Information Acquisition and Government Intervention in Credit Markets

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ABSTRACT

This paper investigates government intervention in credit markets, a phenomenon commonly observed in many countries, especially in East Asia. We construct a model in which investments are undertaken by entrepreneurs who obtain all their financing from banks. Project risk is made up of an idiosyncratic and an aggregate (industry-wide) component. Banks can investigate industry-wide risk, and they can evaluate the idiosyncratic risk of each entrepreneur. Banks engage in Bertrand competition for entrepreneurs interest rates. Through such competition, any information obtained by a bank on aggregate risk is fully revealed, and that on entrepreneur-specific risk is partly revealed. Banks will choose not to investigate aggregate risk, while they will evaluate entrepreneurs too intensively. We identify various sources of inefficiency that result from the inability to appropriate all the benefits of information acquisition. Efficiency can be improved by public acquisition of information on industry risk and by loan guarantees partially covering the inability of entrepreneurs to repay bank loans.

KEY WORDS: information acquisition, credit markets, tagging, Bertrand Competition, loan guarantee

JEL CLASSIFICATION: G14, G28, H11

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1. INTRODUCTION

There has been considerable debate over the role of government in economic development. The debate originated partly in response to the literature on endogenous growth (Lucas (1988), Romer (1986)), and partly as a result of the experience of high growth rates in countries in East and Southeast Asia, many of which have been characterized by high degrees of government involvement in the investment process. The endogenous growth literature has emphasized various externalities associated with the accumulation of capital and has led many economists to view the levels of investment and saving as key determinants of growth and as suitable objects for government encouragement. This would call for broad-based investment and/or savings incentives, leaving the market to decide how best to deploy the capital among uses.

Government policies in rapidly growing Asian countries often take a more interventionist approach, interfering with capital markets to direct financing into particular activities (World Bank (1993)). Examples include such things as loan guarantees that cross-subsidize certain risky activities, investment subsidies, tax incentives, or direct public investment. Governments might even become involved in financial intermediation, either by establishing public banks or by intervening directly in the allocation of financing through private financial intermediaries. In Japan, the Ministry of International Trade and Industry (MITI) pursued an ‘export-push strategy’ in the 1950’s and 1960’s intended to promote specific industries using an array of instruments, such as export credit and licenses (World Bank (1993)). At the same time, the Japan Development Bank, a public bank, was established to provide long-term loans to businesses in targeted industries. Similar industrial policies have been taken by other East Asian nations, notably Korea.

The argument for governments intervening in the process of financial intermediation

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1 Ishi (1997) argues that the Japanese public preferred the ‘visible hand’ of government guidance and business cooperation to the market’s invisible hand. However, the historical evaluation of Japan’s industrial policy is still controversial. Some authors argue that MITI’s policy was not intended to develop new industries, such as automobile and electronic. For example, Ito (1996) notes that MITI failed to identify prospective industries. But he claims that its policy was certainly successful in promoting exports. Aoki et al (1997) contains useful observations on the Japanese experience, and other East Asian countries more generally. In any case, it can be said that government policy and regulation in East Asia has been intended to supplement the market mechanism rather than to substitute it (World Bank (1993)).
presumably has to do with the fact that private credit markets do not allocate capital efficiently, so that the full potential of economic growth and development is not being realized. Standard arguments for government intervention in credit markets tend to be based on asymmetric information leading to well-known problems of adverse selection and moral hazard. Thus, equilibria may be characterized by credit rationing, screening, and costly monitoring (Stiglitz and Weiss (1981), Williamson (1987)). Moreover, credit markets may be viewed as imperfect institutions for trading risk, they may be plagued by incompleteness, and they may be subject to corrupt or rent-seeking practices. Stiglitz (1993) summarizes the types of credit market failure due to asymmetric information and their implications for forms of government intervention.

A problem with such explanations for government intervention in credit markets is that, in a world of asymmetric information, governments are not likely to be any better informed than private lending institutions. They may not be any better able to pool risks, to root out corruption or to overcome rent-seeking. In other words, the mere fact of market failure does not imply a need for government intervention. To justify government intervention, it must be demonstrated that market decision-making leads to inefficient decisions, given the technology and information that is available to both the public and private sectors.

The potential source of inefficiency that we focus on is the production or acquisition of information by costly means. Given that information once obtained is like a public good, we might expect that, as with other public goods and externalities, its acquisition will be inefficient. Either it will be difficult to exclude others from learning the information so that its benefits cannot be fully appropriated, or the information will be hoarded by those who obtain it even though the social opportunity cost of making it available to others is zero. We consider the role of banks as producers of information about the profitability or riskiness of various projects: they are willing to use resources to find out something about the expected profits of potential lenders. We construct a model in which the process of competing for firms leads to costly information being revealed to other banks, thereby creating incorrect incentives to acquire information and causing capital to be misallocated. We argue that such a model can account for some of the types of policies that we observe in practice, such as loan guarantees or indicative planning designed to influence the allocation of capital among industries.

The role of banks as information producers has been discussed widely in the literature of finance. We focus on acquisition of information of two sorts — information on the idiosyncratic risk faced by individual firms within an industry, and information on the risk faced by an industry as a whole. We show that a distinct type of market failure can apply to each. If banks behave as competitors, and as few as two banks can be competitors in the Bertrand sense given that their services are close substitutes, competition to attract clients will cause a dissipation of part of the benefits of evaluating clients for idiosyncratic risk and

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2 This same view of the role of banks is stated by Higano (1986), referring to the Japanese case. Presumably similar sorts of arguments would apply to other sorts of financial institutions, such as stock markets or non-bank lenders.
of investigating industry-wide risk. The problem arises because banks unwittingly reveal their information by the interest rates they are willing to offer clients of various types. It turns out that, even though government is no better informed than banks, this market failure is amenable to partial correction by government policies of standard sorts.

Much of the existing literature concentrates on two roles of financial intermediaries. One is to internalize the incentive that exists for investors to free ride on each other’s effort in monitoring borrowers. The other is to pool the risks of investments. (For example, see Campbell and Kracaw (1980) and Diamond (1984).) Our model has elements that are similar to these approaches. But, they tend for the most part to be interested in analyzing the behavioral and equilibrium consequences of asymmetric information between lenders and borrowers. Our purpose is to uncover inefficiencies in the lending process, particularly when lenders can acquire information about the profitability of borrowers at cost. This provides a rationale for government intervention in information acquisition and financial intermediation.

Some recent work closely related to our model is by Hellmann et al (1997). They focus on the efficiency with which competing banks monitor their outstanding loans. They argue that credit market failure is associated with the fact that inter-bank competition eliminates all rents from banking. According to them, a positive rent motivates banks to behave as long-run agents. The dissipation of rents through excessive competition for profits discourages banks from monitoring their clients from a long-run standpoint, and encourages them to search for short-term profits by gambling with deposits. So, both an efficient allocation of capital and financial stability are compromised. They advocate a policy of financial restraint, an example being lending rate controls. The rationale for controlling lending rates is to create positive expected profits for the banks, referred to as ‘franchise value’ or contingent rent. Our emphasis is on ex ante evaluation of potential lenders, rather than ex post monitoring of loans.

We proceed by outlining in the next section the key elements of the basic model used in the paper. Our model consists of a small number of banks competing with one another in interest rates to attract potential borrowers. The borrowers are ex ante identical entrepreneurs who are randomly assigned either a good project or a bad one. Banks, who finance the entrepreneurs, must expend resources to obtain information about the probability of success of each entrepreneur, which depends both on idiosyncratic and on industry-wide risk. The timing of decisions is extremely important for determining the market equilibrium and its efficiency. Section 3 analyzes decision-making by entrepreneur and banks and characterizes the market equilibrium. This is followed by a derivation of the socially optimal (efficient) allocation of resources, including a discussion of sources of market failure. Section 5 then analyzes the role for government policy and demonstrates the potential usefulness of government investigation of industry risk as well as loan guarantees. Section 6 departs from the basic model by investigating several alternative assumptions about industry structure and information. In an appendix, we sketch out a dynamic version of the model, and shows how the policy implications carry through to it.
2. THE STRUCTURE OF THE BASIC MODEL

The economy is a static one consisting of three type of decision-makers — entrepreneurs, banks and a government. We concentrate in the first two sections on entrepreneurs and banks, leaving issues of government intervention until we have outlined the workings of the private sector. Although the model is static, decision-makers take a sequence of decisions, and the order of that sequence is important for both the equilibrium and efficiency of the economy. The sequence is summarized at the end of this section. We consider the role of the entrepreneurs and the banks in turn.

Entrepreneurs

There are $M$ entrepreneurs, all of whom are identical \textit{ex ante}, where $M$ is a large number. They are assumed to be risk-neutral so that we can avoid issues of risk sharing, and have no assets so must borrow all funds they need from the banks with no collateral. The $M$ entrepreneurs borrow to purchase $k$ units of capital which is used to produce output according to an increasing and strictly concave production function $f(k)$.

Outcomes from production in the risky sector are stochastic: each entrepreneur's firm will either succeed or fail. If it succeeds, the output $f(k)$ is sold at a unit price and the bank loan is repaid. If it fails, no sales occur, either because output is zero or because the price is zero, and no loan repayment can occur. Let $q$ be the probability of success. Then, expected profits of the entrepreneur are $q(f(k) - rk)$, where $r$ is the gross interest rate. An entrepreneur's problem is:

$$\max_{\{k\}} q(f(k) - rk).$$  \hspace{1cm} (E)

The solution to this problem is the demand for capital $k(r)$, where $k'(r) < 0$. Note that this is independent of $q$, so banks cannot use credit rationing schemes to separate entrepreneurs who face different probabilities of success. This simplifies our analysis and allows us to focus on other information market failures that are more relevant for our purposes. The maximum value function for problem (E) is the profit function $\pi(q, r)$, with $\pi_r < 0$, $\pi_{rr} > 0$ and $\pi_q = f(k) - rk$.

Entrepreneurs face uncertainty about the probability of success $q$, reflecting both idiosyncratic and aggregate (industry) risk. Consider each form of risk in turn. The $M$ entrepreneurs, after they have decided to become entrepreneurs, are randomly assigned to 'good' projects and 'bad' projects in the proportions $\rho$ and $(1 - \rho)$. The good projects are referred to as type 2 projects and have an idiosyncratic probability of success $q_2$. Similarly, bad, or type 1, projects have a probability of success $q_1$, where $q_2 > q_1$. Given that there is a continuum of entrepreneurs, there is no uncertainty about the number of type 2 projects, $\rho M$, and type 1 projects, $(1 - \rho) M$. The proportion $\rho$ is common knowledge, but the value of $q_i$ drawn is private information to each entrepreneur.

Aggregate risk is associated with good projects only. This simplifies our analysis considerably. For bad projects, $q_1$ is the probability of success. For good projects, the probability of success is given by $q_2 + \epsilon$, where $\epsilon$ is an aggregate risk which is the same for all good projects. It can take on one of two values, $\bar{\epsilon}$ or $\underline{\epsilon}$, with equal probabilities, where $\bar{\epsilon} > 0$ and $\bar{\epsilon} = -\underline{\epsilon}$ (so $\epsilon \epsilon = 0$). The overall probability of success for a good project will be
either $q_2 = q_2 + \epsilon$ or $q_2 = q_2 + r$. We assume that $q_2 > q_2 > q_1$, so aggregate risk does not affect the ranking of good versus bad projects. Note that $E[q_2 + \epsilon] = q_2$. The value of $\epsilon$ is initially not known to either the entrepreneurs or the banks, but banks are able to find out whether $\epsilon$ or $r$ applies by undertaking a costly investigation.

