The Effects of Bank Market Structure and Organizational Form on Entrepreneurial Incentives

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Abstract

We study a model where economic agents must exert costly effort to develop entrepreneurial projects, and agents benefit from the entrepreneurial efforts of other agents. Agents rationally anticipate each other's actions but cannot coordinate them. The equilibrium of the resultant "global game" is characterized by a "tipping point." Only when an economic state variable is above this point does a functioning economy arise. We then show that a noncompetitive or inefficient banking system raises the tipping point, potentially severely retarding economic development. A further implication is that small economic shocks and subtle changes in the structure of the financial system may have a large systemic impact on the economy, even in the absence of direct contagion among financial intermediaries. Our results include a prescription for an organizational form of the financial intermediary that ameliorates the effects associated with bank market power, namely that of the cooperative financial institution ("CFI"), which is owned by its borrowers and savers instead of a third party. In an extension of our basic model, we also study "redlining" and show that it can arise as an equilibrium phenomenon.

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1 Introduction

The link between financial markets and economic activity has been the subject of research and debate at least from Schumpeter (1912). A large body of empirical and theoretical research suggests that financial sector development is an important catalyst of economic development.[1] Although the role of financial markets in economic growth has been extensively studied, the relative efficacy of different structures of financial markets has received less attention. A major question that remains is how the financial markets should be structured to foster entrepreneurship and growth. In recent years, with crises like the bursting of the "dotcom bubble" in 2002 and the subprime crisis starting in 2007, attention has also turned to the issue of economic and financial stability. Academics and practitioners alike have asked how the health of the financial system and whole sectors of the economy can change rapidly without an obvious significant external catalyst.

In this paper, we examine these issues by studying a general equilibrium of a model with the following characteristics. In a departure from the common assumption in the corporate finance theory literature that entrepreneurs are simply endowed with investment projects, in our model, entrepreneurs acquire projects by expending costly effort. The motivation for this assumption is the observation that it requires a great deal of effort simply to investigate the viability of, and lay the groundwork for, an entrepreneurial project, as anyone who has started a business knows. A similar logic applies to the development of entrepreneurial and other skills relevant to economic activity. In the words, of Fogel, Hawk, Morck, and Yeung (2006, pg. 540), "[S]kills are not endowments. Individuals decide to develop those skills that advance their well being and to forgo developing those that do not." A would-be entrepreneur will accordingly only expend the effort if the economic benefits are sufficiently large in relation to the costs.

The second characteristic of our model is that there are positive externalities from economic activity. For example, there is little reason to invent a conveyance if no one has goods that need transport or the wealth to seek personal transport for recreational purposes. Thus, when pessimistic agents decide not to exert costly effort for economic gain, slightly less pessimistic agents rationally anticipate the behavior of their more pessimistic compatriots and also choose to demur, and so forth. In this way, agents anticipate each other's actions but cannot coordinate their actions. The

[1] See Levine (2005) for a comprehensive survey of this literature and a detailed argument about its interpretation.

relative pessimism and optimism of agents is in turn distributed "nosily" about the true value of an underlying economic state variable. The result is that the development of a "healthy" economy in our model is a "tipping point" phenomenon. Given a set of values for the model's parameters, there is a *unique* threshold level of the underlying economic state variable above which enough agents receive positive signals for the economy to flourish and below which the economy crashes or simply does not come into being in the first place. There is also a range of values of the economic state variable where economic vitality could be achieved and every agent would be better off if all agents exerted costly effort to develop entrepreneurial projects and human capital; yet, absent a coordination mechanism, it is individually rational for each individual agent not to exert costly effort in this endeavor.

We examine a general equilibrium of the model in order to study the effects of bank market structure and organizational form on these phenomena. If the banking market is not competitive, much of the profits from entrepreneurial activity may be captured by financial intermediaries, leaving less for the entrepreneur. This dissuades pessimistic agents from exerting costly effort in skill acquisition and the development of entrepreneurial projects with all the concomitant ripple effects, raising the tipping point and potentially "wrecking" the economy.[2] In similar fashion, an external shock that curtails intermediation activity - or even the possibility of such a shock, if anticipated by economic agents - can have similar effects. As such, systemic crises can be self-fulfilling even without "sun spots" or financial institutions having a direct impact on each other's liquidity through, for example, trading or lending with each other.[3] Rather, the contagion operates entirely through the rational expectations of individual economic agents.

Another important result of our analysis is that the problems associated with bank market power may be substantially mitigated if the financial intermediary adopts the form of a cooperative financial institution ("CFI"), which is owned by its borrowers and savers instead of a third party. Organizational forms with communal ownership, which we call the CFI, have been relatively more prevalent in the financial sector than in the real economy. CFIs have long played a large role in the

[2] This is consistent with the result in Cetorelli and Strahan (2006) that greater bank competition is associated with there being more firms in operation. However, in our model, banks do not refuse to lend to entrants to protect existing borrowers. Rather, rent extraction by banks dissuades entrepreneurs from exerting costly effort.

