is increasing and $\rho'' < \rho'$.■

A.4 Proof of Proposition 2

The economic problem presented can be represented as a game with four stages. In the first stage, nature withdraws a realization from the distribution of the random variable r_D. In the second stage, nature withdraws the private signals. At the third stage, each household decides whether to invest or not. At the final stage, those households that decided to become investors, choose the best security in which to invest. Treating each realization of household i's signal as a possible "type", we solve for a Bayesian Equilibrium. I use backwards induction.

First, determine the optimal action at the final stage of the game.

Result *An agent with updated belief ρ_i: (i) Invests exclusively in the security with highest expected return; (ii) His maximum expected gain from investing is given by $G(\rho_i) = \max\{\rho_i, \overline{r}_B + \sqrt{\alpha}\sigma_B(\rho_i - \overline{r}_D)\}$; (iii) The threshold at which he switches from one form of finance into the other equals ρ^I.*

Proof. To see this note that $G(\rho_i) = \max_{\lambda\in[0,1]} E[\lambda r_D + (1-\lambda) r_B|\rho_i] = \max_{\lambda\in[0,1]} \lambda E[r_D|\rho_i] + (1-\lambda) E[r_B|\rho_i]$, where $E[r_D|\rho_i] = \rho_i$ and $E[r_B|\rho_i] = \overline{r}_B + \sqrt{\alpha}\sigma_B(\rho_i - \overline{r}_D)$. Under our assumptions, we obtain $\lambda = 1$ if $E[r_D|\rho_i] > E[r_B|\rho_i]$ and $\lambda = 0$ if $E[r_D|\rho_i] < E[r_B|\rho_i]$. When $E[r_D|\rho_i] = E[r_B|\rho_i]$ then $\lambda \in [0,1]$. Hence, function G is the upper envelope of two straight lines which intersect at $\rho^I = \frac{\overline{r}_B - \sqrt{\alpha}\sigma_B\overline{r}_D}{1-\sqrt{\alpha}\sigma_B}$. Given that $E[r_D|\rho_i] = \rho_i$ and

$E\left[r_B|\rho_i\right] = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$, it is easy to confirm that, except for $\rho_i = \rho^I$, the optimal portfolio is constituted by one single security.■

Second, I analyze the next to the last stage and determine if each household should invest or not.

Result *Provided $\gamma \leq 2\pi\psi$ there is a unique equilibrium. In this equilibrium, every household i refrains from investing if and only if $\rho_i \leq \rho^*$, where ρ^* is the unique solution to $G\left(\rho^*\right) = \Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right)$.*

Proof. This proof is identical to the proof of part (ii) in proposition 1, where function g is equal to G. Under this setup, the uniqueness condition becomes $\gamma \leq \min\left\{2\pi, 2\pi\alpha\sigma_B^2\right\}$.■

Finally, the proof that $\rho^* = \min\left\{\rho', \rho''\right\}$ is by contradiction. Note that, since function G is the upper envelope of two straight lines, then $\rho^* \in \left\{\rho', \rho''\right\}$. Suppose that $\rho^* = \rho'$ and $\rho' > \rho''$. Then $\rho^* = \Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right)$ and, given $\gamma \leq 2\pi\psi$, the slope of the function $\Phi\left(\sqrt{\gamma}\left(\rho - \overline{r}_D\right)\right)$ with respect to ρ is lower than 1 and we obtain $\rho_i < \Phi\left(\sqrt{\gamma}\left(\rho_i - \overline{r}_D\right)\right)$ for $\rho_i < \rho^*$. On the other hand, if $\rho'' < \rho^*$ then $\rho'' < \Phi\left(\sqrt{\gamma}\left(\rho'' - \overline{r}_D\right)\right) \Leftrightarrow \rho'' < \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho'' - \overline{r}_D\right)$. The definition of G implies that $\rho^* = \rho''$ and this is a contradiction. The proof for the case $\rho^* = \rho'' > \rho'$ is similar.■

A.5 Proof of Proposition 3

First, consider the cases in which in which $\sigma_B < \sqrt{\frac{1}{\alpha}}$.