**The Banks**

There are assumed to be two banks, though any other small number would do as well. They acquire funds at a gross interest rate $R$, given by international capital markets, and lend to entrepreneurs at an rate $r$, which can vary across entrepreneurs. The two banks are Bertrand competitors in interest rates. Banks cannot observe the probability of success of individual entrepreneurs, and, as mentioned, cannot implement contracts that induce entrepreneurs with different $q$’s to separate. They can, however, acquire information at a cost about probabilities of success. Information acquisition can be of two sorts — evaluation of client entrepreneurs to obtain information on good versus bad projects ($q_2$ versus $q_1$) and investigation of the risky industry to obtain information on aggregate risk $\epsilon$. Consider each in turn.

When banks evaluate their clients, they obtain for each one a signal $\delta$, which takes on one of two values, $h$ or $\ell$. Following the literature on tagging (Akerlof (1978), Parsons (1996)), we refer to entrepreneurs who obtain a signal $\delta = h$ as ‘tagged’ and those who receive $\delta = \ell$ as ‘untagged’. These signals are correlated with $q_2$ and $q_1$. In particular, the probability of obtaining a signal $h$ for a type 2 entrepreneur, $Pr(h \mid 2)$, is unity, while $Pr(\ell \mid 1) = p(e) > 0$, where $e$ is the cost of evaluation per client. The function $p(e)$ is increasing and strictly concave with $p(0) = 0$, $p'(0) = \infty$, and $p(e) \to 1$ as $e \to \infty$. This specification ensures that there are no type I errors (since all type 2 entrepreneurs obtain $\delta = h$), but there will be type II errors (since $Pr(h \mid 1) = 1 - p(e) > 0$). The absence of type I errors simplifies our analysis considerably. (The case of type I errors is taken up in section 6.) Given that a proportion $\rho$ of each bank’s entrepreneurs are type 2, which will be the case in the symmetric equilibria with which we work, the probability of any given entrepreneur being tagged is:

$$Pr(h) = \rho + (1 - \rho)(1 - p(e))$$  \hspace{1cm} (1)

Using Bayes’ Rule, the probability of a tagged entrepreneur being successful is:

$$Pr(\text{Success} \mid h) = \frac{\rho(q_2 + \epsilon) + (1 - \rho)(1 - p(e))q_1}{\rho + (1 - \rho)(1 - p(e))}$$  \hspace{1cm} (2)

Of course, the probability of success given $\delta = \ell$, $Pr(\text{Success} \mid \ell)$, is just $q_1$.

The outcome of client evaluation is private information to the banks and the client who has been evaluated. Entrepreneurs choose their banks before they are evaluated, and are able to change banks costlessly after the evaluation is performed, but before they sign a contract. We assume that entrepreneurs borrow from only one bank, and that evaluation occurs only once. That is, entrepreneurs are not re-evaluated if they change banks. In fact, given our assumptions, banks would not re-evaluate entrepreneurs who switch banks since by switching they reveal themselves to be type 1’s.
The investigation of aggregate risk $\epsilon$ takes a very simple form. Banks choose whether to investigate or not. If they investigate, they incur a cost $I$, and learn the true value of $\epsilon$, either $\overline{\epsilon}$ or $\underline{\epsilon}$. We assume that a bank can observe whether the other bank conducts an investigation, but it cannot observe the outcome of the investigation. But, we show that the outcome gets revealed through competition in interest rates offered to entrepreneurs. This implies that free riding occurs on the information obtained through investigation, so the incentive for banks to investigate is dulled considerably.

The banks offer interest rates of $r^h$ and $r^\ell$ to clients depending on the signal obtained from evaluation. The size of the loan is given by $k(r^h)$ or $k(r^\ell)$ and, as mentioned, does not depend on the probability of success (type of project). An interest rate $\hat{r}$ is offered to an entrepreneur who changes banks. At the stage when an entrepreneur might change banks, we allow an original bank to revise its contract offer to prevent existing clients from moving. Note that once the evaluation is made, a bank has an incentive to renege on its initial contract by revising the interest rate offered to tagged clients upwards. This incentive, referred to as to \emph{ex-post} moral hazard, arises because the outcome of evaluation is known only to the bank and its client. We avoid this problem by supposing that the banks can commit themselves not to revising an original contract in a way that makes clients with $\delta = h$ worse off. We return to how this commitment might become effective once we have developed the basic model. Avoiding \emph{ex post} moral hazard allows us to concentrate on inefficiencies arising from inter-bank competition, which is our main concern.

The equilibria of interest will be symmetric ones, so that all banks have the same mix of type 1 and type 2 entrepreneurs and offer the same set of interest rates, $r^h, r^\ell, \hat{r}$. Define $q_2^\epsilon \equiv q_2 + \mathbb{E}(\epsilon)$ as the expected value of the probability of success for type 2 projects. If there is no investigation of aggregate risk, $\mathbb{E}(\epsilon) = 0$, so $q_2^\epsilon = q_2$. With investigation, $\epsilon$ is either $\overline{\epsilon}$ or $\underline{\epsilon}$, so $q_2^\epsilon$ is either $\overline{q}_2$ or $\underline{q}_2$ depending on the result of the investigation. In the equilibria we will be interested in, there will be no changing of banks by entrepreneurs; the benefit from so doing will be competed away by Bertrand competition. In this case, expected profits per client will be given by:

$$
\pi^B(r^h, r^\ell, q_2^\epsilon, \epsilon) = \Pr(h) \left( \Pr(\text{success} \mid h) r^h - R \right) k(r^h) \\
+ \Pr(\ell) \left( \Pr(\text{success} \mid \ell) r^\ell - R \right) k(r^\ell) - \epsilon
$$

or,

$$
\pi^B(r^h, r^\ell, q_2^\epsilon, \epsilon) = \left[ \left( \rho q_2^\epsilon + (1 - \rho)(1 - p(\epsilon))q_1 \right) r^h - \left( \rho + (1 - \rho)(1 - p(\epsilon)) \right) R \right] k(r^h) \\
+ (1 - \rho)p(\epsilon)(q_1 r^\ell - R) k(r^\ell) - \epsilon
$$

\textbf{Timings of Decisions and Equilibria}

As mentioned, the order in which events occur is important for determining equilibrium outcomes. The following lists the sequence of events in their order of occurrence:

1: Nature chooses $\epsilon$ from $\overline{\epsilon}, \underline{\epsilon}$.
2: Banks decide whether or not to investigate at a cost $I$ to learn the true value of $\epsilon$.

3: Entrepreneurs are randomly assigned to type 2 or type 1 projects in the proportions $\rho, 1 - \rho$. They know their own type.

4: Banks compete for entrepreneurs by offering $r^h$ and $r^l$ conditional on the signal obtained after evaluation, and entrepreneurs choose a bank.

5: Banks evaluate entrepreneurs and observe a signal $\delta = h, l$ for each entrepreneur at a cost of $e$.

6: Entrepreneurs sign a contract, or switch banks and obtain $\hat{r}$ without evaluation.

7: Entrepreneurs borrow and invest $k(r^h), k(r^l)$ or $k(\hat{r})$.

8: The state is revealed for each entrepreneur, and either positive or zero revenues are obtained. If positive, banks are repaid.

In the following section, we proceed to solve the system for its equilibrium by adopting the standard approach of backward induction. We suppose that equilibrium is achieved at each stage and concentrate on the case where the equilibrium is symmetric. Thus, banks offer the same set of contracts $r^h$, $r^l$ and $\hat{r}$ to entrepreneurs, expend the same resources $e$ on evaluation, and have access to the same aggregate information on $\epsilon$. In fact, given the assumptions we have made, the equilibrium will turn out to be symmetric, but it is extremely tedious to allow for non-symmetric equilibria at each stage. We also know that the equilibrium will be a separating one with banks putting positive resources into evaluating clients and offering different interest rates to clients with different signals.

3. DETERMINATION OF PRIVATE MARKET EQUILIBRIUM

Each of the eight stages listed above determines one type of variable, but some of them have already been dealt with or require no further analysis. Thus, the determination of capital investment in stage 7 has already been discussed, stages 1 and 8 involves nature’s moves, and stage 3 involves random assignment of entrepreneurs. That leaves the following stages with their respective variables to be analyzed: 2 ($I$), 4 ($r^h, r^l$), 5 ($e$), and 6 ($\hat{r}$). We begin with stage 6 and work our ways backwards. Our discussion will be largely heuristic, and will in some cases rely on what we know the final equilibrium outcome to be.

Stage 6: Determination of $\hat{r}$

This stage involves banks competing for entrepreneurs who have already been evaluated at stage 5, but for whom the outcome of the evaluation is private to the original bank (and the entrepreneur). At the start of stage 6, $r^h, r^l$ and $e$ have been determined, and, since we are supposing that the equilibrium is symmetric, they will be the same for both banks. Moreover, $q_2^e$ will be the same for both: either both will be informed or neither will. (We shall see later how information that one bank may have about aggregate risk becomes available to the other bank through price competition.) These assumptions about symmetry are natural in our model with Bertrand competition, and arise because an equilibrium with banks offering differing interest rates will not be sustainable. In addition,
we suppose \( r^h \leq r^\ell \). Entrepreneurs will either sign a contract at the relevant interest rate \( r^h \) or \( r^\ell \) or they will change banks and obtain \( \hat{r} \). It is the latter price that is determined at this stage.

Bertrand competition between banks proceeds such that each bank attempts to attract entrepreneurs from the other bank, and the latter attempts to prevent its existing clients from moving. Competition is not symmetric in the sense that a bank can revise a contract for its existing clients knowing the outcome of the evaluation in stage 5, while the other bank must offer a pooling contract, \( \hat{r} \), for all new clients. Recall that, by assumption, the bank cannot identify the outcome of the other bank’s evaluations. The issue is which entrepreneurs will be tempted to change banks. If the banks know that only untagged entrepreneurs might change, the interest rate offered to them will be:

\[
\hat{r} = \frac{R}{q_1}
\]  

(4)

The reason is that all untagged entrepreneurs are type 1, and (4) follows from the fact that Bertrand competition drives the profit of untagged entrepreneurs down to zero. So if original \( r^\ell \) is higher than \( R/q_1 \), the bank lowers the interest rate for the existing untagged entrepreneurs to that rate.

Both tagged and untagged entrepreneurs in one bank might be tempted to move to the other. We can show, however, that this cannot arise in the equilibrium at this stage. If both types move, each bank can offer at least \( \tilde{\tau} = R/(\rho q_2^e + (1 - \rho)q_1) \) for the entrepreneurs changing banks. This would only attract tagged entrepreneurs if \( \tilde{\tau} < r^h \). To prevent such movement, the original bank can always offer a revised contract such that the tagged entrepreneurs obtain an interest rate less than or equal to \( \tilde{\tau} \). (Recall that we are allowing banks to revise a contract that have been offered as long as the contract becomes more favorable to the entrepreneur.) This is possible since the original bank is better informed of each client’s type. Thus, the bank can offer \( R/(\rho q_2^e + (1 - \rho)(1 - p(\epsilon))q_1) \) for the existing tagged clients. (At this stage, the evaluation cost \( \epsilon \) is already sunk so need not be covered in the revised contract offer.) Therefore, the mobility of tagged entrepreneurs is always prevented. Anticipating this, neither bank will attempt to obtain the tagged entrepreneurs from the other. This implies that the original contract, \( r^h \), will not be revised in the equilibrium. So we can suppose that the banks compete for the untagged (and thus type 1) entrepreneurs only, offering \( \hat{r} = R/q_1 \).

\[ \text{3 Also note that, since each entrepreneur behaves competitively, he takes } \hat{r} \text{ as given and will not ask for a contract revision, threatening to change banks otherwise. The same reasoning applies even in the case where information on } \epsilon \text{ differs between the banks at the beginning of this stage. Suppose the uninforme} \]
A couple of things are worth noting about the equilibrium in stage 6. First, the interest rate paid by type 1 persons who are not tagged will never differ from \( R/q_1 \). If banks set \( r^t > R/q_1 \), no such entrepreneurs would sign a contract since they could move and obtain \( \hat{r} = R/q_1 \). On the other hand, setting \( r^t < R/q_1 \) imposes negative profit per untagged entrepreneur net of \( e \) when \( e > 0 \). Banks would not set \( r^t \) so low. Given that, we can suppose that banks actually set \( r^t = \hat{r} = R/q_1 \) (anticipating here the outcome of stage 4). Second, given this, the interest rate paid by those obtaining the signal \( \hat{r} \) covers only the cost of financing \( R \). It does not contribute to the cost of evaluation \( e \), so \( r^h \) must in turn be high enough to cover the full cost of \( e \), given the non-negative profit condition. This will turn out to be a source of market failure in the private market equilibrium.