[3] This is a consequence of our modeling the coordination game as a global game à la Carlsson and van Damme (1993). We have chosen this structure to capture the underlying economics where agents are coordinating without perfect information.

US economy, currently counting over 40% of the population as members, and are a growing presence in the developing world. According to the World Council of Credit Unions (2005), CFIs accounted for $894 billion of assets worldwide and had over 157 million members. Examples include mutual savings and loans, community savings banks, and credit cooperatives. A principal feature of these institutions is that the owners are the borrowers and savers who use the institution for financial intermediation (Cuevas and Fischer, 2006). Our model shows the CFI form can substantially mitigate the problem caused by bank market power, even where the intermediary continues to price loans and deposits to maximize profits. In essence, the "excessive" profits that a monopoly CFI earns from noncompetitive loan pricing are redistributed to borrowers and savers through their ownership of the intermediary; thus, the money "travels in a circle" back into the hands of economic agents, who accordingly have a greater incentive to exert costly effort toward economic activity. Monopoly deadweight loss remains, but its baleful effects are not as severe as when the intermediary is owned by a third party. It follows that in areas where the level of economic activity is too low for multiple banks to operate profitably, social welfare will be higher if intermediaries are CFIs. Indeed, the formation of a CFI may be both necessary and sufficient for a non-subsistence economy to develop at all.

An additional implication of our analysis is that two regions with similar natural endowments and cultures may enjoy very different economic outcomes if the underlying drivers of economic growth are only slightly different. For example, it is well known that Northern Italy has a substantially higher per capita income than Southern Italy despite having a common government and formal institutional environment for over a century. Various reasons why have been proffered, with differences in social capital being perhaps the leading explanation (Guiso, Sapienza, and Zingales, 2004). What our paper shows, by contrast, is that if social capital is indeed the primary influence, it would take only small differences therein to produce vastly different levels of economic activity in the two regions. Moreover, to the extent that social capital instead arises endogenously as a consequence of the decision by economic agents to develop human capital and engage in trade, even small differences in the other attributes of the two regions may account for the divergent economic outcomes.

In our basic model, we assume for simplicity that banks can separate entrepreneurs who have exerted costly effort and may have a positive NPV project from entrepreneurs who have not exerted effort and therefore do not have a positive NPV project. We relax this assumption as an extension to study "redlining," the phenomenon whereby lenders refuse to lend to certain neighborhoods, particularly urban areas with a high percentage of low-income or minority inhabitants.[4] It is often argued by community advocates that these communities are viable but fall into decay, in part because banks refuse to lend there despite the presence of viable borrowers. Bank executives respond that they cannot lend profitably in those areas. [See Aalbers (2006, pg. 1074) for a treatment of these issues.] Our results suggest both parties may be right. In marginal economic states, a healthy loan market and economy would arise in the absence of a coordination problem. But pessimistic agents demur at exerting entrepreneurial effort. These agents then pollute the future pool of borrowers, by lowering the percentage of loan applicants who have viable projects and thereby making it impossible for banks to operate profitably. Although many agents anticipate that the loan market will not exist, if the information environment is sufficiently coarse, some agents will receive particularly favorable signals and develop what would be viable projects if only banks would provide capital.

As a full survey of related literature would be too vast, we limit ourselves to a sample of the most relevant related work. Some authors have explored how increasing bank competition may have other effects beyond reducing "monopoly deadweight loss," as in standard industrial organization economics. For example, competition among banks may lead to a "winner's curse" in bidding for loans (Broecker, 1990; Riordan, 1993) or drive up deposit interest rates, prompting banks to make riskier loans to generate higher returns. [See Allen and Gale (2000a) and Hellmann, Murdock, and Stiglitz (2000) but also Boyd and De Nicoló (2005) for a counterargument.] Competition may also increase information dispersion among lenders, exacerbating the adverse selection problem faced by each bank and thereby causing interest rates to rise (Marquez, 2002; Dell'Ariccia and Marquez, 2006).

Our argument is closer to the one advanced in Fogel et al. (2006). These authors argue informally that economies where the institutional environment does not protect successful entrepreneurs

[4] Although large-scale empirical studies have often failed to find evidence of redlining, micro-level studies of particular cities have found direct evidence of the practice. See, for example, the discussion of the "coloured map of Rotterdam," in Aalbers (2005), which was quite literally used to make decisions on mortgage loans. In Aalbers (2005, pg. 573)'s words, "Exclusion took place solely on the basis of neighborhood....Low-income people had a chance of getting a mortgage in another neighborhood, but middle and high-income people - just like low-income people - were barred from obtaining mortgages in excluded zip codes."

from rent extraction through the theft of intellectual property or the obligation to pay bribes will see little entrepreneurship and consequently experience greatly diminished economic activity. In our model, the rent extraction arises through bank market power, and the carryover effects can be so severe that what would have been a healthy economy if the bank market had been more competitive instead utterly fails to materialize.

