Monitoring and the acceptability of bank money*

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Abstract

This paper presents a simple environment where bank-like financial intermediaries can endogenously emerge. The economy is one with investment projects whose returns depend on monitoring, and where agents value the liquidity of their investment. While monitoring enhances the economic return of long term projects, it also creates informational asymmetries that hamper their tradeability. In this setting, *ex ante* identical agents can specialise in the monitoring of project and create liquidity for their claim-holders. Intermediaries have the following appealing features. *(a)* They monitor their investments and as a consequence have private information about their quality; *(b)* Their assets are therefore illiquid; *(c)* Depositors are not informed about the quality of intermediaries' assets before they are realised; *(d)* Claims on intermediaries therefore have a high acceptability in exchange, and can be used as "inside money" by agents acting as depositors.

Keywords: banks, financial intermediation, monitoring, liquidity, informational asymmetries.

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1 Introduction

According to Gorton & Winton (2002), the circulation of some banks liabilities (deposits) as inside money remains an empirical puzzle to be explained. This paper tries to challenge this puzzle and to qualify the ongoing gap between financial intermediation theory and monetary theory. To do so, I construct an environment where financial intermediaries emerge that match two widely accepted stylised facts about banks. Indeed, banks provide useful services on both sides of their balance sheet. On the asset side, they closely monitor investment projects on which they have private information (Diamond 1984). On the liability side, they issue claims that have a high acceptablity in exchange and serve as means of payments (Tobin 1963). Considering the whole balance sheet, banks therefore transform illiquid private claims into liquid assets (Gurley & Shaw 1960).

While banks have historically performed those two functions – credit monitoring and liquidity creation – economic theory provides few explanations for this fact. Indeed, some famous economists advocate banking regulation that separate those two activities in two different types of financial insitutions, with a view to improve the stability of the payment system (Friedman 1959, e.g.). However recent developments in the microeconomics of banking and in monetary economics suggest that there can be economic logic behind this correlation between credit intermediation and liquidity provision[1]. Therefore, to analyse the welfare implication of these kinds of policies, it is important to construct models with explicit frictions that can account for this intertwinning between credit monitoring and inside money circulation. Ideally, we would like to have environments answering the following question: "Why do the same institutions that engage in credit monitoring have their claims circulating as means of payments?". More precisely, "Is there an exogenous reason that allows the existence of both activities, or is it the interplay between both activities that is essential?". This paper is an attempt to construct one such environment.

There is a scarce but growing literature on inside money, focusing on different issues and using different settings where money can play a role. Williamson (1999) introduces a banking sector in a search theoretic monetary framework *à la* Kiyotaki & Wright (1993) to allow for the circulation of private money. In a setting with limited commitment to repay one's debt,

[1] See e.g. Diamond & Rajan (2001) or Kashyap, Rajan & Stein (2002) for the microeconomics of financial intermediation, and Cavalcanti (2001) or Bullard & Smith (2002) for models of monetary economies. Early authors emphasising the linkage between money and credit include Schumpeter (1934) and Gurley & Shaw (1960).

Kiyotaki & Moore (2000) show that agents exogenously endowed with a higher ability to commit can issue inside money and "lend" their commitment skills to others. In Cavalcanti & Wallace (1999) and Cavalcanti (2001), this exogenous commitment technology is introduced through a subset of agents – labeled banks – that have their trading history publicly observed, and as a consequence can be socially disciplined[2]. From a somewhat different perspective, McAndrews & Roberds (1999) and Breton (2002) also use commitment problems to show how a centralised banking system can help agents engage in intertemporal exchange, even though the banking system faces the same frictions as individuals. In the latter paper, the threat of being excluded from the access of an intrinsically worthless bank note can be essential. Bullard & Smith (2002) build a model with spatial separation and an exogenous pattern of agents move to account for the joint activity of credit and money issuance by some individuals. However the aforementioned papers fail to explain the emergence of financial intermediaries and abstract from informational problems on the asset side, issues that have received wide attention in theories explaining financial intermediation. The paper most related to my work is Andolfatto & Nosal (2001). Embedding a *Costly State Verification* model in the wicksellian intertemporal triangle put foreward by Kiyotaki & Moore (2000), they provide an environment where the overall efficiency of exchange is higher when an agent acting as delegated monitor also issues money.

This paper explores another (complementary) route to explain the "moneyness" of banks liabilities and the illiquidity of their assets. I focuss primarily on informational asymetries as the main impediment to trade. This idea is associated with the formal work by Akerlof (1970), and has been used to rationalise the circulation of ouside money. The idea goes back to the property of recognisability of money, and is forcefully expressed by Alchian (1977, p. 39)[3]:

> It is not the absence of double coincidence of wants, nor the cost of searching out the market of potential buyers and sellers of various goods nor of record keeping, but the costliness of information about the attributes of goods available for exchange that induces the use of money in an exchange economy.

[2] These papers use a mechanism design approach and explore the idea that exchange can be obtained by collective punishment with perfect public memory (Kocherlakota 1998).

[3] See also Brunner & Meltzer (1971) and Goodhart (1989). However, this intuition has only been formalised recently, for instance by Williamson & Wright (1994) and Banerjee & Maskin (1996). See the discussion below.

The symmetry of information about the value of money can therefore explain why money is the most liquid asset (Holmström 1996). This idea seems particulary appealing when it comes to the circulation of bank deposits as means of payments, *id est* inside money. The monitoring activity of banks comes with some private information that can account for the illiquidity of their assets (Goodhart 1989). Besides, there is empirical evidence that depositors in a given bank do not have specific information about the asset of that bank, suggesting a reason why banks deposits could more easily be exchanged among depositors.

To abstract from reputation issues, I will consider a three date ($t = 0, 1, 2$) production economy where long term projects can be costly monitored, and agents value the liquidity of their investment. The main features of the environment and the intuitions can be best presented with a simple example. Take an individual A who owns an asset whose quality is uncertain and uneasy to ascertain by any other agent. That asset will yield a return at date 2. A himself knows the true quality of his asset and for some exogenous reason – consumption need or investment opportunity – he seeks to sell his asset, say at date $t = 1$ before it yields anything (before maturity, at date $t = 2$). He meets a potential buyer B. If the uncertainty of the asset's quality is high, B can fear that A is willing to sell not because of a liquidity need, but because of A's private information on the future profitabilty of the asset. Informational asymmetry between A and B then limits the liquidity of the asset.

Now further assume that the asset owned by A was initally (at date $t = 0$) an investment opportunity (a project). A can take two decisions regarding this project. First he can decide whether or not to undertake it. Then, if he undertakes it, he can decide whether or not to acquire some specific information on the project characteristics, allowing him to take some actions that enhance the future profitability of the project. We shall say that he "monitors", which implies that he exerts effort and will know more about the project that outsiders. This information allows more efficient actions to be taken. But it also reduces the ability to sell the asset in case of a liquidity need, for the reason presented before. Monitoring and the associated information acquisition about projects create informational asymmetries (with respect to other economic agents). The problem is still more complicated if monitoring is unobservable, for A will take into account in his date 0 decision to monitor or not the fact that he could try to sell his project at date 1, which could lead to lower incentives to exert costly monitoring.