**Stage 5: Choice of \( e \)**

By stage 5, \( r^h \) and \( r^t \) have already been determined. Banks anticipate that \( \hat{r} = R/q_1 \), and that all untagged persons will pay no more than that. As above, we therefore take it that \( r^t = R/q_1 \) (and \( r^h < r^t \)). Banks select \( e \) to maximize their profits. Given \( r^t = R/q_1 \) and using (3), the problem of a bank can be written:

\[
\text{max}_{\{e\}} \left( \left( p q_2^e + (1 - \rho)(1 - p(e))q_1 \right) r^h - \left( \rho + (1 - \rho)(1 - p(e)) \right) R \right) k(r^h) - e \quad (B)
\]

The first-order condition is:

\[
p'(e)(1 - \rho)(R - q_1 r^h)k(r^h) - 1 = 0 \quad (5)
\]

By our assumption that \( p'(0) = \infty \), this will yield an interior solution, \( e(r^h) \). Given that \( R - q_1 r^h > 0 \) (since \( r^h < r^t \)), \( e'(r^h) < 0 \).

Note that the amount of resources devoted to evaluation does not depend upon \( q_2 \), so it is affected neither by the value of \( e \) nor by whether or not an investigation of aggregate risk is undertaken. The maximum value function for problem (B) is the profit function \( \pi^B(r^h, q_2^e) \). It is easy to see that \( \pi^B(\cdot) \) is increasing in \( q_2^e \). We also suppose \( \partial \pi^B / \partial r^h > 0 \), which seems to be plausible in the context of Bertrand competition.

**Stage 4: Offers of \( r^h \) and \( r^t \)**

This stage is critical for determining the outcome of the private market economy, since it is here that the banks compete for entrepreneurs. They do so by offering interest rates \( r^h \) and \( r^t \), given the expectation of aggregate risk \( e \) facing the type 2 projects, and thus \( q_2^e \) of each of the banks as determined in stage 1. This stage determines both the interest rates charged by each bank as well as the allocation of entrepreneurs by type between banks. In principle, the equilibrium could take many different forms. It could be a pooling equilibrium in which banks do not attempt to separate the entrepreneurs by evaluation and uninform bank can, therefore, update its information on aggregate risk, which converts interbank competition into the symmetric information case. In the same way, we can show that, when the informed bank attempts to obtain the tagged clients from the uninform bank at this stage, the offer made by the former reveals information on aggregate risk to the latter.
offer the same interest rate $\bar{r}$ to all entrepreneurs; it could be an asymmetric equilibrium in which the proportions of good and bad entrepreneurs differ across banks and therefore differ from $\rho$; and it could be asymmetric in the sense that the two banks have different expectations about aggregate risk, so $q_2^e$ differs across banks. In fact, it can be shown that Bertrand competition will result in an equilibrium which is symmetric and separating, in which both banks choose the same intensity of evaluation $\epsilon > 0$, offer the same set of contracts $r^h, r^\ell$ with $r^h < r^\ell$ and have the same proportion of type 2 entrepreneurs $\rho$. Moreover, both banks will have the same expected value for the probability of success by type 2 entrepreneurs $q_2^e$ regardless of the number of banks that choose to inform themselves through investigation in stage 1: the information obtained if only one bank informs itself is revealed to the other bank through Bertrand competition.

To demonstrate the validity of the above assertion, let us start from the case of symmetric information (both banks are equally informed or uninformed). First of all, we can eliminate a pooling contract. When contract is a pooling one, banks would choose $\epsilon = 0$ since the signal obtained from evaluation is not used. Bertrand competition would therefore result in $r^h = r^\ell = \bar{r}$ where $\bar{r} = R/(\rho q_2^e + (1 - \rho)q_1)$ by zero profits of the banks. It would then pay one of the banks to raise $r^\ell$ while holding $r^h$ constant, anticipating that $\epsilon$ would rise in stage 5 so that signals $h$ and $\ell$ could be obtained. Such a change would not induce any movement of type 2 entrepreneurs (since type 2 entrepreneurs can surely obtain $r^h = \bar{r}$), but would induce some type 1’s to switch from this bank to the one offering a pooling contract. The resulting reduction in the share of type 1 entrepreneurs would increase the expected profits of the bank (since type 1 entrepreneurs are paying the pooling interest rate $\bar{r} < R/q_1$ so generating a loss). Thus, there can be no pooling contract. Second, given that the equilibrium is a separating one with $p(\epsilon(r^h)) > 0$, the contract offered to type 1 entrepreneurs will be simply $r^\ell = R/q_1$ for the reason already mentioned. Bertrand competition ensures that the same contract should be offered by both banks and $r^h$ should be such that $\pi^B(r^h, q_2^e) = 0$, which can be shown to be strictly less than $\bar{r}$.

Now we turn to the case where information on the aggregate risk differs between the two banks: one bank is informed and other is not. As in the case of symmetric information, we can rule out a pooling equilibrium and we can let $r^\ell = R/q_1$. Therefore, the banks compete each other in $r^h$. Reasonably we can presume $r^h < R/q_1$, which guarantees that $\hat{r} = R/q_1$. Also note that since type 2 entrepreneurs are surely tagged, they would always choose the bank which offered the lower $r^h$: the difference in informational structure does not affect the choice of banks by type 2. Moreover, type 1 entrepreneurs would also prefer to go to the bank with the lower $r^h$ where they have a chance of being tagged through a type II error. There is no chance for type 1 entrepreneurs to be tagged when they choose a bank offering a higher $r^h$ than the other. The reason is that such a bank realizes that no clients are type 2 (that is, all clients must be type 1) so it will simply offer $r^\ell$ at the next stage.

To describe the way that any informational advantage initially possessed by one bank is revealed to the other, we can start from the situation where $r^h$ is the same between the two banks and see whether or not at least one of the two has an incentive to undercut
the interest rate. The uninformed bank will initially suppose \( q_2^e = q_2 \). The informed bank will know that the true value of the probability of success is either \( q_2 > q_2 \) or \( q_2 < q_2 \). Bertrand competition continues as long as the interest rate, \( r^h \), yields non-negative expected profit for both banks. It should be noted that \( \pi^B(r^h, q_2) < \pi^B(r^h, q_2) < \pi^B(r^h, q_2) \) for any \( r^h < R/q_1 \). In the case that the informed bank obtained \( q_2 \), it will not be willing to match any reduction in \( r^h \) offered by the uninformed bank from the level yielding \( \pi^B(r^h, q_2) = 0 \); at that level, the uninformed bank’s expected profit is still positive given \( q_2^e = q_2 \). The uninformed bank, observing that the other ceases competing, can infer \( \epsilon \): \( \epsilon = \epsilon \) is revealed. On the other hand, if true value of \( \epsilon \) is \( \epsilon \), the informed bank undercuts the interest rate, \( r^h \) below the level such that \( \pi^B(r^h, q_2) = 0 \), which also reveals that the true state is \( \epsilon \). Thus, any information obtained by one bank by investigation will freely become available to the other bank, thereby dissipating the advantage that the informed bank has acquired. This will turn out to be another source of failure in the market for information.

Given that the equilibrium is a symmetric one with \( R^t = R/q_1 \), the interest rate offered to tagged entrepreneurs is determined in Bertrand competition by the zero-profit condition \( \pi^B(r^h, q_2^e) = 0 \), or

\[
\left[ (\rho q_2^e + (1 - \rho)(1 - p(e(r^h))) q_1 \right] r^h - \left( \rho + (1 - \rho)(1 - p(e(r^h))) \right) R = 0
\]

(6)

The solution to (6) is \( r^h(q_2^e) \). Stability of equilibrium requires that \( \partial \pi^B(\cdot)/\partial r^h > 0 \), which we assume. Using this stability condition, we can show that \( r^h(q_2^e) < 0 \). This is intuitively reasonable: the greater the probability of success of good projects, the lower will be the interest rate offered to tagged entrepreneurs in a Bertrand (zero-profit) equilibrium. An implication of this is that, since \( e'(r^h) < 0 \), \( de/dq_2^e = e'(r^h) \cdot r^h(q_2^e) > 0 \). An important property of the zero-profit condition (6) that is satisfied in the Bertrand equilibrium between banks is that any costs incurred in investigating aggregate risk (I) will not be covered by revenues. This is a consequence of the fact that by the time of stage 4, I is a sunk cost. The implication is obvious: combined with the fact that any information obtained by one bank is revealed through competitive offerings of \( r^h \), the payoff to a bank from investigating aggregate risk will be negative; in fact, it will be \(-I\).

**Stage 2: Bank Investigation of \( \epsilon \)**

The outcome of stage 2 is obvious from what we have already learned. The payoff to a bank from investigating \( \epsilon \) is negative. As we saw in stage 4, Bertrand competition entails that if one bank investigates and the other does not, the information obtained from the investigation is revealed to the other bank, and the cost of investigating is not recouped since profits will be driven to zero net of any cost of investigating I. If both banks investigate, they both learn the true value of \( \epsilon \), but again their costs of investigation are not recouped. So regardless of what the other bank does, the payoff to a bank investigating aggregate risk is \(-I\). Therefore, banks will not investigate. The implication is that in all subsequent stages, banks operate under the assumption that \( q_2^e = q_2 \).

The banks only learn in the final stage what the true value of \( \epsilon \) is, and they do so by
discovering what proportion of their loans to tagged entrepreneurs cannot be repaid. If \( \epsilon = \tilde{\epsilon} \), the banks earn a profit, while if \( \epsilon = \epsilon^* \) they make a loss. Of course, we presume that the banks can absorb any losses they make (implicit in the assumption that they are risk-neutral). Our model can be viewed as being a partial equilibrium analysis of one of many risky industries or activities that the banks are involved in financing.

This completes our discussion of equilibrium determination in the market economy. The key features of it are as follows:

- Banks do not investigate aggregate risk; they assume \( q_2^e = q_2 \).
- The interest rate offered to entrepreneurs who obtain a signal \( \delta = \ell \) is \( r^\ell = R/q_1 \).
- The interest rate offered to those who obtain \( \delta = h \) is the solution to (6), \( r^h(q_2) < \tilde{\epsilon} \).
- The amount of resources per entrepreneur spent in evaluation of projects is the solution to (5), \( \epsilon(r^h) \)

Recall that we have neglected the problem of \textit{ex post} moral hazard by assuming the banks can commit to offering their tagged clients contracts no worse than \( r^h \). Otherwise, after evaluation, the banks would increase the interest rate offered to tagged entrepreneurs to an amount just below what would induce them to change banks (\( r^\ell \)). In equilibrium, the interest rate offered to the tagged and untagged entrepreneurs would be almost the same. This would remove almost all the incentive to evaluate clients so the credit market would produce almost no information at all. This is not an uncommon problem in the adverse selection literature, and there are various ways around it. One is to invoke reputational effects for the banks. Another is to suppose the banks can organize themselves internally through strategic delegation so that an original offer is credible. (Strategic delegation by firms has been used in other contexts; see Vickers (1987).)