Other authors have examined the role the financial intermediation sector may play in aggravating the business cycle or even being, in a sense, the cause of a shock through financial contagion. For instance, Bernanke and Gertler (1989, 1990) present models where an initial shock to collateral values increases borrower agency costs, leading to a curtailment of lending and thereby exacerbating economic cyclicality. Other authors have presented models where contagion arises through cross-investment among banks (Allen and Gale, 2000b) or because a bank failure reduces overall liquidity (Diamond and Rajan, 2005). In our model, contagion occurs because agents cannot coordinate but still anticipate each other's actions.

The existing literature on CFIs has emphasized mutual insurers more than mutual banks, the focus here. Representative work includes Fama and Jensen (1983), who argue that the ability of mutual members to liquidate their claim on the firm disciplines the firm's managers and Smith and Stutzer (1990), who show that mutuals can arise endogenously to cope with adverse selection. Hart and Moore (1998) present a model where the level of competition and the degree of preference alignment among agents determine whether cooperative or outside ownership is preferable. In contrast, what makes CFIs special in our paper is their positive influence on the incentive economic agents have to exert costly effort toward entrepreneurial and other economic activity.

Our model embeds a coordinated investment game inside a general equilibrium framework. The investment game is a "global game," and may be regarded as a generalization of the investment game in Carlsson and van Damme (1993), the seminal paper on global games. An advantage of this approach is that it allows us to identify a unique focal equilibrium based on the iterated elimination of dominated strategies, thereby avoiding the multiplicity of equilibria that often arise in models where the agents choose an action based on their expectations about other agents' behavior (e.g., Diamond and Dybvig, 1983; Shleifer, 1986). Morris and Shin (1998), in a famous application, use a global game to model the coordinated response of participants in the foreign currency markets to a signal of a future economic state variable. In the field of finance, Goldstein and Pauzner (2005) use the global game framework to model bank runs in a way that eliminates "sun spot" equilibria.

The next section of the paper presents a general equilibrium model of coordinated investment with financial intermediation. The subsequent section of the paper discusses empirical implications, and the final section concludes. Proofs of formal propositions are in the Appendix.

2 The Model

2.1 Basic Setup

The economy is composed of risk-neutral agents of measure 1. These agents are identical and have access to the following technology. The outcome from the technology depends on whether the agent exerts effort $e > 0$ in period $t = 0$.[5] If the agent does not exert effort, the technology yields nothing. If the agent does exert e, then in period $t = 1$, the agent obtains the following. With probability p, the agent obtains a lump sum of a numeraire good (the "fruit" of the agent's labor), which may be consumed at $t = 1$ or stored risklessly and losslessly until $t = 2$. In this case, the agent is a "saver." With probability $1 - p$, the agent obtains a project requiring investment at $t = 1$ and generating a return at $t = 2$. In this case, the agent is a "borrower." The return from the project is stochastic. With probability γ, the project yields $1 + r$ per unit of the numeraire good invested (that is, the project is "viable") and 0 otherwise (that is, the project is not "viable"). r is distributed uniformly on $[0, \overline{r}]$ across borrowers.

The quantity of the numeraire good received by each saver at $t = 1$ is denoted by $\theta + \Delta$. $\theta + \Delta$ also denotes the scale of each borrower's risky project, that is an investment of $\theta + \Delta$ at $t = 1$ results in a return of $(\theta + \Delta)(1 + r)$ at $t = 2$ with probability γ and zero otherwise. θ is a state variable for economic conditions at $t = 1$ with higher θ being "better," and $\Delta \in [0, 1]$ is the endogenously determined proportion of agents who have exerted effort at $t = 0$. The effect of Δ captures the positive externality that entrepreneurs have on each other. This reflects the notion that commerce requires trade and the recombination of inputs. The greater the proportion of agents who have generated these inputs, the greater the potential opportunities for business. We make the simplifying assumption that $\gamma \leq \frac{p}{1-p}$ to avoid the case where savers do not generate enough of the

[5] The technology may be entrepreneurial, or, more broadly, represent the agent's career, in which case e would represent, say, making the effort to do well in school.

numeraire good to fund all viable projects. The following chart summarizes the possible outcomes for each agent:

Agent Outcome Chart

Do Not Exert $e \Longrightarrow$ Receive 0

$$
\text{Exert } e \Longrightarrow
\begin{cases}
p \quad \Rightarrow \quad \textit{Saver} \\
\qquad\qquad\ \ \text{Obtain lump sum } \theta + \Delta \\
\\
\qquad\qquad\ \ \textit{Borrower} \\
1-p \quad \Rightarrow \quad \text{Obtain project of scale } \theta + \Delta
\left\langle
\begin{array}{lll}
\gamma & \Rightarrow & \text{Project is viable} \\
1-\gamma & \Rightarrow & \text{Project is not viable}
\end{array}
\right.
\end{cases}
$$