In this environment, information about projects has a positive side for it allows a better use of resources. It also has a negative side because it creates information asymmetries that destroy some exchange opportunities. This "double value" of information suggests a way for financial intermediaries to create liquidity. Suppose that some agents give up liquidity and act as delegated monitors: they collect some endowments, monitor some projects, and promise their claim-holders (henceforth "depositors") a future payment in case of success. Information about projects will therefore be concentrated in the hand of those agents exerting monitoring. My claim is that this frees other agents from the negative aspect of information: as they don't have *interim* (date $t = 1$) private information about their intermediary's projects, they can exchange their rights over future goods. For this to work, the agents that monitor must of course be compensated from giving up liquidity and must monitor the projects (monitoring is not observable). This agency problem is solved through the intermediary structure. The fact that an intermediary keeps the project till completion and that he creates liquidity for depositors have a positive effect on its incentives. As liquidity has a value for depositors, they are ready to accept a lower future expected payment. Moreover, the illiquidity of intermediaries' assets are rationalised by their private information.

The remaining of this paper constructs a formal environment for this example, and shows that this intuition is valid. The financial intermediaries that will endogenously emerge have the following appealing features:

- They monitor their investments and as a consequence have private information about their quality;
- Their assets are therefore illiquid;
- Depositors are not informed about the intermediaries' assets;
- The claims on intermediaries can therefore be exchanged (Financial intermediaries liabilities are liquid).

Apart from the literature on inside money, this paper is related to two strands of literature. First, it is related to the bunch of papers that build on a lemon problem *à la* Akerlof (1970) to explain the role of money. The informational problem can be related to uncertainty about goods to be exchanged as in Williamson & Wright (1994) or Banerjee & Maskin (1996), or about the quality of assets as, e.g., in Freeman (1985) or Smith (1986). One caveat of those papers is that they take private information as given. In my analysis, private information on projects will be an endogenous outcome related to the decision to monitor. Distribution of information on any asset – including inside money – will be endogenously determined. Indeed, in a developed financial system, most private information about investment comes from some agents engaging in costly monitoring activities.

As the working example makes clear, this work is also closely related to the literature on the rationale for financial intermediation. The analysis brings together costly information acquisition on the asset side with liquidity provison on the liability side. However delegated monitoring does not come from economies in auditing costs as in Diamond (1984). Indeed, individuals have enough endowment to invest in a project and monitor on their own. On the liability side, the emphasis is not on liquidity insurance through demandable deposits as in Diamond & Dybvig's (1983) seminal paper, but on the higher acceptability of the claim on intermediaries. This yields some important differences with recent contributions considering the fragility of banks stemming from the deposit withdrawing option as an incentive scheme for disciplining the banker (Calomiris & Kahn 1991). Diamond & Rajan (2001) build on this idea a theory of bank where the fragility of the balance prevents the initial lender – the bank – to use his relationship capital to extract future rent. However, banks deposits are liquid mainly because they can be used as means of payments. I think that this is the main mechanism by which the banking system creates liquidity.

The remaining of the paper is organised as follows. Section 2 presents the environment, as well as two benchmark cases, autarky and full information. Section 3 presents a market outcome for this economy, and section 4 an equilibrium with financial intermediation. Section 5 shows which one will prevail, and section 6 concludes.

2 The environment

2.1 Preferences

I consider a two periods (three dates, $t = 0, 1, 2$) economy populated by two groups of risk-neutral agents.

First, there is a continuum of agents born at $t = 0$ and living for two periods, with mass unity. Those group 1 agents maximise a utility function with stochastic time preference. At $t = 0$, their expected utility is given by

$$u\left(\tilde{\phi}, c_1, c_2\right) = \tilde{\phi} c_1 + c_2 \quad (1)$$

with the preference shock $\tilde{\phi}$:

$$\tilde{\phi} = \begin{cases} 1 & \text{with probability } 1-\lambda \\ \rho & \text{with probability } \lambda \end{cases} \tag{2}$$

with $\rho > 1$. With probability λ, an agent has at date 1 a preference for date $t = 1$ consumption over future consumption, measured by ρ: he is "impatient". With probability $1 - \lambda$, he is "patient". Preference shocks are realised at $t = 1$, publicly unobservable and i.i.d. accross agents. Furthermore, those agents have an initial endowment $e_0 = 1$ that they invest in a long term project described below.

Second, there is a continuum of group 2 agents born at $t = 1$, with mass higher than 1. They maximise their date 2 expected consumption (their utility is given by $v(c_1, c_2) = c_2$) and have an endowment $e_1 > y$ at $t = 1$. This second group of agents is introduced as a simple way to have potential buyers at $t = 1$ for the long term projects initiated by agents in the first group[4].

2.2 Technology

There are two technologies, a storage technology available to every agent, and long term projects available only to group 1 agents. The storage technology is perfectly divisible and yields one unit of date $t + 1$ good for each unit of t good stored.

Group 1 agents can invest an amount $I_0 = 1$ at $t = 0$ in a long term project with the following properties. Once undetaken, a project only produces at maturity, at $t = 2$. A project can succeed and yield y or fail and yield nothing. The probability of success depends on the agent's action, *id est* wether he monitors the project or not. Without monitoring, a project succeeds with probability π_1. The agent investing in the project can choose to monitor the project, by exercising an effort $t = 0$ which costs c. Monitoring is not publicly observable and has two effects. First, it raises the probability of success from π_1 to π_2. Second, the agent receives at $t = 1$ a perfect private signal on the success/failure of his project in time $t = 2$. These assumptions capture the idea that in order to monitor one needs to acquire specific information about the project[5]. Monitoring is socially efficient

[4] The following structure would yield the same results. There is only one type of agents, but only some of them are endowed with a project opportunity, and there are enough patient agents at date $t = 1$ for the storage technology to be used at date 1.

[5] This could be rationalised as follows. Monitoring is an action that can be taken in case you know that the project is going to fail (probaibilty $1 - \pi_1$). This action succeeds

by assumption

$$(\pi_2 - \pi_1)\, y > c \tag{A1}$$

Parameters are such that group 1 agents strictly prefer investing in a project over using the storage technology. With the preferences (1), the following condition holds:

$$\pi_2 y - c > \lambda\rho + 1 - \lambda \tag{A2}$$

To simplify the analysis, I will assume that an unmonitored project has a low return. More precisely, I assume that:

$$\rho\pi_1 < 1 \qquad\qquad \pi_1 y < 1 \tag{A3}$$

This assumption is not critical but allows to simplify the analysis of the market outcome.

2.3 Assumption on information

There are three sources of private information in this environment. Individual preference shocks realised at $t = 1$ are private. The action of monitoring and the signal received by the agent are private information. The distinctive feature of the environment is the combination of unobservable private preference shocks and unobservable monitoring.