To understand this latter method, suppose that the bank manager employs an inspector who is responsible for evaluating clients and assigning the signal \( \delta \) to them. The bank manager can also delegate the role of revising contracts to a third person. Denote the reports assigned by the inspector as either \( \hat{h} \) or \( \hat{\ell} \). Truthful evaluation implies \( \hat{h} = h \) and \( \hat{\ell} = \ell \). Suppose that the reward for the inspector is given by \( \bar{w} + k \cdot \Pr(\text{success} \mid \hat{h}) \), where \( k > 0 \). By the law of large numbers, \( \Pr(\cdot) \) is the proportion of entrepreneurs assigned \( \hat{h} \) who are successful. When the inspector reports the results of evaluations honestly, \( \Pr(\text{success} \mid \hat{h}) = \Pr(\text{success} \mid h) \), given by (2). It can be shown that the inspector has no incentive to misreport the outcome of an evaluation.\(^4\) Also \( k \) can be adjusted so that the choice of \( \epsilon \) by the inspector coincides with that given in (5). In addition, an incentive scheme can be designed such that the person responsible for revising the contracts will not change them upwards, and will only change \( r^h \) downwards to a rate below \( \tilde{\epsilon} \) when the

\(^4\) Assume the inspector reports \( \hat{\ell} \) for a client with \( \delta = h \). This has no effect on the proportion \( \Pr(\text{success} \mid \hat{h}) \). If he reports \( \hat{h} \) for client with \( \delta = \ell \), for \( r^h \), \( \Pr(\text{success} \mid \hat{h}) \) decreases, which decreases his payoff.
other bank attempts to obtain the tagged clients.\(^5\)

The issue to which we turn now is whether or not these solution values determined in the private market equilibrium are the optimal ones. To address that we characterize the socially optimal allocation and then discuss a possible role for government intervention in the market economy.

4. THE EFFICIENT ALLOCATION

In the economy we have postulated, all agents are risk-neutral and entrepreneurs are identical \textit{ex ante}. In this context, a socially efficient allocation is one which maximizes the expected aggregate profits of the banks and the \(M\) entrepreneurs. Denote expected aggregate profits per entrepreneur by \(\Pi(r^h, r^\ell, e, q^e_2)\), where:

\[
\Pi(r^h, r^\ell, e, q^e_2) \equiv \left( \rho q^e_2 + (1 - \rho)(1 - p(e))q_1 \right) f \left( k(r^h) \right) + (1 - \rho)p(e)q_1 f \left( k(r^\ell) \right) \\
- \left( \rho + (1 - \rho)(1 - p(e)) \right) Rk(r^h) - (1 - \rho)p(e)Rk(r^\ell) - e
\]

The size of \(\Pi(\cdot)\) will depend upon whether or not the investment \(I\) is undertaken to determine the true value of \(e\). It is useful to postpone consideration of \(I\).\(^6\) For a given value of \(q^e_2\), the efficient allocation of resources will be achieved by selecting the values of \(r^h, r^\ell\) and \(e\) that maximize \((7)\). Given that \(f'(k(r^h)) = r^h\) for each tagged entrepreneur, the first order condition with respect to \(r^h\) can be written:

\[
r^h = \frac{\rho + (1 - \rho)(1 - p(e))}{\rho q^e_2 + (1 - \rho)(1 - p(e))q_1} \cdot R < \frac{R}{q_1}
\]

\(^5\) Another way to avoid \textit{ex post} moral hazard is as follows. Suppose banks commit themselves not to revise the set of contracts offered \((r^h, r^\ell)\) upwards, but they can misassign entrepreneurs between categories. Let \(\hat{r}^\delta\) be the revised interest rate, \(\hat{r}^\delta \leq r^\delta\). This is plausible since the menu of contracts offered is observable, although the outsider cannot see which interest rate is offered to which clients. Also, suppose that the tagged entrepreneurs change banks if they are offered \(r^\ell = \hat{r}\). Let us start from the market equilibrium assuming the banks do not renege on their contracts: so \(r^\ell = \hat{r} = R/q_1\) and \(r^h < \hat{r}\). There are two possible ways that banks might be motivated to deviate from this equilibrium without violating their commitment: (i) offer \(r^\ell\) to the tagged entrepreneurs or (ii) revise \(r^\ell\) to \(\hat{r}^\ell < R/q_1\) and offer it to all clients. In the first case, as supposed above, the tagged clients move to the other bank at stage 6. The belief on new clients possessed by the other bank will be improved, so it reduces its offer \(\hat{r}\) below \(R/q_1\). The deviator will lose all clients, so this case cannot be beneficial. In the second case, all clients receive \(\hat{r}^\ell < R/q_1\). Again the other bank anticipating this deviation offers \(\hat{r}\) slightly less than \(r^\ell\) to obtain all clients from its rival. The competition continues until \(\hat{r}^\ell = \hat{r}\) and \(\hat{r}\) reach \(\bar{r}\). It is immediate to see that \(\hat{r}^\ell = \bar{r}\) yields negative profit for the deviator since the evaluation cost \(e\) is not covered. Therefore, we conclude that neither bank has an incentive to deviate from the equilibrium, and the \textit{ex-post} moral hazard issue can be resolved.

\(^6\) So, precisely speaking, \((7)\) is the expected profit gross of \(I\).
Similarly, for \( r^\ell \), we have:

\[
r^\ell = \frac{R}{q_1}
\]  

(9)

And, the first order condition for \( e \) is:

\[
(1 - \rho)p'(e) \cdot ((q_1 \cdot f(k(r^\ell))) - R \cdot k(r^\ell)) - (q_1 \cdot f(k(r^h)) - R \cdot k(r^h)) - 1 = 0
\]  

(10)

Using the expected profits for the entrepreneurs, \( \pi(q, r) = q(f(k(r)) - rk(r)) \), this may be rewritten as:

\[
(1 - \rho)p'(e)(R - q_1 r^h)k(r^h) - 1 = (1 - \rho)p'(e)(\pi(q_1, r^h) - \pi(q_1, r^\ell))
\]  

(11)

These three equations, (8), (9) and (10) (or (11)), jointly determine \( r^h \), \( r^\ell \) and \( e \). By (9), we see that the efficient value of \( r^\ell \) is also that obtained in the private market equilibrium. The optimal value of \( r^h \), and therefore of \( e \), depend on the value of \( q_0^r \). (Effort \( e \) does not depend directly on \( q_2 \), only indirectly through \( r^h \).) It can be shown that \( r^h(q_2^\ell) < r^h(q_2^0) < r^h(q_2^a) \).\footnote{Obviously, these functions are different than those that apply in the market equilibrium case. To avoid notational complexity, we have not distinguished between the two sets of functions in anticipation that readers will not find it confusing.}

(Recall that \( q_0^r = q_2^0 \) if no investment \( I \) is undertaken, but either \( q_2^\ell \) or \( q_2^a \) if investment is undertaken to find the true value of the aggregate risk parameter \( e \).) Also, since \( e \) is inversely related to \( r^h \) in the social optimum, \( e(q_2^\ell) > e(q_2^0) > e(q_2^a) \).

Comparing the efficient outcome with the market equilibrium, \( r^\ell \) is the same for both, but the efficient values for \( r^h \) and \( e \), determined by (8) and (11), will generally be different from the private market values determined by the solutions to (6) and (5). In particular, the term on the right-hand side of (11), which is positive since \( \pi_r(\cdot) < 0 \), does not appear in the market condition (5). The implication is that there is an incentive for banks to choose too high a value of \( e \) in the private market equilibrium. The intuition for this unexpected result that banks exert too much effort is as follows. The left-hand side of (10) represents the social gain from a marginal reduction in type II errors, in other words, in the number of tagged type 1 entrepreneurs. In the market equilibrium, untagged type 1 entrepreneurs bear none of the evaluation cost so obtain the entire net social gains from their projects, since \( \pi(q_1, r^\ell) = q_1 \cdot f(k(r^\ell)) - R \cdot k(r^\ell) \). On the other hand, the net social gain from a tagged type 1’s project, \( q_1 \cdot f(k(r^h)) - R \cdot k(r^h) \), can be divided into two parts, the expected profit of the tagged type 1, \( \pi(q_1, r^h) \), and that of bank: the latter appears as the first term on the left-hand side of (11). When choosing \( e \), each bank is only concerned with the marginal gain accruing to it. Because \( \pi(q_1, r^h) > \pi(q_1, r^\ell) \), this implies that banks over-evaluate the benefit from raising \( e \): that is, the private gain exceeds the social one. Thus, it is the failure of the banks to appropriate all of profits of tagged and untagged type 1’s projects them induces them to be too cautious about type II errors.

As for \( r^h \), condition (6) may be rearranged as follows:

\[
r^h = \frac{\rho + (1 - \rho)(1 - p(e))}{\rho q_2^r + (1 - \rho)p(e)q_1} \cdot R + \frac{e(r^h)}{(\rho q_2^r + (1 - \rho)p(e)q_1) k(r^h)}
\]  

(6')
The second term on the right-hand side of \((6')\) does not appear in the efficiency condition \((8)\). Since it is positive, it results in a tendency for \(r^h\) to be larger than in the efficient allocation. Of course, these tendencies for \(e\) and \(r^h\) to be set too high are only partial equilibrium effects. In a general equilibrium, they may not translate into larger values of both these variables compared with the efficient allocation. Nonetheless, the direction of the deviation of the market conditions from the efficient ones provides some intuition for the sorts of government policies that might be efficiency-improving.

Another indication of inefficiency in the market equilibrium comes from considering the expected profits of the banking sector in the efficient allocation. Recall the expression for expected bank profits per client, given by equation \((6)\). Substituting \((8)\) and \((9)\) for \(r^h\) and \(r^f\) in \((6)\) yields \(\pi^B(r^h, r^f, q^e_2) = -\varepsilon < 0\). Thus, the banking sector must operate at a loss in the efficient allocation, and this is without taking account of any costs of investigation of aggregate risk. The loss represents the cost of evaluating each entrepreneur, reflecting the fact that the information gained from the evaluation has the nature of a fixed cost: it has no effect on the opportunity cost of lending a marginal dollar.

An alternative way of viewing the inefficiency of the market equilibrium is to evaluate the effect on \(\Pi(\cdot)\) of local changes in \(r^h\) and \(e\). Differentiating the expression for \(\Pi\) with respect to \(r^h\) and using the private market equilibrium condition \((6)\) that determines \(r^h\) yields (for a given value of \(q^e_2\)):

\[
\frac{\partial \Pi}{\partial r^h} = \frac{ek'(r^h)}{k(r^h)} < 0
\]

Thus, a small reduction in \(r^h\) starting at the private market equilibrium increases efficiency. Similarly, differentiating \(\Pi\) with respect to \(e\) and using condition \((5)\) yields:

\[
\frac{\partial \Pi}{\partial e} = (1 - \rho)p'(e) \left( \pi(q_1, r^f) - \pi(q_1, r^h) \right) < 0
\]

So a small reduction in \(e\) will also improve efficiency.

Finally, we have not addressed the issue of investigation for aggregate risk. The question is whether it is worth investing \(I\) to determine for certain whether the probability of success of type 2 entrepreneurs is \(\overline{q}_2\) or \(q_2\). Suppose we denote the optimized value of the expected profit per entrepreneur obtained from solving \((8)-(10)\) for given \(q^e_2\) as \(\Pi(q^e_2)\). It is straightforward to show that in the social optimum, \(\Pi(q^e_2)\) is increasing and strictly convex in \(q^e_2\). This implies that if \(I\) is not too large, expected aggregate profits net of \(I\), \(M \cdot \Pi(q^e_2) - I\), will be higher than \(M \cdot \Pi(q_2)\), the expected value when the investment \(I\) is not incurred. In the market allocation, we cannot be sure that the expected value of the aggregate profit is strictly convex in \(q^e_2\). If it is concave, investing in \(I\) would definitely not be welfare-improving regardless of the size of \(I\).