There is a number $N \in \overline{\mathbb{Z}}_{+}$ of profit-maximizing entities that collect funds from savers and use said funds to make loans to borrowers. Call these entities banks.[6] At $t = 1$, each bank decides on the quantity of funds that it will lend. Based on the total quantity of funds banks decide to lend, a market interest rate is determined. Borrowers whose reservation r is above this rate approach banks for funds conditional on being favorably screened. Finally, banks raise the funds they need from savers at the competitive rate of 0 interest. This competitive framework provides a convenient and analytically tractable way of varying the level of bank market power by raising and lowering the number of competing banks. Other competitive frameworks could be used instead - e.g., spatial or Bertrand competition - without fundamentally changing the paper's results. We assume for the present that banks may costlessly distinguish between "genuine" borrowers who have exerted e and may have a viable project and "false" borrowers who have not and therefore do not. (We will revisit this assumption later.) However, among the genuine borrowers, a bank must incur a screening cost c per unit of loan principal to determine whether a project is viable. In other words, the screening technology exhibits constant returns to scale.

We make two simplifying assumptions to ensure that there is a role for bank screening in the economy. First, if γ were sufficiently close to 1, banks could lend profitably without screening,

[6] Since N agents would be of measure 0, one can think of each of these intermediaries as being owned and managed by a third class of risk-neutral agents drawn from the measure 1 of agents comprising the economy.

whereas if γ were sufficiently close to 0, banks could never earn a profit. Let us assume, then, that γ is strictly larger than the $\underline{\gamma}$ that solves $\overline{r} - \frac{c}{\gamma} = 0$ and strictly smaller than the $\overline{\gamma}$ that solves $\gamma\overline{r} - 1 = 0$. Second, we assume that borrowers learn their private r at $t = 1$, but do not know whether their projects are viable. Thus, perfect price discrimination is impossible, and there is no separating mechanism available to prevent genuine borrowers without viable projects from submitting their projects for screening. One could equally well assume that borrowers receive a private benefit from borrowing regardless of the viability of their project. This would complicate, but not materially change, the exposition below.

At $t = 0$, agents do not know what θ will be, but only that it is distributed uniformly on an interval $[a, b]$. Each agent receives a private signal s that is uniformly distributed about the true future θ. In other words, $s \in [\theta - \varepsilon, \theta + \varepsilon]$. Define $\overline{\theta}$ as the θ that solves $p\theta - e = 0$ and $\underline{\theta}$ as the θ that solves

$$\begin{aligned} p(\theta+1) + (1-p)(\theta+1)\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)} - e &= 0 \\ (\theta+1)\left(p + (1-p)\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\right) - e &= 0 \end{aligned}$$

We assume that $b > \overline{\theta} + 2\varepsilon$ on the top and that $a < \underline{\theta} - 2\varepsilon$ on the bottom. In other words, there are threshold values of θ so high (low) that agents elect to exert (not to exert) effort regardless of what other agents do and the unconditional distribution of θ extends at least a little bit beyond these two threshold values.[7] For intermediate values of θ, agents play a coordination game.

2.2 Loan Market

Take θ and Δ as given. The following Lemma characterizes the dynamics of the loan market, if one arises.

Lemma 1 *The following properties characterize the loan market:*

[7] The assumptions in this paragraph can be made more general without fundamentally changing the paper's results.

(i) Each bank earns profits of

$$\pi = (1-p)(\theta+\Delta)\left(\frac{1}{N+1} - \frac{N}{(N+1)^2}\right)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}$$

(ii) Savers earn 0 *on their deposits, and borrowers receive aggregate surplus of*[8]

$$CS_L = (1-p)(\theta+\Delta)\left(\frac{N}{N+1}\right)^2\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}$$

(iii) Total surplus generated by the loan market is equal to

$$W_L = (1-p)(\theta+\Delta)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\frac{N^2+2N}{N^2+2N+1}$$

The loan market is competition à la Cournot. Because there is always a surplus of deposits vis-à-vis demand in the loan market and savers have an outside option, savers supply banks with funds at cost. Banks decide on the quantity of loans to make taking the quantity decisions of other banks into account. The resulting equilibrium has the familiar property that borrower surplus increases asymptotically in N. For all finite N, some borrowers do not receive funding because the market interest rate is higher than the maximum rate those borrowers are willing to pay.

2.3 Coordination Game

The first-best outcome, in the absence of coordination problems, would be for all agents to exert effort if and only if $\theta \geq \underline{\theta}$. If agents could perfectly foresee θ, the first-best outcome would be one of a continuum of equilibria with no obvious way to choose among them. However, perfect foresight is not realistic, and introducing some noise into agents' ability to foresee the future, no matter how small, shrinks the number of equilibria to one and permits a more refined analysis.