Corollary 2 *When parameters are such that $\sigma_B < \sqrt{\frac{1}{\alpha}}$ and $\rho^* < \rho^I$, there is coexistence between direct and intermediated finance. Households with an updated belief below ρ^* do* *not invest, households with updated beliefs belonging to the set* $\left[\rho^*, \rho^I\right)$ *deposit their funds in the FI and those with higher updated beliefs invest directly in the firm.*

Proof. Households with updated beliefs above ρ^* expect positive returns. Their expected gain is equal to (i) ρ_i if they choose direct finance; and (ii) $\overline{r}_B+\sqrt{\alpha}\sigma_B\left(\rho_i+\overline{r}_D\right)$ if they choose intermediated finance. Investors with updated beliefs in the interval $\left[\rho^*, \rho^I\right)$ have $\rho_i < \overline{r}_B+\sqrt{\alpha}\sigma_B\left(\rho_i+\overline{r}_D\right)$ and they choose intermediated finance. Agents with updated beliefs above or equal to ρ^I have $\rho_i \geq \overline{r}_B+\sqrt{\alpha}\sigma_B\left(\rho_i+\overline{r}_D\right)$ and choose direct finance. ■

Corollary 3 *When parameters are such that* $\sigma_B < \sqrt{\frac{1}{\alpha}}$ *and* $\rho^* \geq \rho^I$*, financial intermediation is not feasible. Every investor chooses direct finance.*

Proof. When $\rho^* \geq \rho^I$ and $\sigma_B < \sqrt{\frac{1}{\alpha}}$, the expected gain on direct finance is higher than the expected gain on intermediated finance for those households with updated beliefs above ρ^*. ■

I now show that the two types of equilibria exist. The next result implies that the size of the intermediation sector depends on the value of the parameter $\overline{r}_B$.

Lemma 1 *When* $\sigma_B < \sqrt{\frac{1}{\alpha}}$*, then* $\frac{\partial\left(\rho^I-\rho^*\right)}{\partial\overline{r}_B} > 0$*.*

Proof. Two cases are possible. First, when $G\left(\rho^*\right)=\rho^*$, then $\frac{\partial\left(\rho^I-\rho^*\right)}{\partial\overline{r}_B}=\frac{1}{1-\sqrt{\alpha}\sigma_B}>0$. Second, when $G\left(\rho^*\right)=\overline{r}_B+\sqrt{\alpha}\sigma_B\left(\rho^*+\overline{r}_D\right)$, then $\frac{\partial\left(\rho^I-\rho^*\right)}{\partial\overline{r}_B}=\frac{1}{1-\sqrt{\alpha}\sigma_B}-\frac{1}{\phi\left(\sqrt{\gamma}\left(\rho^*-\overline{r}_D\right)\right)\sqrt{\gamma}-\sqrt{\alpha}\sigma_B}$. Since $\gamma \leq 2\pi\psi$, then $\phi\left(\sqrt{\gamma}\left(\rho^*-\overline{r}_D\right)\right)\sqrt{\gamma} < \sqrt{\alpha}\sigma_B$ and the result follows. ■

Proposition 5 *When* $\sigma_B < \sqrt{\frac{1}{\alpha}}$*, there is a threshold for* $\overline{r}_B$ *equal to* $\widehat{r}_B$ *above which intermediation exists and below which intermediation is not feasible.*

Proof. When $\rho^I > \rho^*$ financial intermediation exists and, when $\rho^I \leq \rho^*$, financial intermediation is not possible. For $\overline{r}_B > 1$ we obtain $\rho^I > 1 \geq \rho^*$. Using the definition of ρ^I, it is easy to confirm that $\rho^I > 1$. As for $\rho^* \leq 1$ note that: (i) if $G(\rho^*) = \rho^*$ then $\rho^* \leq 1$ because $\Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right) \leq 1$; (ii) if $G(\rho^*) = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ then $\rho^* = \frac{\Phi\left(\sqrt{\gamma}(\rho^* - \overline{r}_D)\right) - \overline{r}_B}{\sqrt{\alpha}\sigma_B} + \overline{r}_D < 1$.