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\(^8\) This follows immediately from differentiating the expression above for \(\Pi\) twice with respect to \(q^e_2\), making use of the envelope theorem and the fact that \(r^h\) is decreasing in \(q^e_2\).
5. THE ROLE OF GOVERNMENT

We have identified in the previous section three sources of market failure. These involve the market determination of the interest rate offered to tagged entrepreneurs, \( r^k \); the amount of resources devoted to evaluating entrepreneurs, \( \epsilon \); and the discrete investigation decision, \( I \). The main difficulty in devising policies to address these market failures is that the government cannot observe some relevant variables in the private sector. For example, the government cannot observe the effort devoted by banks to evaluating entrepreneurs, so cannot condition its policy on \( \epsilon \). And, it cannot observe the signal \( \delta \) assigned to each entrepreneur. We assume it can observe whether an entrepreneur is forced out of business by a bad state. Because it does not have the same information as the banks or the entrepreneurs, only a second-best efficient outcome can be achieved. Of course, the government could take over the functions of the banks and act as a financial intermediary, undertaking its own evaluation of entrepreneurs.\(^9\) We do not consider that as an option for the usual sorts reasons that decentralized decision-making is preferred. We do, however, allow the government to become directly involved in the acquisition of information about aggregate risk, given that banks would be unwilling to invest in this at all.

Given these limitations on government policy, we restrict ourselves to a sample of policies that are informationally feasible and have been used in practice. These include loan guarantees that are payable to the banks in the event of bankruptcy by entrepreneurs, lending rate controls, and, as mentioned, acquisition of information on aggregate risk. As is typically the case, the full characterization of second-best policies and allocations is extremely complicated. Our analysis will be much more limited than that. It will simply indicate the sorts of policies that might be efficiency-enhancing in the type of economy we have stipulated. Since most the government policies we consider will involve budgetary expenditures, revenues will have to be raised. We assume that the government can obtain revenues using a lump-sum tax, thereby avoiding problems of inefficiency due to distortionary taxation.

**Information Acquisition**

The most straightforward policy option to consider is the acquisition of information on aggregate risk by the government, something that the banks would be unwilling to undertake because of their inability to appropriate the benefits of the information obtained. Suppose the government undertakes the necessary expenditures \( I \), determines the true probability of success of type 2 entrepreneurs, \( q_2 \) or \( q_1 \), and announces that to the private sector. This case of information acquisition by the public sector can be thought of as a form of *indicative planning*. It may be the case that investigation requires some professional skill, which is lacking in the public sector. Instead, the government might act as a co-ordinating

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\(^9\) In Japan, the government's Japan Development Bank has been considered as a substitute for private banking (Higano (1986), Ishi (1997)). Higano (1986) argues that the Bank has played a significant role in evaluating firms, in particular, smaller-sized ones. He also notes that loans provided by the Bank send a signal of a borrower's quality, and induces additional loans by private banks. He aptly calls this phenomenon the 'cow-bell effect'.
agency for bringing together the banks in the investigation of industry risk.\textsuperscript{10}

If direct or coordinated information acquisition is the only policy undertaken by the public sector, the values of $r^h$ and $e$ will be determined by (6) and (5) with $q_k^e$ set equal to either $\eta_2$ or $q_2$ as appropriate. As in the social optimum, it can be shown that $r^h(\eta_2) < r^h(q_2)$ and $\epsilon(\eta_2) > \epsilon(q_2) > \epsilon(q_2)$. But their values will generally be different from the efficient ones, determined by (8) and (11) for the same value of $q_k^e$. We have already seen the ways in which these conditions differ. Of course, information acquisition may or may not be socially efficient. Indeed, even if information should be produced in the social optimum, it may not be efficient to produce it in the market equilibrium. In what follows, we proceed with our analysis assuming that the investment $I$ is efficient in the market economy setting although such an assumption is not essential.

**Information Acquisition and a Loan Guarantee**

In addition to investment in information acquisition, suppose that the government compensates the banks for part of the losses they incur from individual entrepreneurs. This can be viewed as a form of loan guarantee. Let $s$ be the compensation per dollar invested paid to a bank on each loss it suffers. The loan guarantee is provided for any investments in the risky industry. To implement this scheme, the government obviously has to be able to verify success or failure of each individual project, which we assume. Otherwise, the banks will have an incentive to cheat by making a false report. Recall from the previous section that starting from the private equilibrium, efficiency will be improved if $r^h$ and $e$ are reduced. Our analysis will concentrate on the effect of changes in the loan guarantee on $r^h$ and $e$ to see whether such an instrument can be efficiency-enhancing.

When a loan guarantee of size $s$ is in effect, the potential mobility of untagged type 1 entrepreneurs causes the interest rate $r^e$ to be revised to:\textsuperscript{11}

$$
 r^e = \frac{R - (1 - q_1)s}{q_1}
$$

This follows directly from the requirement that zero profits be earned on potentially mobile entrepreneurs. Note that (4s) implies that $r^e$ will deviate from the socially efficient value when $s > 0$, implying that we are necessarily dealing with a second-best situation. Now suppose that the investigation of aggregate risk uncovered that fact that the probability of success of type 2 projects was $\eta_2$. This is simply to make the analysis concrete; all the following analysis also applies in the case where this probability is $q_2$. The expected profits of the banks per entrepreneur can then be written:

$$
\pi^B = \Pr(h) \left( \Pr(\text{success} \mid h) r^h + \Pr(\text{fail} \mid h) s - R \right) k(r^h) - e
$$

\textsuperscript{10} Of course, co-ordination among banks in the acquisition of information may induce collusion among them, allowing them to behave like a monopolist in credit markets. As Hellmann et al (1997) point out, this may entail the use of anti-trust policies.

\textsuperscript{11} We assume in what follows that $s < R$, which is reasonable and will not restrict the analysis we subsequently undertake.
The first-order condition for the choice of \( e \) is now:

\[
(1 - \rho)p'(e)(R - q_1 r^h)k(r^h) - s(1 - \rho)p'(e)(1 - q_1)k(r^h) - 1 = 0
\]

(5s)

This determines \( e(r^h, s) \), which when substituted into (12) gives the profit function for the banks \( \pi^B(r^h, \bar{q}_2, s) \). The market equilibrium value for \( r^h \) is determined in Bertrand competition by setting \( \pi^B(r^h, \bar{q}_2, s) = 0 \), or:

\[
\left[ \left( \rho \bar{q}_2 + (1 - \rho) (1 - p(e(r^h))) q_1 \right)(r^h - s) - \left( \rho + (1 - \rho) (1 - p(e(r^h))) \right)\right](R - s) \quad k(r^h)
\]

\[-e(r^h) = 0
\]

(6s)

This equation can be solved for \( r^h(\bar{q}_2, s) \).

Equations (4s)—(6s) jointly determine the variables \( r^\ell \), \( e \) and \( r^h \) for any values of \( s \) and \( \bar{q}_2 \). Our main interest is in \( e \) and \( r^h \), and they are determined solely by (5s) and (6s), independent of the value of \( r^\ell \). A routine comparative static analysis yields the result that \( dr^h/ds < 0 \), but that generally the sign of \( de/ds \) is indeterminate. This is because the direct effect of \( s \) is to decrease \( e \), but the indirect effect through \( r^h \) is to increase it. However, if we evaluate these expressions at \( s = 0 \), we obtain:

\[
\left. \frac{dr^h}{ds} \right|_{s=0} < 0; \quad \left. \frac{de}{ds} \right|_{s=0} < 0
\]

(13)

Given that decreases in \( r^h \) and \( e \) starting from the private market equilibrium will be welfare-improving, efficiency will be improved by introducing a loan guarantee. Of course, while such a policy will improve efficiency for small values of \( s \), there will be a limit to its optimal size since, as (4s) indicates, larger values of \( s \) cause \( r^\ell \) to deviate increasingly from its efficient level.

The loan guarantee is just one example of a policy that can improve the efficiency of our economy characterized by informational externalities. A potential policy that is not unambiguously efficiency-improving is an investment subsidy \( \sigma \) paid on each dollar of investment. Such a policy would cause the demand for capital to become \( k(r - \sigma) \) for any value of \( r \). An analysis similar to the above shows that while this investment stimulus causes \( r^h \) to fall as desired, it causes \( e \) to rise. The latter results from the fact that, unlike with the loan guarantee, the direct effect of \( \sigma \) on \( e \) is to increase it.

**Information Acquisition and Lending Rate Control**

The defect of a loan guarantee (as well as an investment subsidy) is that it subsidizes bad projects as well as good ones. An alternative that avoids that is to directly control the lending rate, \( r^h \), which is set higher than the socially optimal level in the market. Lending
rate control is advocated by Hellmann et al (1997) to create ‘franchise value’ and induce the banks to monitor loans after they have been made, an issue we do not address. They also consider deposit rate control, which we have ruled out by assuming deposit rates are determined on international capital markets. In our context, the control of \( r^h \) is, at best, an imperfect instrument. For one thing, social efficiency cannot be achieved by this policy. This is because the social optimum always requires the pecuniary external effect arising from the client evaluation (measured by the right-hand side of (11)) to be internalized and this implies that the banks be operated with negative profits, \(-\epsilon\) per entrepreneur. For the government to overcome this, it would need to offer a subsidy. When evaluation effort \( \epsilon \) is not observable, a subsidy contingent on \( \epsilon \) is simply unfeasible. Therefore, government policy is necessarily still second-best.

For another, the appropriate direction of the lending rate control is ambiguous. While lowering \( r^h \) from the market equilibrium value raises aggregate output as we saw above (\( \partial \Pi / \partial r^h < 0 \)), it also raises the effort level unambiguously (\( \epsilon'(r^h) < 0 \)), which works to decrease \( \Pi(\cdot) \). Thus, the net effect of marginally reducing \( r^h \) from the market solution on the aggregate output becomes ambiguous. Unlike with the loan guarantee, it is not the case that a marginal reduction in the lending rate is unambiguously welfare-improving; it is possible that the welfare-improving policy involves forcing banks to increase their interest rate to tagged entrepreneurs. Moreover, even if reducing lending rates is welfare-improving, the government would need to provide a subsidy the banks to cover the losses they would suffer from \( r^h \) being less than the market equilibrium rate.\(^{12}\)

To summarize this section on government policy in the basic model, the banking sector will not have the incentive either to investigate aggregate risk or to devote the optimal amount of resources to evaluating clients. As a consequence, no investigation will be done, and there will be a tendency to spend too many resources evaluating clients. This will result in an interest rate \( r^h \) that is too high. Welfare can be improved by implementing policies that reduce \( r^h \) and \( \epsilon \). One such policy is a partial loan guarantee to banks for losses suffered when entrepreneurs cannot repay their loans. Such a policy will not be fully optimal because it causes \( r^e \) to fall below its optimal value. An alternative to a loan guarantee might be direct control of the lending rate on tagged clients, \( r^h \). As discussed above, however, in our context, the desirability of this policy relative to the loan guarantee is not obvious, unlike in the case of Hellmann et al (1997).

6. ALTERNATIVE ASSUMPTIONS

The description of the market solution and the implications for government policy obviously depend upon the structure of the model, including the informational assumptions and the equilibrium concepts used. The contracts we have considered involve only an interest rate: entrepreneurs are allowed to borrow as much as they want. Bertrand competition and its zero-profit outcome for the banks result in an inability of banks to appropriate the returns from investing resources in obtaining information that will be revealed to other banks. Similarly, the fact that some information obtained by banks is private has implications for

\(^{12}\) Note that when \( \epsilon \) is optimized, we have supposed \( \partial \pi^B(r^h, q^h)/\partial r^h > 0 \).
the efficiency of market outcomes. In addition, our model involves only type II errors in the evaluation process, which accounts for banks over-evaluating. We briefly explore the consequences of adopting alternatives to these assumptions. We also allow the number of the entrepreneurs to be endogenous by including an occupational choice stage. This allows us to examine how credit market failure leads to an inefficient number of entrepreneurs.

**User Charges, Collateral and Internal Finance**

We have so far restricted our attention to the case where the contract offered to entrepreneurs stipulates only an interest rate to be paid on capital borrowed from the bank. This is because entrepreneurs are assumed to have no initial wealth. If they do have some wealth, more complicated forms of contracts are possible. We discuss briefly three alternatives here — user charges, collateral requirements and internal financing. In each case, they complicate the analysis considerably without changing the basic nature of credit market failure.