2.4 Benchmark cases

It will be usefull in what follows to compare the equilibrium with the benchmark case of perfect information. If all information was public, projects would be undertaken (see assumtion (A1)) and monitored (see assumption (A2)). Conditional on a preference shock ρ, an impatient agent with a project worth y units of date $t = 2$ good could trade it with a group 2 agent for y units of date $t = 1$ good. *Ex ante* utility for a group 1 agent would be given by:

$$V^* = [\lambda\rho + 1 - \lambda]\, \pi_2 y - c \tag{3}$$

Another usefull benchmark is autarky. First assume that no exchange can take place : an agent investing in a project cannot sell it at date $t = 1$.

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with probability γ in which case the project yields y. Information acquisition allows to raise the probability of success by $(1 - \pi_1)\, \gamma$. One gets the specifications in the text with $\pi_2 - \pi_1 = (1 - \pi_1)\, \gamma$.

With no monitoring, utility is given by the expected date 2 consumption $\pi_1 y$. With monitoring, a group 1 agent has a expected utility $\pi_2 y - c$. Under assumptions (A1) and (A2), agents invest in projects and monitor. The expected utility V^a of a group 1 agent in autarky is then

$$V^a = \pi_2 y - c \tag{4}$$

Goods in process are by assumption an illiquid asset. Compared to the first best V^*, this illiquidity has a cost, for an impatient agent must wait till $t = 2$ to consume:

$$V^a = V^* - \underbrace{\lambda\,(\rho - 1)\,\pi_2 y}_{\text{cost of autarky}} \tag{5}$$

The cost of autarky C^a can be computed as

$$C^a = \lambda\,(\rho - 1)\,\pi_2 y \tag{6}$$

The higher the probability of being impatient (λ) or the bigger the impatience (ρ), the higher the cost C^a. As a group 2 agent is indifferent between consuming at $t = 1$ or at $t = 2$, there should be trading opportunities between an impatient agent ($\rho > 1$) and a group 2 agent.

We next turn to the analysis of two institutional arrangements for this trading, involving a market or intermediation.

3 A market equilibrium

Suppose that at $t = 1$ a market opens where impatient agents could sell their project to group 2 agents. Such a market aims at creating liquidity. The problem is that neither preference shocks nor monitoring activities are publicly observable. Public information does not allow an outside agent to discriminate between projects at date $t = 1$. As a consequence, any project that is offered on this market should obtain the same price. Suppose that at $t = 1$ a project can be sold to a group 2 agent against l units of date 1 good. l is the price of a project.

3.1 Monitoring strategy

Compared to autarky, behaviour of group 1 agents is modified in two ways. On the one hand, a patient agent can use the market to get rid of a project that he knows will yield nothin at $t = 2$. On the other hand, the opportunity to sell can weaken the incentives to monitor the project: one can invest in a project in order to sell it at $t = 1$. The opening of a market raises both the surplus from not monitoring and the surplus from monitoring. What follows is a precise analysis of this fact.

Consider first the no monitoring strategy. At $t = 1$, the agent does not have any information on the future ($t = 2$) realisation of his project. The date $t = 1$ expectation of the date $t = 2$ yield of the project is therefore $\pi_1 y$. If he keeps his project, his expected $t = 2$ consumption is then $\pi_1 y$. If he sells his project at date $t = 1$ at the price l in order to consume at $t = 1$, his utility is given by ρl or l conditional of his preference shock. Taking into account the optimal selling decision at $t = 1$, the no monitoring strategy yields an expected utility at $t = 0$:

$$V^u = \lambda \max(\rho l, \pi_1 y) + (1 - \lambda) \max(l, \pi_1 y) \tag{7}$$

On the contrary, an agent that monitors his project knows at $t = 1$ its future return. With probability $(1 - \pi_2)$, he learns that the project will yield nothing at $t = 2$;. he then uses the market to sell his worthless project at $t = 1$. With probability π_2, he learns that his project will yield y with certainty at $t = 2$. In this case, his selling decision is conditional on his preference shock and on the price l. As preference shocks and project outcome are independant variables, the date $t = 0$ expected utility for an agent monitoring his project is:

$$V^i = (1 - \pi_2)(\lambda\rho + 1 - \lambda) l + \lambda\pi_2 \max(\rho l, y) + (1 - \lambda)\pi_2 \max(l, y) - c \tag{8}$$

The equilibrium decision to monitor depends on $V^i - V^u$. Let x denote the proportion of group 1 agents who control their projects. Formally, this is given by the correspondance:

$$x = \begin{cases} 0 & \text{iff} \quad V^i - V^u < 0 \\ [0,1] & \text{iff} \quad V^i - V^u = 0 \\ 1 & \text{iff} \quad V^i - V^u > 0 \end{cases} \tag{9}$$

Comparing (7) and (8) shows that the value of monitoring for an individual is twofold:

- On the one hand, monitoring enhances long term returns on projects. In this respect, monitoring has a positive social value. This was the only relevant aspect of monitoring in autarky.

- On the other hand, the private information about projects allows an agent to sell at date $t = 1$ a project that is going to yield nothing at $t = 2$. This information has a positive individual value, but has a negative effect on the economy as a whole.

3.2 Equilibrium

Group 2 agents are fully rational. They do not discount future consumption, and their total endowment is higher than the total amount of date 2 goods that can be generated by projects. As a consequence, the equilibrium market price is the expected return on a project offered at date 1:

$$l = \mathrm{E}\left[\tilde{y}|selling\right] \tag{10}$$

Expectations in (10) are taken with respect to the monitoring decision of agents and to the optimal selling decision comditional on private realised shocks (preference and signal) and on the price l. A rational expectation equilibrium for this market can therefore be defined as a price l and monitoring and selling strategies that validate this price:

Definition 1. *An equilibrium on the market is a price l^* and a proportion of agents that monitor x^* such that:*

1. *The price l^* is validated by selling decisions for a given x^*. Formally, l^* is given by (10).*
2. *Monitoring strategies are rational for the price l^*. Formally, x^* is on the correspondence (9)*

Assumption (A3) imposes restrictions on the candidate equilibrium price. Firstly, investing without monitoring is not rational if the expected price is lower than 1, because storage is then prefered to investing without monitoring (assumptions (A2) and (A3)). So there cannot be uninformed agents at $t = 1$ if $l < 1$. Secondly, the market price must be higher than $\frac{y}{\rho}$. Otherwise, no project yielding y with certainty would be offered. At best some project yielding an expected $\pi_1 y$ would be sold, implying $l^* < 1$. Using the preceding reasoning, $x = 1$ and only projects yielding 0 at $t = 2$ are offered. If the market is active, one therefore has:

Lemma 1. *If the market is active ($l^* > 0$), then $\frac{y}{\rho} \leq l^* < y$. Moreover if some projects are not monitored ($x^* < 1$), then $1 < l^*$.*