It turns out that this equilibrium is one where, even in the absence of bank market power,

[8] Because our agents are of measure 1, the formula also describes the expected per agent surplus, conditional on θ and Δ, if a loan market develops.

i.e., even if $N = \infty$, coordination problems among agents mean that there is underinvestment in costly effort e. More precisely, for all economic states of the world, there is a threshold value of the underlying economic state variable $\theta^* > \underline{\theta}$ such that $\forall \theta \leq \theta^*$, if ε is "small," no agent exerts effort and no loan market develops in the sense that no loans are made. θ^* has the properties of a "tipping point" on which a seesaw is balanced. If the underlying economic state variable is above this point, a health economy and financial system develop; otherwise, they do not.

Proposition 2 *The iterated elimination of strictly dominated strategies results in a unique threshold $s^* > \underline{\theta}$ such that for all signals below s^*, no agent undertakes costly effort, and for all signals above s^*, all agents undertake costly effort. For $\varepsilon < s^* - \underline{\theta}$, $\exists \theta^* > \underline{\theta}$ such that $\forall \theta \leq \theta^*$, no loan market develops.*

A formal proof of this Proposition may be found in the Appendix. The idea of the proof can be understood by undertaking the following thought experiment. Suppose that an agent receives a signal $s \geq \overline{\theta} + \varepsilon$. The agent will undertake costly effort e, because even if no other agent exerts effort, the focal agent's (expected) private returns make exerting e worthwhile. We can eliminate other actions of such an agent as "dominated strategies." Now, consider an agent with a slightly lower signal s'. The agent "knows" that all agents with a signal $s \geq \overline{\theta} + \varepsilon$ will exert e, and the measure of such agents must be close to 1, since s' is only slightly lower than s. Thus, our new focal agent exerts effort e as well. We have thus eliminated dominated strategies a second time. We can repeat this exercise until we converge to a unique s^* defined by

$$\left(s^* + \frac{1}{2}\right)\left(p + (1-p)\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\right) - e = 0$$

s^* is clearly larger than $\underline{\theta}$. We can also repeat the exercise in reverse by starting with a signal so low ($s \leq \underline{\theta} - \varepsilon$) that the focal agent does not exert effort regardless of what other agents do. In either case, we arrive at the same s^*. As long as the information environment is not sufficiently "coarse," i.e., as long as $\varepsilon < s^* - \underline{\theta}$, there will be economic states of the world above the first-best threshold $\underline{\theta}$, where no agent exerts effort, because even the most "optimistic" agents receive a signal below s^*. θ^*, the threshold value of the economic state variable below which no loan market develops, converges to s^* from below as ε goes to 0. In the remainder of the paper, except as otherwise noted, we will assume that ε is "small" so $\theta^* \approx s^*$.

Another way of understanding this equilibrium is to consider the thought process of an agent who receives an arbitrary signal s. The agent does not know θ but does know that $\theta \in [s - \varepsilon, s + \varepsilon]$. The agent has two choices, exert e or not. The utility from not exerting effort is 0. The utility from exerting e is the expected earnings as a saver or borrower calculated by integrating out θ over $[s - \varepsilon, s + \varepsilon]$. The lowest s where this calculation yields a non-negative outcome, given that other agents are engaged in a similar reasoning process, is s^*.

Thus, agents can rationally anticipate each other's actions, conditional on their signals, but have no way of coordinating their actions. Their beliefs about future economic conditions differ, and more pessimistic agents induce pessimism among other agents by reducing the expected benefit from exerting costly effort toward economic activity such that expectations about future economic conditions have to leave a "margin for error" before an economy properly speaking can arise. The remainder of this paper is primarily concerned with how aspects of the financial intermediation sector shrink or expand this difference.

2.4 Bank Market Structure

We begin our study of the effects of bank market structure and organizational form by considering bank market power. First, we must establish the reference point of comparison. In standard industrial organization economics, the cost of monopoly power is measured as deadweight loss, or the loss of producer and consumer surplus that arises because a monopoly (or set of oligopoly) firms do not price at marginal cost. This cost - call it "conventional deadweight loss" - takes the number of market participants as given. Conventional deadweight loss is also present in our setting, but our focus is elsewhere. Namely, we will demonstrate that by reducing agents' incentive to exert costly effort towards entrepreneurial and other economic activity, the cost of bank monopoly power is actually higher than the traditional social welfare analysis implies.