For $\overline{r}_B < 0$ we obtain $\rho^I < 0 \leq \rho^*$. It is easy to check that $\rho^I < 0$. As for $\rho^* \geq 0$, note that: (i) If $G(\rho^*) = \rho^*$ then $\rho^* \geq 0$ because $\Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right) \geq 0$; (ii) If $G(\rho^*) = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ then $\rho^* = \frac{\Phi\left(\sqrt{\gamma}(\rho^* - \overline{r}_D)\right) - \overline{r}_B}{\sqrt{\alpha}\sigma_B} + \overline{r}_D > 0$.

Hence $\rho^I - \rho^* < 0$ for $\overline{r}_B < 0$ and $\rho^I - \rho^* > 0$ for $\overline{r}_B > 1$. The functions $\rho^*\left(\overline{r}_B\right)$ and $\rho^I\left(\overline{r}_B\right)$ are continuous and, given lemma 1, there is a unique threshold for $\overline{r}_B$ such that $\rho^I = \rho^*$ above which intermediation exists and below which intermediation is not feasible.

It remains to show that having $\rho^I = \rho^*$ is equivalent to having $\overline{r}_B = \widehat{r}_B$. To see this, consider the case in which $\rho^I = \rho^*$. Then $\rho^I = \overline{r}_B + \sqrt{\alpha}\sigma_B + \left(\rho^I - \overline{r}_D\right)$ and $\rho^I = \rho^* = \rho'$. From this expression, it is easy to derive that $\rho^I = \rho' \Leftrightarrow \overline{r}_B = \widehat{r}_B$. We can also obtain that $\rho^I \lesseqqgtr \rho^* \Leftrightarrow \overline{r}_B \gtreqqless \widehat{r}_B$ and the result follows. ■

Hence we have proved the first part of the proposition. Second, consider the cases in which $\sigma_B > \sqrt{\frac{1}{\alpha}}$.

Corollary 4 *When parameters are such that* $\sqrt{\frac{1}{\alpha}} < \sigma_B$ *and* $\rho^* \leq \rho^I$*, there is coexistence between direct and indirect finance. Households with an updated belief below* ρ^* *do not invest, households with updated beliefs belonging to the set* $\left[\rho^*, \rho^I\right]$ *invest directly in the firm, and those with higher updated beliefs deposit their funds in the FI.*

Proof. Investors with updated beliefs belonging to the set $\left[\rho^*, \rho^I\right]$ find direct finance more attractive since $\rho_i \geq \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i + \overline{r}_D\right)$, while more optimistic investors prefer direct finance. ■

Corollary 5 *When parameters are such that* $\sqrt{\frac{1}{\alpha}} < \sigma_B$ *and* $\rho^* > \rho^I$, *every investor chooses intermediated finance.*

Proof. We have $\rho_i < \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i + \overline{r}_D\right)$ for all investors. ■

Lemma 2 *When* $\sqrt{\frac{1}{\alpha}} < \sigma_B$, *then* $\frac{\partial\left(\rho^I - \rho^*\right)}{\partial \overline{r}_B} < 0$.

Proof. Similar to the proof of lemma 1. ■

Proposition 6 *When* $\sqrt{\frac{1}{\alpha}} < \sigma_B$, *there is a threshold for* $\overline{r}_B$ *equal to* $\widehat{r}_B$ *above which only intermediation exists and below which there is coexistence between direct and intermediated finance.*

Proof. When $\rho^I \geq \rho^*$, there is coexistence and when $\rho^I < \rho^*$ direct finance is not possible. For $\overline{r}_B > \sqrt{\alpha}\sigma_B$ we obtain $\rho^I < \rho^*$. First note that, with the definition of ρ^I, we can show that $\rho^I < 0$. Hence (i) if $G\left(\rho^*\right) = \rho^*$ then $\rho^* \geq 0$ and $\rho^I < \rho^*$; (ii) if $G\left(\rho^*\right) = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ then $\rho^* = \left(1 - \frac{1}{\sqrt{\alpha}\sigma_B}\right)\rho^I + \frac{\Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right)}{\sqrt{\alpha}\sigma_B} > \rho^I$.