Consider first user charges as a way for the banks to recoup at least part of the costs of evaluation. Suppose the banks charge an amount $c$ up front to all entrepreneurs they evaluate. To implement this, entrepreneurs must possess some income, which is not used for financing their projects. (We consider internal financing below.) For simplicity, we assume $c$ is fixed and uniform between the two banks. Since $c$ is paid before evaluation by all entrepreneurs, untagged entrepreneurs cannot avoid it by changing banks. This implies that $c$ does not influence the choice of $e$. Also, $r^f$ will not deviate from $R/q_1$ since the threat to change banks is not affected by $c$, which must be paid in any case. But, the user charge will reduce $r^h$ by the zero-profit condition: banks earn part of their profits in the form of the user charge and thus they can afford to offer lower interest rates. The user charge will enhance efficiency because it decreases $r^h$, but it will not suffice to achieve the social optimum. Moreover, in practice, the use of such a fee may be quite limited.

If entrepreneurs have some personal wealth, banks may insist that the wealth be used as collateral to reduce the possible loss in the event of bankruptcy. Banks may require the same amount of collateral from each entrepreneur with given signal $\delta$. Or, they may use collateral to separate the tagged entrepreneurs. We discuss each of these cases in turn. Uniform collateral will act essentially like a loan guarantee because it compensates the banks for losses when their clients go bankrupt. As such, it will discourage client evaluation effort $e$. At the same time, interbank competition, which drives the expected profit including the expected payments of collateral to zero, will result in a lower interest rate $r^h$ than in the absence of collateral. Since collateral is provided by the untagged entrepreneurs as well, competition for them will reduce $r^f$ below $R/q_1$, as in the case when a loan guarantee is provided. This implies that untagged type 1 entrepreneurs will over-invest. Thus, as with a loan guarantee, a collateral requirement reduces $e$, $r^h$, and $r^f$. The former two will be socially beneficial, but the latter increases inefficiency.

Banks may choose to use collateral to separate type 1 from type 2 entrepreneurs. It is well-known that, if contracts can include an amount of collateral, the inefficiency arising from asymmetric information on credit markets will be mitigated the using collateral as a screening device (Bester (1985)). In our model, type 2 entrepreneurs will be willing to
provide more collateral than type 1 at any given interest rate. Let \((r^i, C^i)\) be the contract intended for the tagged type \(i\) entrepreneurs \((i = 1, 2)\), where \(C^i\) is collateral to be paid in the case of bankruptcy. The expected profit of type \(i\) tagged entrepreneurs is given by \(\pi(q_i, r^i) - (1 - q_i)C^i\). It is obvious that, given a contract \((r, C)\), the single-crossing property holds, which implies that the separation is always feasible.\(^\text{13}\) It is also easy to verify that type 2's will be asked for more collateral and offered a lower interest rate than type 1's. As in the uniform collateral case, the presence of collateral discourages effort. In addition, separating contracts will improve the banks' expected profit from the tagged type 1's. As long as this expected profit, \((R - q_1r^1)k(r^1) + (1 - q_1)C^1\), is negative, the banks will still have an incentive to evaluate their clients. And, when \((1 - q_1)C^1\) does not suffice to cover the rent accruing to the tagged type 1 due to type II errors, there still exists over-evaluation. Thus, the qualitative results of the basic model still apply.

Finally, suppose entrepreneurs use their wealth to provide some of their own internal financing rather than for collateral. Obviously, type 2 entrepreneurs will be more willing to invest in their own assets than type 1, and they will do so as long as a corner solution is not optimal in which all wealth is invested internally by both types. Then, contrary to our basic model, the demand for external financing, \(B\), will be different between the two types of entrepreneurs. If so, the banks will be able to separate the tagged type-1 and type-2 entrepreneurs by offering contracts that include both an interest rate and an amount of lending \(B\). In effect, entrepreneurs are offered the choice between \((r^1, B^1)\) and \((r^2, B^2)\) where \((r^i, B^i)\) is the contract intended for type \(i\) tagged entrepreneurs. To prevent tagged type 1's from mimicking type 2's, the contracts must be designed so that the relevant self-selection constraint is satisfied: there will be credit rationing for \((r^2, B^2)\). On the other hand, \(r^\ell\), the interest rate offered to untagged entrepreneurs, should be the same as before because of interbank competition at stage 6: \(r^\ell = R/q_1\). As long as \(r^1\) is strictly less than \(R/q_1\), and thus the banks suffer a loss from the tagged type 1 entrepreneurs, they can increase their expected profits by putting some effort \(\epsilon\) into evaluation so as to decrease the number of tagged type 1's.\(^\text{14}\) Thus, while separating contracts along with credit rationing will complicate our analysis, the role of client evaluation remains as before. Separating contracts would not lead to an efficient allocation. Due to the self-selection constraint, the banks will not be able to appropriate the rents of the tagged type 1 entrepreneurs, which will induce them to over-estimate the cost of type II errors, as we have already discussed. Of course, the use of separating credit-rationing contracts will not be feasible if both types invest all their initial wealth in their own projects and therefore rely on internal finance to the same extent.

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\(^{13}\) To see this, note: \(-dC/dr|_{i=2} = q_2k(r)/(1 - q_2) > q_1k(r)/(1 - q_1) = -dC/dr|_{i=1}\).

\(^{14}\) \(r^1\) needs to be less than \(r^\ell = R/q_1\) since the tagged type 1's would be worse off otherwise. When \(r^\ell < r^1\), type 1 entrepreneurs will declare themselves to be type 1, which eliminates the need of tagging or separation. Then \(r^2\) will be lowered to \(R/q_2\) through interbank competition. But once this rate is realized with \(\epsilon = 0\), type 1 can mimic type 2 with certainty. Thus, there will be an issue of non-existence of equilibrium.
Monopoly Bank

Consider the polar opposite case of Bertrand competition, monopoly behavior by the banking sector. There may be literally only one bank, or banks may be able to collude effectively and maximize their joint profits. A monopoly bank would invest in determining the aggregate risk parameter $\epsilon$ if that served to increase its expected profits. Of course, the conditions under which it would pay to invest an amount $I$ to learn whether the true value of $\epsilon$ was $\bar{\epsilon}$ or $\epsilon$ would be somewhat stricter than for a social planner: expected bank profits rather than expected aggregate profits would have to rise by enough to cover $I$. Let us proceed by supposing that the bank has invested $I$ and has found out the true value of $\epsilon$, say, $\bar{\epsilon}$.

Given the probability of success of type 1 projects, $\bar{q}_2$, expected bank profits (i.e., actual profits, *ex post*) would be given by (3) with $q_2^* = \bar{q}_2$, or

$$\pi^M(r^h, r^\ell, \bar{q}_2, \bar{\epsilon}) = \left[\left(\rho \bar{q}_2 + (1 - \rho)(1 - p(\bar{\epsilon}))q_1\right)r^h - \left(\rho + (1 - \rho)(1 - p(\bar{\epsilon}))\right)R\right]k(r^h)$$

$$+ (1 - \rho)p(\bar{\epsilon})(q_1 r^\ell - R)k(r^\ell) - \epsilon$$

The monopoly bank would choose $r^\ell$, $\epsilon$ and $r^h$ to maximize profits, or

$$\max_{\{r^\ell, \epsilon, r^h\}} \pi^M(r^h, r^\ell, \bar{q}_2, \bar{\epsilon})$$

(M)

The first-order conditions with respect to $r^\ell$ and $r^h$ are:

$$r^\ell = \frac{R}{q_1 (1 - 1/\eta^\ell)}$$

(4m)

$$r^h = \frac{\left(\rho + (1 - \rho)(1 - p(\bar{\epsilon}))\right)R}{\left(\rho \bar{q}_2 + (1 - \rho)(1 - p(\bar{\epsilon}))q_1\right)(1 - 1/\eta^h)}$$

(5m)

where $\eta^h = -r^h k'(r^h)/k(r^h)$ and $\eta^\ell = -r^\ell k'(r^\ell)/k(r^\ell)$. Comparing these with (8) and (9), both $r^\ell$ and $r^h$ are larger than their efficient values, which should not be surprising for a monopolist. The first-order condition with respect to $\epsilon$ gives

$$(1 - \rho)p(\bar{\epsilon})\left((q_1 r^\ell - R)k(r^\ell) - (q_1 \cdot r^h - R)k(r^h)\right) - 1 = 0$$

(6m)

Comparing (6m) with (10) does not give an obvious ranking of $\epsilon$ for the monopolist bank relative to the efficient allocation.

More insight can be obtained by comparing the monopolist outcome with the Bertrand equilibrium, given information acquisition. Obviously, $r^\ell$ is higher in the monopoly situation since $r^\ell = R/q_1$ in Bertrand competition. To compare $r^h$ and $\epsilon$ in the two outcomes,

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15 Collusion here would have to include a full sharing of information among the banks.
consider the derivatives of $\pi^M(r^h, r^\ell, \bar{q}_2, \epsilon)$ with respect to $r^h$ and $\epsilon$. It is straightforward to show that, starting at the Bertrand equilibrium values of $r^h$ and $\epsilon$ and the monopoly value of $r^\ell$, both of these will be positive. The implication is that the monopolist will tend to set both $r^h$ and $\epsilon$ higher than the Bertrand competitive values. Since the latter are already higher than the efficient levels, the monopoly allocation will be less efficient than that under Bertrand competition, given information acquisition. Therefore, the case for a loan subsidy applies here as well.

The issue of information acquisition is resolved differently in the monopoly case than with Bertrand competition. In the latter, as we have seen, any information acquisition must be done by the government. On the other hand, a monopoly bank may choose to invest in information since the benefits are appropriated. Of course, the monopolist’s choice of whether to invest may not be the socially efficient one. It may not choose to invest even though it is socially efficient to do so because external benefits from information acquisition are ignored.

### Evaluation Signals Observable to Other Banks

Let us return to the Bertrand competition case with two banks. Again we treat the case where the government invests $I$ to obtain the true value of $\epsilon$, which we arbitrarily take to be $\bar{\epsilon}$. Now, suppose that the signals $\delta$ obtained by a bank’s evaluation are observable to the other bank. The consequences of this are dramatically different from the base case where $\delta$ cannot be observed. (Recall that in that case banks will evaluate more intensively than is efficient.) When $\delta$ is observable, it is easy to see that banks will not undertake any evaluation ($\epsilon = 0$).

To see this, begin with stage 6 of the equilibrium determination and work backwards. In stage 6, $\epsilon$, $r^h$ and $r^\ell$ will have been determined and entrepreneurs will have an opportunity to change banks. Since all banks can observe the signal $\delta$ any given entrepreneur has received, banks will compete for entrepreneurs by offering $\hat{r}^h$ and $\hat{r}^\ell$ to those with signals $h$ and $\ell$. Bertrand competition at this stage will result in these interest rates being bid down so that zero profits are earned by entrepreneurs with each type of signal. Since those with signal $l$ will all be type 1’s by assumption, zero expected profits will yield, as before, $\hat{r}^\ell = R/q_1$. The implication is that in stage 4, banks will offer $r^\ell$ no higher than $R/q_1$. We can therefore anticipate that $r^\ell = R/q_1$ as earlier.