Define $\underline{\theta}^N$ as the threshold level of the economic state variable, *conditional on* N, such that it is socially optimal for all agents (not) to exert effort whenever $\theta > \underline{\theta}^N$ $\left(\theta < \underline{\theta}^N\right)$. In other words, $\underline{\theta}^N$ is the lowest θ where a benign social planner with the power to coordinate agent effort but no power to affect the level of bank competition would direct agents to exert e. $\underline{\theta}^N$ is defined mathematically as the solution to:

$$\left(\underline{\theta}^N+1\right)\left(p+(1-p)\left(\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\left(\frac{N}{N+1}\right)^2\frac{1}{2}+\left(\frac{N}{N+1}-\left(\frac{N}{N+1}\right)^2\right)\right)\right)\right)-e=0$$

Let s^{*N} be the threshold signal given that the market has N banks. We have the following Proposition:

Proposition 3 *The following four properties of s^{*N} obtain:*
(i) $s^{*N}>s^*$
(ii) $s^{*N}>\underline{\theta}^N$
(iii) $s^{*N}-s^*$ is decreasing in N
(iv) $s^{*N}-\underline{\theta}^N$ is decreasing in N

The foregoing Proposition essentially says that the problem of agent coordination is aggravated by bank market power. In particular, the gap between s^*, the equilibrium tipping point signal, and $\underline{\theta}^N$, the socially-optimal threshold level of the economic state variable, grows as the number of competing banks decreases. The intuition is that banks with market power extract some of the rent that would otherwise be captured by borrowers with viable projects. Agents anticipate the rent extraction, which accordingly lowers their incentive to exert costly effort to develop a project in the first place. Why work hard to develop a business plan when the bank that would finance it will capture all the profits? Agents who receive signals close to $\underline{\theta}$ accordingly elect not to exert effort. But the effects do not stop there, because of the externality in returns to effort (Δ). Therefore, agents with somewhat (more optimistic) higher signals anticipate that the first set of agents with slightly (more pessimistic) lower signals will not exert effort and decide not to exert effort either. The rent extraction by banks with market power thus has a ripple effect.

The ripple effect can be profound. Consider an economy with two banks. If θ is just a little bit larger than s^{*2}, a healthy loan market and economy will develop. If those banks merge, the conventional deadweight loss may appear modest, but conventional deadweight loss does not incorporate agents' incentive to exert economic effort and develop entrepreneurial projects in the first place. If $s^{*1}>\theta>s^{*2}$, a bank merger will, in a sense, "wreck" the economy.

The analysis also has implications for financial stability. Suppose that the number of banks shrinks not because of bank mergers but due to some shock external to the relations between banks and borrowers or between banks and savers. Examples include trading losses (as seen in the sub-prime crisis) or defaults on foreign loans (e.g., the Latin American debt crisis of the 1980s), in each case causing some financial intermediaries to cease or curtail operations. The reduction in intermediation activity can raise the "tipping point" above the future realized value of the underlying economic state variable, causing widespread dislocation even without direct contagion effects among financial intermediaries. More worrisome, if economic agents impute a positive probability to such an event prior to making the decision to exert effort toward economic activity, agents with marginal, pessimistic signals will demur at exerting effort with the same carryon ripple effects. Thus, agents' lack of confidence in the safeness and soundness of the financial system may become a self-fulfilling prophecy, even in the absence of "sun spots."

2.5 The Cooperative Institutional Form

A long-standing puzzle in financial intermediation is the persistence of the cooperative institutional form, which in this context, would mean credit unions, mutual savings and loans, or any financial institution with some kind of member ownership. Cuevas and Fischer (2006: pg. 5) identify the following four features as being key to the classification of a financial intermediary as a cooperative financial institution ("CFI"):

- The principle of one-man/one-vote;
- Unbundling votes and membership is not allowed;
- Residual claimants (owners) both supply and use funds; and
- Dividends (if any) are distributed to both savers and borrowers in proportion to their share of intermediation activity.

Suppose that instead of being profit-maximizing entities owned by third parties, the banks are owned by their savers and borrowers, as described in the four principals above. As $\gamma(1-p) \leq p$, the banks will, by the principal of one-man/one-vote, ultimately seek to maximize loan profits, but, by the principal of distributing profits in proportion to intermediation activity, these profits will be redistributed to savers and borrowers. The new ownership arrangement alters the impact of bank market power. Let s_C^{*N} denote s^{*N} where all the banks are CFIs.

Proposition 4 *$s_C^{*N} < s^{*N}$ and $s^{*N} - s_C^{*N}$ is decreasing in N.*

Banks continue to price at oligopolistic levels for any finite N, reducing the total economic pie. So, $s_C^{*N} > \underline{\theta}^N$ for all finite N. But because the profits of the banking sector flow back to agents through their common ownership of the banks, entrepreneurs capture more of the fruits of their labor. Thus, agents have more of an incentive to exert costly effort, lowering the tipping point closer to $\underline{\theta}^N$.

In other words, agents can only gain access to the profits of a CFI by becoming a saver or a borrower, i.e., by exerting costly effort to participate actively in the economy. Shares in CFIs are not generally a birthright. The CFI form thereby raises the returns to exerting effort, lowering the tipping point of the economic state variable.