Lemma 1 implies that it is sufficient to compare the monitoring and no monitoring strategies for prices $l > \max\left(1, \frac{y}{\rho}\right)$, as we know that monitoring is a dominant strategy for $l < 1$. For those values, an unmonitored project is always sold at $t = 1$ whatever the preference shock, as $l^* > \pi_1 y$. An agent that monitors sell at $t = 1$ if his project yields nothing at $t = 2$, and sell a project worth y in case of shock ρ, as $l^* > \frac{y}{\rho}$. An agent anticipating that he will be able to sell his project at the price l^1 chooses to monitor if and only if the gain for monitoring $V^i - V^u$ is positive, with:

$$V^i - V^u = \pi_2 (1 - \lambda)(y - l) - c \tag{11}$$

Condition (11) has the following interpretation. With no monitoring, a project is allways sold at $t = 1$ (equation (7)). Therefore, monitoring is only valuable when the project is retained, that is to say when the agent is patient and knows that his project will yield y. This occurs with probability $\pi_2 (1 - \lambda)$. When this is the case, the gain is $y - l$. Comparing with (A2), one can see that the incentives to monitor are modified by the opening of the market. Monitoring raises the probability of success. The information allows a patient agent to keep only valuable projects. the private gain form monitoring decreases with the market price l because the project would be sold if unmonitored. According to (11), a project is monitored if and only if l^* is lower than a threshold l^s:

$$l^s \equiv y - \frac{c}{\pi_2 (1 - \lambda)} \tag{12}$$

The market price at $t = 1$ depends on the proportion x^* of investors monitoring their own project. First consider the case where everyone monitors his project ($x^* = 1$). An investor have at $t = 1$ a private information on the return y or 0 at $t = 2$. If he learns that the project will give nothing at $t = 2$ – which happens with probability $1 - \pi_2$ – he sells it on the market at $t = 1$. As the equilibrium price l^* is necessarily lower than y, a valuable project – probability π_2 – is sold if and only if the agent is impatient – probability λ – and if the price is high enough, $\rho l^* > y$. If this condition holds, the offer of project on the market is as follows. There is a quantity $1 - \pi_2$ of worthless projects and a quantity $\lambda \pi_2$ of projects yielding y. The price is therefore given by:

$$l^1 \equiv \frac{\lambda \pi_2}{\lambda + (1 - \pi_2)(1 - \lambda)} y \tag{13}$$

If $x^* < 1$, there are some unmonitored projetcs owned by passive investor that allways sell their project, while an active investor only keeps project worth y when he is patient. With a reasoning similar to the preceding case, one can compute the expected $t = 2$ value of a project in the market:

$$l(x) = \frac{x\lambda\pi_2 + (1-x)\pi_1}{1 - x + x[\lambda + (1-\pi_2)(1-\lambda)]} y \tag{14}$$

The market price (14) increases with the proportion of agents that monitor, for price values given by lemma 1. As the gain from monitoring decreases with the market price accroding to (11), one can conclude that the equilibrium (l^*, x^*) is unique[6]

Lemma 2. *If there exists an equilibrium with $l^* > 0$, it is unique.*

With lemmas 1 and 2 it is straigthforward to characterise an equilibrium with active market ($l^* > 0$) when it exist. Details of computations and proofs are gathered in appendix A. The graph in figure 1 reproduces the different cases in the (λ, ρ) space.

First consider a situation where every body monitor, $x^* = 1$. The market price is then $l^* = l^1$. For this to be an equilibrium, two conditions must be satisfied. First, the price must be high enough to attract valuable projects, $l^1 > \frac{y}{\rho}$. Second, monitoring must be prefered to no monitoring, $l^1 < l^s$. If those condition hold, the market is active and projects are monitored, $x = 1$ et $l^* = l^1$.Formally, one gets:

Proposition 1. *$l = l^1$, $x = 1$ is an equilibrium if and only if*

$$\pi_2(1 + \lambda(\rho - 1)) > 1 \tag{15}$$

$$\pi_2(1-\lambda)(1-\pi_2)y > [\lambda + (1-\pi_2)(1-\lambda)]c \tag{16}$$

This occurs in area A, figure 1. The price incorporates an information asymmetry premium, but informational asymmetries are not too severe. The private information obtained when monitoring a project hampers the ability of the market to create liquidity, because agents can sell worthless projects. The market is active, but agents strategically use the market to get rid of worthless projects. As a consequence liquidity creation is limited by informational asymmetries, and the price l^1 has a premium component Γ which is paid by impatient agents selling their projects. The market price can be expressed as:

$$l^1 = (1 - \Gamma)\pi_2 y \tag{17}$$

[6] Proofs and computations are contained in appendix A.

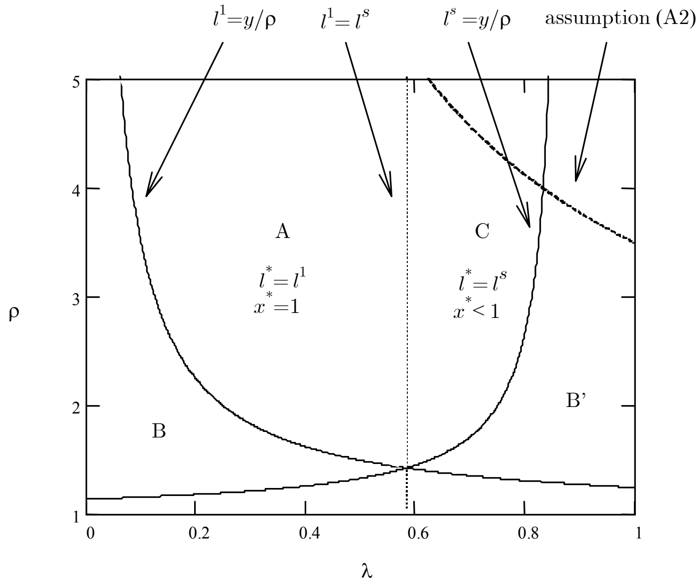

Figure 1: Market configurations. $y = 5$, $\pi_2 = 0,8$, $\pi_1 = 0,16$, $c = 0,5$.

with the information asymmetry premium Γ given by

$$\Gamma = \frac{(1-\pi_2)(1-\lambda)}{\lambda + (1-\pi_2)(1-\lambda)} \tag{18}$$

Γ measures the proportion of pateint agents using the market to sell a project they know will yield nothing at $t = 2$. It is therefore a measure of the use of the market for purposes other than liquidity. Valuable projects are offered if ond only if $l > \frac{y}{\rho}$, which yields:

$$\Gamma < \bar{\Gamma} = \frac{\rho\pi_2 - 1}{\rho\pi_2} \tag{19}$$

When (19) holds, the market is active. Using l^1 and V^i as given by (13) and (8), the *ex ante* utility V^1 for a group 1 agent can be expressed as

$$V^1 = V^* - \underbrace{\lambda(\rho - 1)\Gamma\pi_2 y}_{\text{lemon cost}} \tag{20}$$

$$C^1 = \lambda(\rho - 1)\Gamma\pi_2 y \tag{21}$$

The market then improves on autarky (compare C^1 with C^0 given by (6) and use $\Gamma < 1$).

When condition (19) does not hold, or equivalently when $l^1 < \frac{y}{\rho}$, the lemon problem is so severe that no price can induce impatient agent to sell a valuable project. too many worthless projects are offered in the market.Information asymmetries between buyers and seller lead a market shutdown *à la* Akerlof (1970). Projects are illiquid, and the "cost of the market" is the cost of autarky C^a. This arises in area B on figure 1.