For $\overline{r}_B < 1 - \sqrt{\alpha}\sigma_B$ we obtain $\rho^I > 1 \geq \rho^*$. First note that, by the definition of ρ^I we obtain $\rho^I > 1$. Hence (i) if $G\left(\rho^*\right) = \rho^*$ then $\rho^* \leq 1$ and $\rho^* < \rho^I$; (ii) if $G\left(\rho^*\right) = \overline{r}_B + \sqrt{\alpha}\sigma_B\left(\rho_i - \overline{r}_D\right)$ then $\rho^* = \rho^I + \frac{1}{\sqrt{\alpha}\sigma_B}\left[\Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right) - \rho^I\right] < \rho^I$.

The functions $\rho^*\left(\overline{r}_B\right)$ and $\rho^I\left(\overline{r}_B\right)$ are continuous and, given lemma 2, there is a threshold for $\overline{r}_B$ such that $\rho^I = \rho^*$. The proof that $\rho^I = \rho' \Leftrightarrow \overline{r}_B = \widehat{r}_B$ is identical to the proof in proposition 5. ■

Finally, consider the case in which $\sqrt{\frac{1}{\alpha}} = \sigma_B$. When $\overline{r}_B \leq \overline{r}_D$, the expected gain on direct finance is higher or equal to the expected gain on intermediated finance for every household and every investor chooses direct finance. When $\overline{r}_B > \overline{r}_D$ the expected gain on direct finance is inferior to the expected gain on intermediated finance and every investor chooses intermediated finance. ■

A.6 Proof of Corollary 1

We obtain $\rho^* < \rho'$ because $\overline{r}_B > \widehat{r}_B$ implies $\rho' < \rho^*$ and, when $\sigma_B < \sqrt{1/\alpha}$, we have $G(\rho^*) > \rho^*$. This means that $\Phi\left(\sqrt{\gamma}\left(\rho^* - \overline{r}_D\right)\right) > \rho^*$. Given that $\rho' = \Phi\left(\sqrt{\gamma}\left(\rho' - \overline{r}_D\right)\right)$ and $0 < \phi\left(\sqrt{\gamma}\left(\rho_i - \overline{r}_D\right)\right)\sqrt{\gamma} < 1$, for all $\rho_i \neq 1/2$, then $\rho^* = \rho'' < \rho'$. By the definition of ρ'' and the method of implicit differentiation, we obtain $\frac{\partial \rho''}{\partial \overline{r}_B} < 0$ and $\frac{\partial \rho''}{\partial \sigma_B} = \frac{\sqrt{\gamma}(\rho'' - \overline{r}_D)}{\phi\left(\sqrt{\gamma}(\rho'' - \overline{r}_D)\right)\sqrt{\gamma} - \sqrt{\alpha}\sigma_B}$. Result 1 states that, when $\overline{r}_D > 1/2$, $\rho' < 1/2$. Given that $\rho'' < \rho'$ and $\sigma_B \geq \sqrt{\frac{\gamma}{2\pi\alpha}}$, the result follows.■

References

[1] Acharya, V., Yorulmazer, T., 2007. Too many to fail - An analysis of time-inconsistency in bank closure policies. Journal of Financial Intermediation 16, 1-31.

[2] Acharya, V., Yorulmazer, T., 2008. Cash-in-the-Market Pricing and Optimal Resolution of Bank Failures. Review of Financial Studies 21, 2705-42.

[3] Admati, A. R., 1995. A noisy rational expectations equilibrium for multi-asset securities markets. Econometrica 53, 629-57.

[4] Adrian, T., Shin, H., 2007. Liquidity and leverage. Unpublished paper.

[5] Allen, F., Gale, D., 1997. Financial markets, intermediaries, and intertemporal smoothing. Journal of Political Economy 105, 523-546.

[6] Angeletos, G.-M., Werding I., 2006. Crises and prices: Information aggregation, multiplicity and volatility. American Economic Review 96, 1720-1736.

[7] Angeletos, G.-M., Pavan, A., 2004. Transparency of information and coordination in economics with investment complementarities. American Economic Review 94, 91-98.