A similar process applies for those with signal $h$, except now these will include both type 1’s and type 2’s. The zero-profit condition for these entrepreneurs in stage 6 will be:

$$\left( \Pr(\text{Success} \mid h) \hat{r}^h - R \right) k(\hat{r}^h) = 0$$

where $\Pr(\text{Success} \mid h)$ is given by (2) with $q_2 + \epsilon = \bar{q}_2$. This zero-profit condition yields:

$$\hat{r}^h(\epsilon) = \frac{\rho + (1 - \rho)(1 - p(\epsilon))}{\rho \bar{q}_2 + (1 - \rho)(1 - p(\epsilon))q_1} R$$

(14)

where $\hat{r}^h(\epsilon)$ is decreasing in $\epsilon$. As with $\hat{r}^\ell$, banks will never offer $r^h > \hat{r}^h(\epsilon)$, and we can expect that in Bertrand competition, $r^h = \hat{r}^h(\epsilon)$, given by (14).
In stage 5, the banks choose $\epsilon$ anticipating that $r^\ell = R/q_1$ and $r^h = \hat{r}^h(\epsilon)$. The implication is that the expression for bank profits per entrepreneur given in problem (B) reduces to $\pi^B(r^h, r^\ell, \epsilon, q_2) = -\epsilon$. In these circumstances, banks will obviously set $\epsilon = 0$ and do no evaluation whatsoever. Thus, the observability of $\delta$ causes the private market equilibrium to go from one in which too much evaluation is done to one in which none is done. Since $p(0) = 0$, all entrepreneurs will effectively obtain a signal $\delta = h$. Banks will predict in stage 4 that all entrepreneurs will obtain a signal of $h$, and a pooling equilibrium will result. The interest rate offered by both banks in the pooling equilibrium will be obtained by $r^h = \hat{r}^h(0)$ in (14), or:

$$r^h = \frac{R}{\rho q_2 + (1 - \rho)q_1}$$

The policy options open to the government are not obvious in this case (apart from investigating aggregate risk). Given that entrepreneurs cannot appropriate any of the returns from evaluation, even subsidizing evaluation would not seem to be helpful (unless the subsidy is 100%, in which case a maximum subsidy must presumably be stipulated). An option might be for the government to evaluate entrepreneurs itself, although that would run into well-known problems of public sector inefficiency.

**Type I Errors Only**

In our model, only type II errors are present. This is based on the notion that it is more difficult to detect bad projects that to detect good ones. In practice, both types of errors will be present. To highlight the consequences of being unable to detect good projects perfectly, we consider the opposite case where only type I error can occur in the evaluation process. It turns out that, in this case, the deviation of effort $\epsilon$ from the efficient level is in the opposite direction.

Let $p(\epsilon)$ now refer to the probability of a type 2 entrepreneur being tagged, where $p'(\epsilon) > 0$. Thus, a type I error will occur with probability $1 - p(\epsilon) = Pr(\ell \mid 2)$. Type II errors are absent, so no type 1 entrepreneurs will be tagged. Suppose we ignore aggregate risk, so the probability of success of a type 2 entrepreneur is just $q_2$, which is also the probability of success given $\delta = h$. The conditional probability of an untagged entrepreneur being successful becomes:

$$Pr(\text{Success} \mid \ell) = \frac{\rho(1 - p(\epsilon))q_2 + (1 - \rho)q_1}{\rho(1 - p(\epsilon)) + (1 - \rho)}$$

Using this, we can write the expected bank profits per client as:

$$\pi^B = \rho p(\epsilon)(q_2 r^h - R)k(r^h) + \rho(1 - p(\epsilon))(q_2 r^\ell - R)k(r^\ell) + (1 - \rho)(q_1 r^\ell - R)k(r^\ell) - \epsilon$$

Begin with stage 6 where the clients may change banks and $\hat{r}$ is determined, given $r^h$, $r^\ell$ and $\epsilon$ (the same for both banks). At this stage, the inter-bank competition is asymmetric
in the sense that each bank knows the signal obtained by its own clients. This prevents
the tagged entrepreneurs from moving, so competition leads to:

$$\hat{r} = \frac{R}{\Pr(\text{Success} | \ell)} = \frac{\rho(1 - p(e)) + (1 - \rho)}{\rho(1 - p(e))q_2 + (1 - \rho)q_1} \cdot R$$ (15)

This implies that $\hat{r}$ lies between $R/q_1$ and $R/q_2$. As in section 3, the potential of mobility
prevents the banks from raising $r^\ell$ above $\hat{r}$, while for any $r^\ell < \hat{r}$, they suffer from a loss.
Thus, we can let $r^\ell = \hat{r}$. At stage 5, given $r^h$ and $r^\ell$, each bank chooses $e$, which yields
the first-order condition:

$$\rho p'(e) \left( (q_2 r^h - R) k(r^h) - (q_2 r^\ell - R) k(r^\ell) \right) = 1$$ (5')

Interbank competition over $r^h$ and $r^\ell$ at stage 4 results in zero profit, which leads to
$r^h = (R/q_2) + e/\rho p(e)$ and $r^\ell = \hat{r}$. As in the basic model, all of evaluation cost is borne
by $r^h$.

On the other hand, efficiency requires that $r^h = R/q_2$ and that $e$ satisfies:

$$\rho p'(e) \left( (q_2 f(k^h) - Rk^h) - (q_2 f(k^\ell) - Rk^\ell) \right) = 1$$ (10')

The condition for the efficient value of $r^\ell$ is given by the market equilibrium condition
(15). Now compare the market equilibrium and efficiency conditions for $e$, (5') and
(10'). The left-hand side of (10') represents social net gain from increasing the number
of tagged type 2 entrepreneurs. The term in large parentheses can be rewritten as
$[(q_2 r^h - R) k^h + \pi(q_2, r^h)] - [(q_2 r^\ell - R) k^\ell + \pi(q_2, r^\ell)]$. The two terms in square brackets
indicate how the social gain from tagged and untagged type 2's projects are divided be-
tween the bank and the entrepreneur. Each bank only takes account of the part of the
gain accruing to it. Since $\pi(q_2, r^h) > \pi(q_2, r^\ell)$, the private benefit to the banks from more
accurate tagging (an increase in $p(e)$) is less than the social one. Thus, given $r^h$ and $r^\ell$,
the effort level in the market equilibrium is less than the efficient one. This in turn implies
that the government policy should be designed so as to encourage $e$ as well as to reduce
$r^h$.

In practice, type I and II errors might both be presence. Our presumption has been
that type II errors are the more prevalent; that is, it is harder to detect which projects are
'bad' than which ones are 'good'. But, these results indicate that the presence of type I
ersors alongside type II error would temper the case for a loan subsidy.

**Occupational Choice**

Entrepreneurship has been widely recognized as a key part of the economic growth
process.\(^{16}\) Our basic model took the number of entrepreneurs as given. Suppose instead

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\(^{16}\) For example, it is entrepreneurs who manage the process of creative destruction modeled by
the number of entrepreneurs is endogenous and determined by capable persons choosing between being entrepreneurs in a risky sector or workers in a safe one. We simplify matters by assuming that all potential entrepreneurs are risk-neutral and equally capable, thereby avoiding some of the issues that have been treated in the occupational choice literature.\footnote{Kihlstrom and Laffont (1979) analyze the equilibrium determination of entrepreneurs when persons differ in their degree of risk aversion. Less risk-averse individuals choose to be entrepreneurs rather than workers. Kanbur (1981) and Murphy et al (1991) assume that occupational choice is determined by the ability of individuals — more able individuals choose to become entrepreneurs.}

Suppose that \textit{ex-ante} identical persons consisting of a continuum of size $N$ choose between being entrepreneurs in the risky sector or skilled workers in the risk-free sector. The occupation must be chosen after any investigation of the aggregate risk (stage 2), but before the type of project is known to each entrepreneur (stage 3). Thus, at the occupational choice stage, the information on the aggregate risk becomes available to the potential entrepreneurs if $I$ is invested and the result is announced in public, while each person who chooses to become an entrepreneur faces risk about project type as well as idiosyncratic risk about the success of the project.

As before, let $M$ of them become entrepreneurs. The remaining $N - M$ are skilled workers who produce an output of $G(N - M)$ in the safe sector and receive a wage rate of $G'(N - M)$. All the earlier results on the inefficiency of the private banking sector apply regardless of the number of entrepreneurs $M$, so there are no changes in events after the occupational choice stage. The equilibrium values of $r^h$ and $e$ are given by (6) and (5), and $r^\ell = R/q_1$. In the absence of government intervention, aggregate risk is not investigated, so $q^e_2 = q_2$. Given $q^e_2 = q_2$, potential entrepreneurs anticipate the values of $r^h$, $r^\ell$, $\hat{r}$ and $e$ to be determined in the subsequent stages. Then, occupational choice equilibrium is given by the value of $M$ that solves:

$$G'(N - M) = \rho \pi(q_2, r^h) + (1 - \rho) \left[ p(e) \pi(q_1, R/q_1) + (1 - p(e)) \pi(q_1, r^h) \right] \quad (16)$$

It is straightforward to show that, as expected, $M$ is increasing in $\rho$, $q_1$ and $q_2$, and decreasing in $r^h$ and $e$.

In this two-sector economy, an efficient allocation maximizes expected GNP, where the size of expected GNP is depends on whether the investment $I$ is undertaken. Given $q^e_2$, expected GNP gross of $I$ is defined as:

$$Y = G(N - M) + M \cdot \Pi(r^h, r^\ell, e, q^e_2)$$

The values of $r^h$, $e$ and $r^\ell$ are independent of $M$. As before, $r^h$ and $e$ are too high relative to the efficient ones, while the rate of $r^\ell$ is optimal. Using the definitions of entrepreneurial

Aghion and Howitt (1992). Entrepreneurs, seeking opportunities for monopolistic profit, are willing to engage in the risky projects that displace old technologies with new ones. More generally, entrepreneurs are key players in endogenous growth models which involve the generation of new knowledge through R&D and human capital investment, as emphasized by Romer (1990).
and bank profits, the condition determining the efficient size of $M$ is:

$$G'(N - M) = \rho \pi(q^e_2, r^h) + (1 - \rho) [p(e) \pi(q_1, R/q_1) + (1 - p(e)) \pi(q_1, r^h)] + \pi^B(r^h, r^t, q^e_2)$$

This yields $M(q^e_2)$ in the social optimum. It can be shown by differentiating (17) and applying the envelope theorem that the efficient value of $M$ is increasing in $q^e_2$, so that $M(\overline{q}_2) > M(q_2) > M(q^e_2)$. Comparing the conditions determining $M$ in the market and efficient allocations, (16) and (17), they differ by the term involving expected bank profits per entrepreneur, the last term in (17). Though this term tends to cause $M$ to be high, the fact that $r^h$ and $e$ are both larger than the efficient levels means that on balance $M$ could be either higher or lower than the efficient level.

Contrary to $r^h$ and $e$, a marginal change in $M$ starting from the market equilibrium values does not have a first-order effect on GNP: differentiating $Y$ with respect to $M$, and substituting the condition for occupational choice equilibrium (16) and the zero-profit condition of the banks yields: $\partial Y / \partial M = 0$. This implies that any infinitesimal intervention such as a loan guarantee will not improve the efficiency associated with the occupational choice despite the fact that allocation including $M$ is inefficient. This does not mean, however, any government policy is not called for to correct $M$. We can show that in the presence of a loan subsidy ($s > 0$), the policy should be such as to discourage skilled workers from becoming entrepreneurs. To see this, note that the expression for GNP, including the value of expected profits in the risky sector $\Pi(\cdot)$ is still given by (7), the same as in the absence of the loan subsidy: the loan subsidy represents a transfer of funds from GNP to the risky sector using a lump-sum transfer. Again take the probability of success of type 2 entrepreneurs to be $\overline{q}_2$ for concreteness, and we take advantage of the fact that $r^t$, $r^h$ and $e$ are all independent of $M$. Differentiating GNP with respect to $M$ and substituting (16), (6s), and (4s) yields:

$$\frac{\partial Y}{\partial M} = -\left(\rho(1 - \overline{q}_2) + (1 - \rho)(1 - p(e))(1 - q_1)\right) sk(r^h) - (1 - \rho)p(e)(1 - q_1) sk(r^t)$$

This expression is negative for $s > 0$, implying that if a loan subsidy is in place, efficiency could be improved by reducing the number of entrepreneurs. One way to reduce the number of entrepreneurs is to introduce a tax on successful entrepreneurs. Let $t$ be the tax per entrepreneur. Then, the occupational choice condition becomes:

$$\rho \pi(\overline{q}_2, r^h) + (1 - \rho) [p(e) \pi(q_1, r^t) + (1 - p(e)) \pi(q_1, r^h)] - (\rho \overline{q}_2 + (1 - \rho)q_1) t = G'(N - M)$$

Comparative static analysis shows that $\partial M / \partial t < 0$. Since equation (18) applies at $t = 0$, we can see that efficiency will be enhanced by increasing $t$ above zero, given that $s > 0$.