Proposition 2. *If $\pi_2 (1 + \lambda (\rho - 1)) < 1$ then the market is not active. Everybody monitor ($x^* = 1$), and no project is sold at $t = \dot{1}$. The situation reduces to autarky.*

In the two preceding cases, the problem stems from the private information associated with project monitoring. In the following cases, market failures stems from the weakening of the incentives to monitor. The opportunity to sell leads some of the agents not to monitor because they plan to sell their investment later on. In area C, this inefficiency gives rise to a market price $l^s < l^1$, but the market is still active for the price is high enough to induce active investors to offer projects worth y at $t = 2 : l^s > \frac{y}{\rho}$.

Proposition 3. *The equilibrium is given by $l^* = l^s$ and $0 < x^* < 1$ if and only if the two following conditions hold:*

$$\pi_2 (1 - \lambda) \frac{\rho - 1}{\rho} y \quad > \quad c \tag{22}$$

$$\pi_2 (1 - \lambda) (1 - \pi_2) y \quad < \quad [\lambda + (1 - \pi_2) (1 - \lambda)] c \tag{23}$$

Ex ante utility V^x can be obtained by plugging (12) into V^u:

$$V^x = (\lambda\rho + 1 - \lambda) \left(y - \frac{c}{\pi_2 (1 - \lambda)} \right) \tag{24}$$

$$V^x = V^* - C^x \tag{25}$$

with the cost C^x given by

$$C^x = \frac{\lambda\rho + (1 - \pi_2) (1 - \lambda)}{\pi_2 (1 - \lambda)} c - (\lambda (\rho - 1) + 1) (1 - \pi_2) y \tag{26}$$

Finally, when the monitoring problem is too severe, no equilibrium price can sustain the market. This market shutdown is also due to informational asymmetries as it is not possible to observe monitoring. When the proportion of monitored project is too low, the market cannot work, and one go back to autarky. This market shutdown arises in area B', where $l^1 > \frac{y}{\rho} > l^s$.

Proposition 4. *If* $\pi_2(1+\lambda(\rho-1)) > 1$ *and* $\pi_2(1-\lambda)\frac{\rho-1}{\rho}y < c$, *then the market is inactive*

4 An equilibrium with intermediation

In this environement, information about projects has a positive side for it allows a better use of resources. It also has a negative side because it creates information asymmetries that destroy some exchange opportunities with group 2 agents. In the preceding situation, the market has got to create liquidity and gives the incentives to monitor at the same time.

In this section, we analyse how the emergence of intermediaries is a different answer to the interplay between liquidity and monitoring. The fact that information obtained when monitoring hampers liquidity suggests a way for intermediaries to create liquidity. Suppose that a group 1 agent gives up liquidity. He makes the following offer to N agents (henceforth "depositors"): he collects the endowments, monitors the $N+1$ projets, and promises to the depositors a payoff R in case of success. The intuition runs as follows. Concentration of information about projects frees the N other agents from the negative aspect of information: as they don4t know at date $t=1$ the quality of projects, they can exchange their rights over future goods with group 2 agents. Group 2 agents will not be afraid of participating to an unfair exchange. For this to work, the agent that monitors must of course be compensated from giving up liquidity and must monitor the projects (monitoring is not observable).

We now turn to see whether this can be sustained as an equilibrium. In other words do some agents have an incentive to act as intermediaries and offer a proposition such that they have an incentive to monitor and are able to attract depositors by offering them more than what they could get otherwise? Denote by V^0 the welfare with the market if it is active or with autarky. As an agent can always get this outside option, nobody acts as intermediary or contracts with an intermediary if he does not get at least V^0.

The *ex ante* homogeneity of agents will allow a simple characterisation of equilibrium. An equilibrium with intermediation must satisfy three conditions. 1/ An agent acting as intermediary must yield his depositors at least their outside option. 2/ An intermediary must be given the incentives to monitor. And 3/ As agents can choose between acting as intermediary or being depositors, the equilibrium expected utility should be the same (there is free entry into the intermediation activity).

4.1 Equilibrium conditions

Consider an intermediary contracting with N "depositors". As group 1 population is a continuum, N will be the equilibrium proportion of depositors to intermediaries. For computational comvenience, we treat N as a continuous variable. Denote by V the expected (at $t = 0$) utility that his depositors could get by depositing in an other intermediary or by acting themselves as intermediary. In to attract depositors, an intermediary must offer them at least an expected utility of $\max\left(V, V^0\right)$.

Denote by π^a the expected probability that a project undertaken by the intermediary succeeds[7]. At $t = 1$, an impatient depositor can try to exchange his asset on the intermediary with a group 2 agent in exchange for the quantity d of goods. Depositors participate if and only if

$$\lambda\rho d + (1-\lambda)\,\pi^a R \geq \max\left(V, V^0\right) \tag{27}$$

As depositors do not monitor directly, they do not have any private information at $t = 1$ on the quality of the projects held by the intermediary. Group 2 agents have the same information: at date $t = 1$, a depositor can therefore sell his claim on the intermediary in exchange for $d = \pi^a R$ units of date $t = 1$ goods with group 2 agents. A patient depositor keeps his claim. The participation cosntraint (27) then gives

$$(\lambda\rho + 1 - \lambda)\,\pi^a R \geq \max\left(V, V^0\right) \tag{PCu}$$

The probability π^a depends on the monitoring exerted by the intermediary. Monitoring is not observable but the overall return on the intermediary portfolio could be used to infer the monitoring exerted by the intermediairy. In order not to make the results depending on this property, which is specific to the modelling choice, I exclude this possibility[8]. If the signal given by the proportion of projects that succeed is not used, the monitoring exerted by an intermediary is "all or nothing", because the monitoring cost c is incurred for each project. The incentive condition to monitor is thus:

$$(\pi_2 - \pi_1)\,(y - R) > c \tag{ICif}$$

[7] Whether π^a is the probability or the proportion is irrelevant, as agents are risk-neutral.

[8] It would be easy to build slightly different environments with different inference properties. Here, one can assume that all projects undertaken by a given agent are perfectly correlated, or behave like a big size $N+1$ project, with a probability of success depending on a monitoring intensity $q \in [0,1]$: $\pi = \pi_1 + q\,(\pi_2 - \pi_1)$. Note that this restriction makes the emergence of intermediation less likely.

Comparing with autarky – where the condition writes $(\pi_2 - \pi_1)\, y > c$ – one can see the agency problem stemming from the fact that the intermediary monitors partly on behalf of other agents.