This analysis may shed light on how CFIs arise. In regions with relatively more potential for economic activity, entrepreneurs start shareholder-owned banks and run them to maximize profit, as other businesses are run. Such entrepreneurs, by operating alone or in small groups, may have an advantage in organization costs over CFIs. In contrast, in communities with less potential for economic activity, a shareholder-owned bank would, through rent extraction, dampen entrepreneurial incentives too much to be viable. Accordingly, members of the local community assume the organization costs to found and operate a CFI.

2.6 Redlining

For simplicity, we have assumed either that banks can costlessly distinguish between agents who have exerted effort and those who have not or that only those who have exerted effort wish to borrow. Suppose this is not true. In particular, suppose that even agents who have not exerted effort try to borrow and that is still costs c to separate these "lazy borrowers" from those who have both exerted effort and developed a viable project. (One could also assume that the cost of separating lazy borrowers cost some positive amount less than c without qualitatively changing the results of this subsection.) The new assumption does not change the first-best case, because, in the absence of coordination problems, all borrowers do the same thing. But, the new equilibrium switching signal s^* is higher than before.

Proposition 5 *For all N and using either institutional form in the banking sector, the difference between s^* and $\underline{\theta}$ is larger where banks cannot costlessly distinguish between borrowers who have exerted costly effort and borrowers who have not.*

The foregoing Proposition says that for any number of banks and either institutional form, decreasing banks' screening efficiency increases the severity of the effort coordination problem. One reason for this effect is clear. Banks' screening technology is now less efficient and thus more expensive, and a portion of these higher costs are passed onto borrowers. This lowers the attractiveness of exerting effort for agents with marginal signals, with the consequent ripple effects. Yet, there is also something more subtle at work that magnifies the impact of the change in banks' screening efficiency. Take any candidate threshold signal $s^{*\prime}$. If the proportion of agents receiving a signal above this threshold is sufficiently low, the proportion of loan applicants to each bank is so low that banks cannot operate profitably. In such case, the loan market simply shuts down. Agents rationally anticipate this, which, as we have seen before, dissuades agents with signals slightly higher than $s^{*\prime}$ from exerting effort either.

This result has implications for the phenomenon of redlining. To see why, suppose that information is coarse, in particular that $\varepsilon > s^* - \underline{\theta}^N$. Then, if θ is between s^* and $\underline{\theta}$, agents with particularly high signals (near the top of the distribution, above s^*) will still exert effort and form an economy albeit a very small one. But under the more realistic assumption that banks cannot costlessly distinguish between agents who have exerted effort and those who have not, the latter "lazy" agents pollute the pool of borrowers such that banks cannot operate profitably. Thus, it is simultaneously true (a) that θ is high enough that a vibrant economy and loan market could develop (and this is the welfare maximizing outcome), and (b) that, given the agent coordination problem and banks' screening costs, the loan market never comes into being, so that some borrowers with viable projects are denied credit. This dualism conforms to our stylistic understanding of the redlining phenomenon.

2.7 Variation in Economic Interdependence

Different economies exhibit different levels of interdependence. The success of a large plantation in an agrarian economy may not be casually related to the success of the plantation down the road, except to the extent that the two plantations may compete. On the other extreme are various regions in Northern Italy, where many small businesses exist in an almost symbiotic state, with each firm specializing in a small part of a much larger production chain (Boari, 2001). In this type of economy, economic agents are almost wholly dependent on the efforts of their neighbors. An interesting question is how the results of the paper might be affected as the level of economic interdependence varies in this way.

To address this, consider an extension of the basic model whereby the returns to economic agents from exerting effort are $\lambda\theta + (1-\lambda)\,\Delta,\ \lambda \in [0,1]$. Where λ is closer to 1 (0), the returns to economic effort for a focal agent are less (more) contingent on the efforts of other agents and thus economic interdependence is lower (higher). (Setting λ to $\frac{1}{2}$ results, modulo a normalization, in the model we used above.) We have the following proposition.

Proposition 6 *$s^{*N} - \underline{\theta}^N$ is decreasing in λ and the rate of decrease is decreasing N.*

The first part of the Proposition says that where interdependence is higher, the collective action problem faced by economic agents is more severe, driving a larger wedge between the tipping point and the socially optimal level of the economic state variable above which it is socially optimal for agents to exert effort toward economic activity, if only their actions could be coordinated. The second part of the Proposition says that where bank market power is greater, the effect of economic interdependence is magnified. In other words, the baleful effects of bank market power are larger where the agent coordination problem is more severe, and vice versa.

3 Empirical Implications

In addition to providing a conceptual understanding of the interrelationship between the structure of the banking sector and economic activity, our results have a number of empirical implications, of which we give a representative sample here. First, we find that the competitiveness of the banking sector has a significant impact on economic activity in a non-linear way. In particular, for a given value of the economic state variable, the level of economic activity is a step function of the level of competitiveness of the actual or potential banking sector. The step function is zero with a slope of zero below a threshold level of competitiveness and increases in a discontinuous jump at the threshold. Not only is the presence of such a discontinuity testable in itself, but a further implication is that empirical studies of the relationship between financial sector development and economic growth that assume a linear relationship between the two may be misspecified and thus give rise to misleading results. We find a similar relationship between economic activity and the stability of the banking sector.