7. CONCLUDING REMARKS

The acquisition of information about the profitability of investment projects is a key function of financial intermediaries, like banks. Moreover, it is a critical function for facilitating economic growth. Only if investment prospects are evaluated as efficiently as possible will
investment funding be allocated optimally. Government interference in credit markets is commonplace in growing economies. The issue is whether there can be any justification for that. In this paper, we have explored the sources of market failure in the acquisition of information in credit markets. We have constructed a simple model of investment financing that allows for imperfect information about both project-specific risk that is diversifiable with an industry and aggregate risk that applies to an entire industry. We have shown how Bertrand competition among a small number of large banks can lead to a failure of banks to evaluate individual projects and entire industries efficiently. And, we have investigated how government policies can be efficiency-improving, even when governments have no natural information advantage over banks.

The model we have used is very simple indeed. Many of the assumptions were made to simplify the analysis, including the restriction of industry-wide risk to type 2 projects, the ability to learn the true industry-wide risk parameter, the restriction to two project types, and so on. Others were made to avoid issues not of primary concern. Examples of this include the absence of entrepreneurial effort and the moral hazard problem that entails, and the structuring of the model to eliminate the possibility of credit rationing as a way of inducing truthful revelation of project type. We have only focused on two extreme cases of bank interaction, Bertrand competition and collusion or monopoly. We have also only treated extreme information structures, those with only one type of error (type II or type I) and those in which the results of evaluation are either observable or not observable. It seems apparent that extending the model to account for any of these complications would not affect the sorts of market failure we have identified.

There are other extensions that might be considered as well. There could be more than one risky sector with entrepreneurs free to choose which one to participate in. There could be uncertainly about the proportion of type 1 and type 2 projects (reflected in $\rho$). In an Appendix, we have sketched a dynamic version of the model to show how the basic results and policy implications carry through to that setting; indeed, the loan guarantee policy gets additional impetus. This too relies on a simplified model. But the simplicity of our approach should not detract from the possibility that inefficiency in the gathering of information arising from non-appropriability of returns is a rationale for intervention in credit markets in the real world.
APPENDIX: EXTENSION TO A DYNAMIC SETTING

Capital markets are by their nature institutions for intertemporal trades, yet our model is a static one. In this Appendix, we sketch a simple dynamic version of above base-case model, which is both tractable and yet captures some features of interest. The model is an endogenous growth model designed to yield a steady-state outcome despite having stochastic elements in it. Relative to the static model, it includes some additional features. There is a time lag in the production of final output: intermediate goods produced today by entrepreneurs in two risky sectors are used to produce output next period in a risk-free sector. Beside a given number of entrepreneurs, there is a class of workers who are employed in either the final goods sector or the banks. Otherwise the same basic timing of decisions as in the static model applies in each period.

As mentioned, there are two sectors, labeled X and Y. These two sectors are identical in all ways except for the probability of success of the type 2 projects, \( q^X_2 \) and \( q^Y_2 \). But, these probabilities differ; they are perfectly negatively correlated: if \( q^X_2 = \bar{q}_2, q^Y_2 = \underline{q}_2 \), and vice versa. The probabilities can switch from period to period. If investigation of industry risk is undertaken, the actual values of \( q_2 \) in each industry can be ascertained for that time period. Since the structure of decision-making is the same here as in the static model, neither of the two banks will invest in determining the true values of \( q_2 \). We assume that the government finds it worthwhile to invest, and announces each period the true values of \( q^X_2 \) and \( q^Y_2 \).

These two risky sectors each produce the same intermediate good, say, capital, while a final good is produced in another sector from capital and labor. Entrepreneurs produce the X and Y using capital financed by bank loans and according to a common Cobb-Douglas production function of the form, \( f(k) = A(1-\alpha)k^\alpha \). The parameter \( A \) will represent a knowledge externality to be discussed further below. Since we are dealing with symmetric equilibria, \( M^X = M^Y = M \). Each period, entrepreneurs come to the bank for a fresh loan; there is no long-term relationship between entrepreneurs and banks (since there is no longevity of entrepreneurial characteristics). As in the static model, \( r^f = R/q_1 \), where \( R \) is the rate of interest payable on funds the banks borrow from abroad, but now this applies in both industries. For tagged entrepreneurs, \( r^Xh \) is the interest rate offered in industry X. It will be either be \( r^h \) or \( r^h \) depending on whether \( q^X_2 \) is \( \bar{q}_2 \) or \( \underline{q}_2 \). The same applies for industry Y. These state-dependent interest rates will not change over time in the steady-state analysis used here.

Let the price of the intermediate good in period t be \( z_t \). An entrepreneur purchasing

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18 There is growing interest in relationship between financial development and economic growth. Bencivenga and Smith (1991) claim that financial intermediation can pool the risk of liquidity shock among investors, which induces long-term investments and, therefore, contributes to higher rate of economic growth. King and Levine (1993) provide evidence that economic growth rates are positively correlated with the development of financial institutions. The present model differ from these works in that we focus on the way that credit market failure influences the economic growth path rather than contribution of financial intermediation to it.
capital one period produces output in the next. The problem of an entrepreneur at time \( t \) with a probability of success \( q \) and facing an interest rate \( r_t \) is:

\[
\max_{\{k\}} \quad q \left( z_{t+1} A_{t+1}^{(1-\alpha)}k^\alpha - r_t k \right) \tag{D}
\]

Problem (D) applies to both industries as well as to both types of projects within an industry. In the steady state, \( z \) will be independent of \( t \). The first-order conditions for the various alternatives can then be solved for demand for capital functions of the form:

\[
k_t(r, A_t) = A_t \left( \frac{\alpha z}{r} \right)^{1/(1-\alpha)}
\] (a.1)

These functions, which apply for \( r_X, r_Y \) and \( r^e \), are decreasing in \( r \) and increasing in \( A_t \). The solution to problem (D) yields the expected profit function \( \pi(r, A, q) \), where \( q \) can take on values of \( q_1, q_2 \) or \( q_3 \).

Total output of the intermediate good produced in period \( t + 1 \) is given by:

\[
K_{t+1} = \sum_{j=X,Y} (\alpha z)^{\alpha/(1-\alpha)} MA_t \left[ \left( \rho q_j^h + (1 - \rho)(1 - p(e_j)) \right) (r^j)\alpha/(1-\alpha) \right. \\
\left. + (1 - \rho)q_k p(e_j) \left( r^e \right)^{-\alpha/(1-\alpha)} \right]
\] (a.2)

Following the endogenous growth literature, we assume that knowledge reflects production experience, or learning by doing, and accumulates with the stock of capital. Specifically, let \( A_{t+1} = K_{t+1} \).

Final output is produced using labor and capital, and taking advantage of the same knowledge parameter \( A_t \). The production function is given by:

\[
G(A_t, K_t, L_t) = A_t^{1-\beta} K_t^{\beta} L_t^{1-\beta}
\]

where \( A_t = K_t \). Final output is the numeraire and has a unit price. Since this sector is competitive, inputs \( L_t \) and \( K_t \) are paid their marginal products, which may be written (using \( A_t = K_t \) and the fact that \( L_t \) is constant over time):

\[
w_t = (1 - \beta) L_t^{-\beta} A_t; \quad z = \beta L_t^{1-\beta}
\] (a.3)

Let \( N \) be the total (non-entrepreneurial) labor supply, constant over time. If \( e_j \) is the amount of labor demanded by the banks to evaluate each client in industry \( j \), labor market equilibrium requires:

\[
L = N - (e^X + e^Y) M
\] (a.4)

Note that while \( e^X \) and \( e^Y \) can vary from period to period, their sum will remain unchanged given that the industry risks are perfectly negatively correlated and production conditions are otherwise identical.
The banks operate much like in the static model. They lend funds to entrepreneurs in one period at interest rates which depend upon the signal obtained from an entrepreneur and the value of $q_2$ learned from the government’s investigation of industry risk. Principal and interest are repaid in the next period by successful entrepreneurs, so the present value of expected bank profits at the beginning of period $t$ in industry $j$ can be written:

$$\pi_t^{Bj} = R^{-1}\left(\left(\rho q_2^j + (1 - \rho)(1 - p(e^j))q_1\right)r^{jh} - \left(\rho + (1 - \rho)(1 - p(e^j))\right)R\right)k(r^{jh}, A_t)$$

$$-w_t e^j \quad j = X, Y$$

(a.5)

As earlier, $r^{jh}$ and $e^j$ will be determined by the banks’ zero profit condition and by the first-order condition on $e^j$ which are, respectively:

$$\left(\left(\rho q_2^j + (1 - \rho)(1 - p(e^j))q_1\right)r^{jh} - \left(\rho + (1 - \rho)(1 - p(e^j))\right)R\right)k(r^{jh}, A_t) = Rw_t e^j \quad (6d)$$

$$p(e^j)(1 - \rho)(R - q_1 r^{hj})k(r^{hj}, A_t) - w_t = 0, \quad (5d)$$

where $k(r^{hj}, A_t)$ is given by (a.1) and $w_t$ and $z$ are given by (a.3).

Note that $w_t$ and $A_t$ will grow at the same rate in the steady state, so equations (6d) and (5d) are both invariant with respect to time $t$. This implies that $r^{hj}$ and $e^j$ depend only on the state of the world, not on time. Equations (6d), (5d) and (a.4) then jointly determine $r^{hj}$ and $e^j$ for $(j = X, Y)$, along with $L$. Thus, $r^{hj}$ will take on $\bar{r}^h$ in one industry and $\bar{r}^h$ in the other, and $e^j$ will take on two corresponding values as determined by (5d). Equation (a.2) then determines $K_t = A_t$.

It can be shown that there will exist a steady-state growth path along which $A_t$, $k_t(\cdot)$, $K_t$, output of the final good and $w_t$ all grow at the same rate. One plus the rate of growth, denoted $\gamma$, is given by $\gamma = A_{t+1}/A_t$, or using (a.2):\(^{19}\)

$$\gamma = \sum_{j=X,Y} (\alpha z)^{\alpha/(1-\alpha)} M \left[ \left(\rho q_2^j + (1 - \rho)(1 - p(e^j))\right)(r^{jh})^{-\alpha/(1-\alpha)} \right.$$

$$+ (1 - \rho)q_1 p(e^j) (r^e)^{-\alpha/(1-\alpha)} \big]$$

It depends on the values of the variables determined endogenously in the market economy. In particular, $\gamma$ can be seen to be decreasing in $r^{jh}$, $r^e$ and $e^j$.

This dynamic model is essentially an overlapping sequence of static models. As such, the same argument for government investigation of industry risk and for loan guarantees to affect $e$ and $r^h$ apply here, but now on a period-by-period basis. The size of the loan guarantee differs between industries depending on the state of industry risk. Since we have suppressed occupational choice, there is no role for a tax on entrepreneurs in this version. However, there is now a new source of market failure arising because of the knowledge

\(^{19}\) The transversality condition requires that $\gamma < R$. 31
externality. The demand for capital generates improvements in productivity that accrue economy-wide and will not be accounted for by private investment decisions. A government that is interested in maximizing the discounted value of GNP will want to increase the growth rate above the steady-state market equilibrium value. This is facilitated by the fact that the rate of growth is decreasing in \( r^h \), \( r^e \) and \( e^j \). These are the very variables that a loan guarantee discourages, so such a policy would seem to have an additional rationale in this context. One might have thought that an investment subsidy would also be appropriate, given that the externality arises from an understated incentive to invest. But, as we have mentioned earlier, in this model of imperfect information, though an investment subsidy investment subsidy does cause interest rates to fall and stimulates investment, it also encourages banks to increase evaluation intensity \( e^j \). Since growth rates decrease with \( e^j \), a loan guarantee would again seem to be the preferred policy instrument.
Reference