[8] Bernanke, B., Gertler, M., 1989. Agency Costs, Net Worth, and Business Fluctuations. American Economic Review 79:1, 14-31.

[9] Bernanke, B., Gertler, M., Gilchrist, S., 1996. The financial accelerator and the flight to quality. Review of Economics and Statistics 78:1, 1-15.

[10] Bernanke, B., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework. In: Taylor J, Woodford M (Eds), Handbook of macroeconomics. North Holland.

[11] Bolton, P., Freixas, X., 2000. Equity, bonds, and bank debt: Capital structure and financial market equilibrium under asymmetric information. Journal of Political Economy 108, 324-51.

[12] Boot, A. W. A., Thakor, A. V., 1997. Financial system architecture. Review of Financial Studies 10, 693-733.

[13] Carlsson, H., Damme, E. van, 1993. Global games and equilibrium selection. Econometrica 61, 989-1018.

[14] Chan, Y., Greenbaum, S., Thakor, A., 1992. Is fairly priced deposit insurance possible? Journal of Finance 47, 227-45.

[15] Cottrell, P., 1980. Industrial Finance, 1830-1914, The Finance and Organization of English Manufacturing Industry. Methuen, London.

[16] Danielsson, J., Shin, H., 2003. Endogenous risk. In Modern Risk Management: A History, Risk Books.

[17] Davis, E. P., 2001. Multiple avenues of intermediation, corporate finance and financial stability. IMF Working Paper, WP/01/115.

[18] Davis, E. P., Ioannidis, C., 2004. External financing of US corporations: Are loans and securities complements or substitutes? Public Policy Discussion Papers 04-02, Brunel University.

[19] Demirgüç-Kunt, A., Levine, R., 1999. Bank-based and market-based financial systems: Cross-Country Comparisons. World Bank Policy Working Paper No. 2143.

[20] Demirgüç-Kunt, A., Maksimovic, V., 1998. Law, finance and firm growth. Journal of Finance 53, 2107-2137.

[21] Diamond, D., 1997. Liquidity, banks and markets. Journal of Political Economy 105, 928-956.

[22] Diamond, D., Dybvig, D., 1983. Bank runs, deposit insurance and liquidity. Journal of Political Economy 91, 401-19.

[23] Freixas, X., Rochet, J.-C., 1998. Fair pricing of deposit insurance. Is it possible? Yes. Is it desirable? No. Research in Economics, 52, 217-32.

[24] Freixas, X., Tsomocos, D., 2004. Book vs. fair value accounting in banking and intertemporal smoothing. Oxford Financial Research Centre Working Paper No. 2004-FE-13.

[25] Gatev, E., Schuermann, T., Strahan, P., 2004. How do banks manage liquidity risk? Evidence from the equity and deposit markets in the Fall of 1998. NBER working paper 10982.

[26] Gatev, E., Schuermann, T., Strahan, P., 2008. Managing bank liquidity risk: How deposit-loan synergies vary with market conditions. Review of Financial Studies, forthcoming.

[27] Gatev, E., Strahan, P., 2006. Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market. Journal of Finance 61, 867-892.

[28] Gersbach, H., Uhlig, H., 2007. On the coexistence of banks and markets. Scandinavian Journal of Economics 109, 225-243.

[29] Gorton, G., Pennacchi, G., 1990. Financial intermediaries and liquidity creation. Journal of Finance 45, 49-71.

[30] Greenspan, A., 1999. Do Efficient Financial markets mitigate financial crises? Speech to the Financial Markets Conference of the Federal Reserve Bank of Atlanta, 19 October, http://www.federalreserve.gov/BOARDDOCS/Speeches/1999/19991019.htm.

[31] Greenspan, A., 2000. Global challenges. Speech to the Financial Crisis Conference, Council on Foreign Relations, New York, 12 July, http://www.federalreserve.gov/boarddocs/speeches/2000/20000712.htm.

[32] Grossman, S., Stiglitz, J., 1976. Information and competitive price systems. American Economic Review 66, 246-253.

[33] Hellwig, C., Mukherji, A., Tsyvinski, A., 2005. Self-fulfilling currency crisis: The role of interest rates. NBER Working Paper 11191.