The third condition relates to the activity choice: agents can choose to be a depositor or an intermediary, so an intermediary must obtain in equilibrium at least what he would get as depositor:

$$(N+1)\left(\pi_2\,(y-R)-c\right) \geq \max\left(V, V^0\right) \tag{PCif}$$

To conclude, feasibility requires that

$$0 \leq R \leq y \tag{28}$$

4.2 Equilibrium characterisation

The utilities for an intermediary and a depositor, for an intermediary with N depositors offering a payment R at $t = 2$ can be expressed as:

$$V_D\,(R, N) = (\lambda\rho + 1 - \lambda)\,\pi_2 R \tag{29}$$

$$V_{IF}\,(R, N) = (N+1)\left(\pi_2\,(y-R)-c\right) \tag{30}$$

An intermediary seeks to maximise his utility subject to the participation constraint of depositors:

$$\begin{aligned} \max_{R,N} \quad & V_{IF}\,(R, N) \\ \text{s. t.} \quad & V_D\,(R, N) \geq \max\left(V, V^0\right) \\ & (\pi_2 - \pi_1)\,(y-R) > c \end{aligned} \tag{$\mathcal{P}0$}$$

Free entry into the intermediation activity implies that at an equilibrium with intermediation $V = \max\,(V_D, V_{IF})$. Intermediation is a Pareto-optimal institutional arrangement if and only if there exists a value V higher than V^0 – what agents would obtain with the market – such that individual rationality conditions (PCu) and (PCif), the incentive condition (ICif) and the feasability condition (28) are satisfied. If such a value exists, the outside option of depositors is given by contracting with another intermediary or acting as intermediary. Competition between intermediaries for depositors and the choice between acting as a depositor or as an intermediary gives the following characterisation:

Definition 2. *An equilibrium with intermediation is characterised by a utility level V and intermediaries with size N and payoff R such that*

$$R, N \in \arg\max_{R,N} V_D(R, N) \tag{$\mathcal{P}1$}$$

subject to

$$V_{IF}(R, N) \geq V$$
$$(\pi_2 - \pi_1)(y - R) > c$$

with $V = \max_{R,N} V_D(R, N)$

By solving ($\mathcal{P}1$) one can easily characterise an equilibrium with intermediation, owing to the *ex ante* homogeneity of agents.

Proposition 5. *If the equilibrium is intermediated, then*

$$R = y - \frac{c}{\pi_2 - \pi_1} \tag{31}$$

$$N + 1 = (\lambda\rho + 1 - \lambda)\frac{\pi_2}{\pi_1}\left[(\pi_2 - \pi_1) y - c\right] \tag{32}$$

Proof. See appendix B. □

The choice between the two activities yields a finite size for an intermediary, as the profitability of intermediation increases with N, which attract agents into the intermediation activity. When there is intermediation, the symmetric utility for an intermediary or a depositor is given by (using (29) and (32)):

$$V^{if} = (\lambda\rho + 1 - \lambda)\pi_2\left(y - \frac{c}{\pi_2 - \pi_1}\right) \tag{33}$$

Welfare can be expressed in comparison to the benchmark V^*:

$$V^{if} = V^* - \underbrace{\frac{\lambda(\rho - 1)\pi_2 + \pi_1}{\pi_2 - \pi_1}c}_{\text{cost of intermediation}} \tag{34}$$

$$C^{if} = \frac{\lambda(\rho - 1)\pi_2 + \pi_1}{\pi_2 - \pi_1}c \tag{35}$$

This cost C^{if} can be interpreted as an agency (or delegation) cost due to the necessity to give the intermediaries the incentives to monitor. It is increasing with π_1, and decreasing with $\pi_2 - \pi_1$. When c goes to 0, the cost C^{if} goes to 0, and intermediation allows the first best V^* to be implemented.

5 Equilibrium organisation

Intermediation emerges if and only if $V > V^0$. Figure 2 represents the equilibrium organisation of exchange for the graph of figure 1. Intermediation can emerge whatever the market configuration, and can be dominated by whatever market configurations. For instance in area A, where the market equilibrium is $x^* = 1$. intermediation emerges iff $C^{if} > C^1$, which is in area A2, and the market dominates for area A1. In this region, the market inefficiency decreases with λ (Γ decreases), because the higher the probability of being impatient, the higher the use of the market for a liquidity motive. Similarly, intermediation can improve on autarky and emerge (region B2), or not emerge although the market breaks down (region B1). In region C, the market equilibrium is charactersied by a low monitoring ($x^* < 1$); intermediation emerges when this problem is severe enough (in C2).

To conclude, the cost of intermediation decreases with π_1 whereas C^a, C^1 and C^x do not depend on π_1: intermediation is more likely to be observed when π_1 is low. Moreover, when the monitoring cost c goes to 0, only C^{if} shrinks to 0: intermediation then implements the social optimum, which is not attainable with the market.

When intermediation emerges, a subset of agents specialise in the monitoring of projects. By so doing, they create liquidity for depositors: the claim on the intermediary – which gives right to date 2 goods – is perfectly liquid because depositors do not have any private information at $t = 1$ on the quality of the intermediary asset. The intermediaries' debts can therefore circulate. In some sense, the intermediary frees its depositors from the negative value of information that could restrict the liquidity of their investment.

The agency problem is solved through the intermediary structure. The fact that an intermediary keeps the project till completion and that he creates liquidity ofr depositors have a positive effect on its incentives. As liquidity has a value for depositors, they are ready to accept a lower expected payment $\pi_2 R$ at $t = 2$. Moreover, the illiquidity of intermediaries' assets are rationalised by their private information.

6 Conclusion

This paper has presented an environment explaining bank-like intermediaries. Financial intermediaries that overcome informational frictions on their asset side, and issue claims that have high acceptability in exchanges can

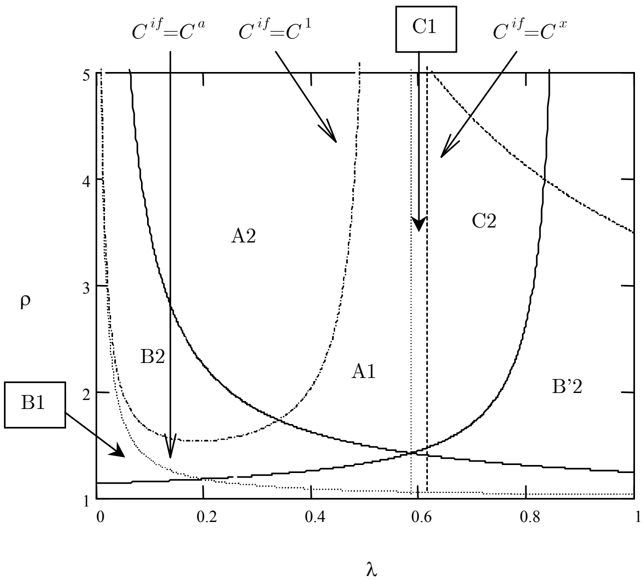

Figure 2: Equilibrium (inactive market, active market, intermediation) depending on market configurations in figure 1. Intermediation emerges in areas A2, B2, B'2 and C2.

be essential. Intermediaries are not assumed exogenously and deal with the same frictions as other agents. It should be emphasised that although financial intermediation *can* be essential, depending on parameters values, the optimal arrangement can be the market, autarky or intermediation. The analysis does not rely on a framework with spatial or intertemporal separation, but focus exclusively on the endogenous distribution of information on assets to explain their degree of liquidity.

The environment combines the two following features. 1/ Investors have a preference for liquidity. 2/ Long term investment should be monitored. In that environment, the acquisition of private information about project has a positive and a negative aspect. While it enhances the long term return to investment, it also hampers the liquidity of investment. Intermediaries are agents that specialise in the monitoring of projects and give up liquidity; by so doing, they create liquidity for agents having claims on them. Centralisation of monitoring and of information on projects allows to separate the two values of information. Monitoring activity and circulation of liabilities reinforce each other. The fact that intermediaries keep the projects till completion enhances the incentives to monitor. As liquidity has a value for depositors, they are ready to accept a lower expected payment. In the same time, the illiquidity of their asset is further rationalised by the private information they have.

The model could easily be modified in a number of ways without affecting qualitatively the result. For instance, while I consider only individuals facing investment opportunities, the environment could be easily extended to a framework with entrepreneurs with projects and no endowment seeking funds form investors with uncertain liquidity needs. However, I abstract from a number of issues that could be relevant to the issuance of money by banks. To conclude, I shall indicate two non trivial extensions that I think interesting.

First, the analyses highlights the lack of information about banks' portfolio as a source of the use of deposits as payment instruments. However, I have abstracted from informational asymmetries at date 2 when the projects returns are realised. For a bank, the interpretation that would fit this assumption could be "If as a depositor I had private information on the probability failure of my own bank, then I could not use my deposits as means of payments". With this interpretation in mind, the assumption that the realised return investment at date 2 are publicly observed is not unrealistic. Relaxing it would allow to analyse the interplay between the acquisition of information by depositors on banks' assets to discipline banks, and the liquidity of deposits.

The second extension relates to the circulation of the intermediaries claims. My analysis accounts for the higher acceptability of claims on internediaries. The *ex ante* homogeneity of individuals and the three date framework adopted herein allow to focus on the emergence of financial intermediaries. As for future research, embedding those intuitions about financial intermediation in a fully-fledged monetary framework could yield interesting insight as to the interplay between the value of circulating private debt and the monitoring of creditors in a dynamic macroeconomic setting[9].

[9] Cavalcanti (2001) presents a model mixing Diamond & Dybvig (1983) and Kiyotaki & Wright (1993). However, he does not consider informational friction on the asset side.

Appendices

Appendix A: Market equilibrium

This appendix characterises the equilibrium for the market economy. Equilibria with an active market can be restricted to $l^* > \frac{y}{\rho}$ (see lemma 1). I first show that an equilibrium is necessarily unique, and then characterises it when it exists.

I. Unicity of the equilibrium

Individual strategies. Investing in a project without monitoring can only be rational if $l > 1$. For $l < 1$, this strategy is dominated by the storage strategy, which is dominated by investing with monitoring according to assumption (A2). It is therefore sufficient to compare V^u and V^i for prices such that $\max\left(1, \frac{y}{\rho}\right) \leq l \leq y$. On this interval, expressions (7) and (8) give:

$$\begin{aligned} V^u &= (\lambda\rho + 1 - \lambda)\, l & (36) \\ V^i &= (1 - \pi_2)(\lambda\rho + 1 - \lambda)\, l + \lambda\pi_2 \max(\rho l, y) + (1 - \lambda)\pi_2 y - c & (37) \end{aligned}$$

The gain from monitoring is

$$\Delta V(l) \equiv V^i - V^u = \pi_2 \left[\lambda(\max(\rho l, y) - \rho l) + (1 - \lambda)(y - l)\right] - c \qquad (38)$$

$\Delta V(l)$ decreases with the price l. Moreover

$$\begin{aligned} \Delta V(y) &= -c < 0 & (39) \\ \Delta V(1) &= \pi_2 \left[\lambda(\max(\rho, y) - \rho) + (1 - \lambda)(y - 1)\right] - c > 0 & \end{aligned}$$

Therefore there exists $1 < l^s < y$ such that $\Delta V(l) > 0$ for any $l < l^s$, and $\Delta V(l) < 0$ for any $l > l^s$. The optimal strategy is therefore to invest and monitor if $l < l^s$, and to invest without monitoring if $l > l^s$. The proportion of agents that monitor is them given by the correspondence

$$x(l) = \begin{cases} 0 & \text{ssi} \quad l > l^s \\ [0,1] & \text{ssi} \quad l = l^s \\ 1 & \text{ssi} \quad l < l^s \end{cases} \qquad (40)$$

Market price. An equilibrium price l^* must be equal to the expected value of a project offered on the market. This expectation depends upon the proportion x and upon the selling decisions for the price l^*. On the price interval $\max\left(1, \frac{y}{\rho}\right) \leq l \leq y$, the expected value of a project in the market is therefore

$$l(x) = \frac{x\lambda\pi_2 + (1 - x)\pi_1}{1 - x + x\left[\lambda + (1 - \pi_2)(1 - \lambda)\right]} y = \frac{\pi_1 + x(\lambda\pi_2 - \pi_1)}{1 - x(1 - \lambda)\pi_2} y \qquad (41)$$

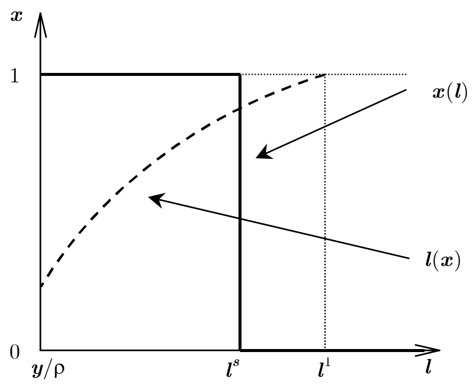

Figure 3: $l(x)$ and $x(l)$

At an equilibrium, $l^* = l(x^*)$, and $x^* = x(l^*)$. A necessary condition for the existence of an equilibrium is $l(x^*) > \frac{y}{\rho}$. Now, $l(.)$ is monotonic on $[0,1]$, with $l(0) = \pi_1 y < \frac{y}{\rho}$ (as $\rho\pi_1 < 1$) and $l(1) = l^1$ given by formula (13). If $l^1 < \frac{y}{\rho}$, there does not exist a value of x such that $l(x) > \frac{y}{\rho}$, and therefore no equilibrium with an active market. A necessary condition for an active equilibrium to exist is therefore $l^1 > \frac{y}{\rho}$. In that case, the price function $l(x)$ increases with x, and reaches a maximum $l(1) = l^1$ for $x = 1$. As $l(x)$ is strictly increasing and $x(l)$ decreasing, the equilinrium is unique if it exists.

II. Equilibrium configurations.

According to the preceding discussion, it is sufficient to find an equilibrium with $l^* > 0$. Firstly, the maximum price being l^1, the market cannot be active if $l^1 < \frac{y}{\rho}$. In that case, no price can attract valuable projects. If $l^1 > \frac{y}{\rho}$, there are two candidate equilibria: $(l^* = l^1, x^* = 1)$ and $(l^* = l^s, x^* \in]0,1[)$.

- **Case 1**. If $l^1 < \frac{y}{\rho}$, the market is not active (the price is degenerate, $l^* = 0$). This condition writes :

$$\frac{\lambda}{\lambda + (1-\pi_2)(1-\lambda)}\rho\pi_2 < 1 \tag{42}$$

which gives

$$\pi_2 (1 + \lambda (\rho - 1)) < 1$$

- **Case 2.**If $l^1 > \frac{y}{\rho}$, two cases must be distinguished whether $l^1 > l^s$ or $l^1 < l^s$.