[34] Hoggarth, G., Reidhill, J., Sinclair, N., 2004. On the resolution of banking crises: Theory and evidence. Bank of England Working Paper no. 229.

[35] Holmstrom, B., Tirole J., 1997. Financial intermediation, loanable funds, and the real sector. Quarterly Journal of Economics, 113, 663-692.

[36] Jacklin, C., 1987. Demand deposits, trading restrictions and risk sharing. In: Prescott E, Wallace N (Eds), Contractual arrangements for intertemporal trade. University of Minnesota Press.

[37] Kane, E., Klingebiel, D., 2004. Alternatives to blanket guarantees for containing a systemic crisis. Journal of Financial Stability 1, 31-63.

[38] Kashyap, A., Rajan, R., Stein, J., 2002. Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking. Journal of Finance 57, 33-73.

[39] Laeven, L., Valencia, F., 2008. The use of blanket guarantees in banking crises. IMF Working Paper, WP/08/250.

[40] Levine, R., 1997. Financial development and economic growth: Views and agenda. Journal of Economic Literature 35, 688-726.

[41] Levine, R., 1999. Law, finance and economic growth. Journal of Financial Intermediation 8, 8-35.

[42] Levine, R., 2002. Bank-based or market-based financial systems: Which is better? Journal of Financial Intermediation 11, 398-428.

[43] Levine, R., Zervos, S., 1998. Stock markets, banks, and economic growth. American Economic Review 88, 537-558.

[44] Morris, S., Shin, H., 1998. Unique equilibrium in a model of self-fulfilling currency attacks. American Economic Review 88, 587-597.

[45] Morris, S., Shin, H., 2001. Rethinking multiple equilibria in macroeconomic modelling. NBER Macroeconomics Annual 2000, 139-161, MIT Press.

[46] Morris, S., Shin, H., 2002. The social value of public information. American Economic Review 92, 1521-1534.

[47] Morris, S., Shin, H., 2004. Liquidity black holes. Review of Finance 8, 1-18.

[48] Morris, S., Shin, H., Tong, H., 2006. Social Value of Public Information: Morris and Shin (2002) IsActually Pro-Transparency, Not Con: Reply. American Economic Review 96, 453-455.

[49] Morrison, A., White, L., 2004. Is deposit insurance a good thing, and if so, who should pay for it? Oxford Financial Research Centre Working Paper No. 2004-FE-08.

[50] Pennachi, G., 2006. Deposit insurance, bank regulation, and financial system risks. Journal of Monetary Economics 53, 1-30.

[51] Plantin, G., Sapra, H., Shin, H., 2008. Fair value accounting and financial stability. Financial Stability Review 12, 85-94.

[52] Repullo, R., Suarez, J., 2000. Entrepreneurial moral hazard and bank monitoring: A model of the credit channel. European Economic Review 44, 1931-1950.

[53] Rochet, J.-C., Tirole, J., 1996. Interbank lending and systemic risk. Journal of Money, Credit and Banking 28, 733-62.

[54] Rochet, J.-C., Vives, X., 2004. Coordination failures and the lender of last resort: Was Bagehot right after all? Journal of the European Economic Association 2, 1116-1147.

[55] Shin, H., 2008. Risk and liquidity in a system context. Journal of Financial Intermediation 17, 315-329.

[56] Song, F., Thakor, A., 2007. Financial system architecture and the co-evolution of banks and capital markets. Available at http://ssrn.com/abstract=879288.

[57] Svensson, L., 2006. Social value of public information: Morris and Shin (2002) is actually pro transparency, not con. American Economic Review 96, 448-452.

[58] Sylla, R.,1998. US securities markets and the banking system, 1790-1840. Federal Reserve Bank of St. Louis Review, May, 83-98.

[59] Tadesse, S., 2002. Financial Architecture and Economic Performance: International Evidence, Journal of Financial Intermediation 11, 429-454.

[60] Woodford, M., 2002. Imperfect common knowledge and the effects of monetary policy. In: Aghion P, Frydman R, Stiglitz J, Woodford M (Eds), Knowledge, Information, and expectations in Modern Macroeconomics. Princeton University Press.