  – *Case 2a.* If $l^s < l^1$, agents do not have any interest to monitor at the price l^1. If the price l^s at which are indifferent between monitoring or not monitoring is consistent with some good projects being offered, then $l^* = l^s$ is an equilibrium. This condition writes $l^s > \frac{y}{\rho}$, and is satisfied iff $\Delta V \left(\frac{y}{\rho}\right) > 0$. Using expression (38), this condition gives (using $\rho > 1$)

  $$\pi_2 (1 - \lambda) \frac{\rho - 1}{\rho} y < c \tag{43}$$

  If cond. (43) holds, l^s is given by $\Delta V = \pi_2 (1 - \lambda)(y - l) - c = 0$, yielding

  $$l^s = y - \frac{c}{\pi_2 (1 - \lambda)} \tag{44}$$

  Condition $l^s < l^1$ then gives

  $$y - \frac{c}{\pi_2 (1 - \lambda)} < \frac{\lambda \pi_2}{\lambda + (1 - \lambda)(1 - \pi_2)} y \tag{45}$$

  $$\pi_2 (1 - \lambda)(1 - \pi_2) y < [\lambda + (1 - \lambda)(1 - \pi_2)] c \tag{46}$$

  Proportion x is given by $l(x) = l^s$:

  $$\frac{\pi_1 + x (\lambda \pi_2 - \pi_1)}{1 - x (1 - \lambda) \pi_2} y = y - \frac{c}{\pi_2 (1 - \lambda)} \tag{47}$$

  solving for x yields

  $$x^* = \frac{\pi_2 (1 - \lambda)(1 - \pi_1) y - c}{\pi_2 (1 - \lambda) [(\pi_2 - \pi_1) y - c]} \tag{48}$$

  – *Case 2b.* If $l^1 < l^s$, then $(l^*, x^*) = (l^1, 1)$ is an equilibrium. As $l^1 > l^s$ monitoring is the dominant strategy. As $l^1 > \frac{y}{\rho}$ and $l^s > l^1$, $l^s > \frac{y}{\rho}$ is given by expression (44), and condition $l^s > l^1$ by the converse of (46):

  $$\pi_2 (1 - \lambda)(1 - \pi_2) y < [1 - (1 - \pi_2) \lambda] c \tag{49}$$

III. Summary.

- Equilibrium is $(l^*, x^*) = (l^1, 1)$ if and only if the two following condition hold:

$$\pi_2 (1-\lambda)(1-\pi_2) y > [\lambda + (1-\lambda)(1-\pi_2)] c \tag{50}$$

$$\pi_2 (1 + \lambda (\rho - 1)) < 1 \tag{51}$$

Welfare is given by

$$\begin{aligned} V^1 &= [\lambda\rho + (1-\pi_2)(1-\lambda)] l^1 + \pi_2 (1-\lambda) y - c \qquad (52) \\ &= (\lambda\rho + (1-\pi_2)(1-\lambda)) \frac{\lambda\pi_2}{\lambda + (1-\lambda)\pi_2} y + \pi_2 (1-\lambda) y - c \\ &= [\lambda\rho + 1 - \lambda] \pi_2 y - c - \frac{(1-\pi_2)(1-\lambda)(\rho-1)}{\lambda + (1-\pi_2)(1-\lambda)} \lambda\pi_2 y \\ &= V^* - \frac{(1-\pi_2)(1-\lambda)(\rho-1)}{\lambda + (1-\pi_2)(1-\lambda)} \lambda\pi_2 y \qquad (53) \end{aligned}$$

- Equilibrium is $l^* = l^s, x^* \in]0,1[$ if and only if $\frac{y}{\rho} < l^s < l^1$, that is to say

$$\pi_2 (1-\lambda) \frac{\rho - 1}{\rho} y < c \tag{54}$$

$$\pi_2 (1-\lambda)(1-\pi_2) y < [\lambda + (1-\lambda)(1-\pi_2)] c \tag{55}$$

Welfare is given by

$$\begin{aligned} V^x &= (\lambda\rho + 1 - \lambda) l^s = (\lambda\rho + 1 - \lambda) y - \frac{c}{\pi_2 (1-\lambda)} \qquad (56) \\ &= V^* - \left(\frac{\lambda\rho + (1-\pi_2)(1-\lambda)}{\pi_2 (1-\lambda)} c - (\lambda (\rho - 1) + 1)(1-\pi_2) y \right) \end{aligned}$$

- In all other cases, the market is inactive. For $l^1 < \frac{y}{\rho}$, informational asymmetries are such that the market shuts down. For $l^s < \frac{y}{\rho} < l^1$, the problem stems from the weakening of incentives to monitor.

Appendix B: Intermediated equilibrium

This section analyses the intermediated situation described in section 4. The utility to be maximised is increasing with R, so that program $\mathcal{P}1$ can be transformed into

$$\max_{R,N} \quad R \tag{$\mathcal{P}2$}$$
$$\text{s.t.} \left\{ \begin{array}{c} (\lambda\rho + 1 - \lambda)\,\pi_2 R = (N+1)\,(\pi_2\,(y - R) - c) \\ (\pi_2 - \pi_1)\,(y - R) > c \end{array} \right.$$

as $(\pi_2 - \pi_1)\, y > c$, the feasibility domain under which the incentive condition is satisfied is non empty. Denote by $\bar{R} \equiv y - \frac{c}{\pi_2 - \pi_1}$ the highest value for R such that this condition holds. If we can find N such that both participation conditions are satisfied for $\bar{R}$, then $\left(\bar{R}, N\right)$ yields the maximum of $\mathcal{P}2$. For $R = \bar{R}$, those participation contraints write

$$(\lambda\rho + 1 - \lambda)\,\pi_2 \bar{R} = (N+1)\left(\pi_2\left(y - \bar{R}\right) - c\right) \tag{57}$$

$$(\lambda\rho + 1 - \lambda)\,\pi_2 \left[y - \frac{c}{\pi_2 - \pi_1}\right] = (N+1)\,\frac{\pi_1}{\pi_2 - \pi_1} c \tag{58}$$

treating N as a continuous variable, we get the final characterisation

$$N + 1 = (\lambda\rho + 1 - \lambda)\,\frac{\pi_2}{\pi_1}\left[(\pi_2 - \pi_1)\, y - c\right] \tag{59}$$

Welfare for an active intermediary or a depositor is given by

$$V = (\lambda\rho + 1 - \lambda)\,\pi_2 \left[y - \frac{c}{\pi_2 - \pi_1}\right] \tag{60}$$
$$= (\lambda\rho + 1 - \lambda)\,\pi_2 - c - \frac{\lambda\,(\rho - 1)\,\pi_2 + \pi_1}{\pi_2 - \pi_1} c$$
$$= V^* - \frac{\lambda\,(\rho - 1)\,\pi_2 + \pi_1}{\pi_2 - \pi_1} c \tag{61}$$

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