We also find that the CFI form has a greater positive impact on economic development, the greater the market power enjoyed by financial intermediaries. This suggests that widespread adoption of the CFI form would be strongly associated with economic growth in areas without the size or wealth to support a large number of banks but weakly associated with economic growth in other areas. Banks in small rural communities would accordingly be more likely to be CFIs, whereas banks in large metropolitan areas would be more likely to be shareholder owned.

Another result is that the baleful effects of bank market power and potential financial instability on economic activity are higher, the greater is the degree of economic interdependence of the local economy. So, we would expect a stronger statistical relationship between such aspects of the banking system and economic growth in an economy composed of small businesses that trade with each other than in an economy where firms trade mostly with external parties.

We show that redlining, when defined as a phenomenon where banks refuse to lend in areas despite the presence of viable borrowers, is more likely to be observed in coarse information environments, where potential borrowers find it harder to predict future economic states and banks find it hard to screen legitimate borrowers from those of ill or irresponsible intent. This suggests that we would see relatively more redlining in small business loans, which may be harder to screen using readily observable "hard" information about the borrower and where the future prospects of the borrower are harder to forecast, and relatively less redlining in home mortgage lending, where creditworthiness is primarily a function of a readily predictable borrower income stream. This is consistent with recent large sample empirical work on redlining in the US mortgage market that has not found much evidence of the phenomenon (e.g., Tootell, 1996).

4 Conclusion

In this paper, we study the incentive to engage in entrepreneurial and other economic activity as a function of the structure of the banking sector. We model entrepreneurial activity as something that requires costly effort and is accordingly endogenous. We also capture the positive externalities of entrepreneurial activity in our model. The equilibrium of the resulting coordination game among economic agents is significantly affected by the organizational form of the financial intermediary and the market power enjoyed by it. Our analysis yields several insights.

In the equilibrium of our model: (a) a noncompetitive banking system may impede economic activity by dissuading marginal or pessimistic economic agents from investing costly effort in skill acquisition and the development of entrepreneurial projects; and (b) when marginal or pessimistic economic agents are so dissuaded, slightly less marginal or pessimistic agents are also dissuaded, with carryon ripple effects. Whether a healthy economy develops is accordingly a tipping point phenomenon in relation to an underlying economic state variable. A consequence is that small changes in underlying economic conditions and the financial system can have a major impact on the resulting level of economic activity if the economy is (often unobservably) already near the tipping point. The model thus operates similarly to recent financial and economic crises, which have seemed to arise suddenly without an obvious, large external shock.

We also show that the effects associated with bank market power may be substantially ameliorated if financial intermediaries adopt the form of a cooperative financial institution, in which case the intermediary is owned by its borrowers and savers instead of a third party. In extensions of our basic model, we study "redlining," showing that it can arise as an equilibrium phenomenon, and demonstrate that the baleful effects of bank market power are an increasing function of the degree of economic interdependence.

Finally, we believe the paper gives rise to a number of interesting questions. Do behavioral biases among agents affect the tipping point? Is there a role for government in raising or lowering the tipping point? What are the trade-offs between the efficiencies that may arise in bank mergers and the potential baleful effects on the incentives of savers and borrowers to exert effort toward economic activity. A resolution of these issues must await further research.

5 Appendix: Proof of Propositions

Proof of Lemma 1: Since $\gamma (1-p) \leq p$, the supply of deposit funds is sufficient to fund all viable projects. Moreover, since storage yields a riskless return of zero, the interest rate in the deposit market is 0. We can then aggregate across agents to find an aggregate inverse demand curve for viable loans at $t = 1$:

$$r = \overline{r} - \frac{Q\overline{r}}{\gamma}$$

where $Q = \sum_i^N q_i, q_i \in [0, \gamma]$, i.e., the sum of the individual quantities of funds managed by each bank.

This leads to an equilibrium à la Cournot in the loan market, where each bank lends and raises a quantity of funds based on the quantity the other banks are lending. Total profits for a particular bank i are thus:

$$\begin{aligned}
\pi &= (1-p)\,\theta\left(\left(\overline{r} - \frac{Q\overline{r}}{\gamma}\right) q_i - \frac{c}{\gamma} q_i\right) \\
\frac{d\pi}{dq_i} &= (1-p)\,\theta\left(\left(\overline{r} - \frac{Q\overline{r}}{\gamma}\right) - \frac{c}{\gamma} - \frac{\overline{r}}{\gamma} q_i\right)
\end{aligned}$$

Setting this equal to zero and making use of symmetry yields

$$\begin{aligned}
q_i &= \frac{1}{N+1} \frac{\overline{r} - \frac{c}{\gamma}}{\left(\frac{\overline{r}}{\gamma}\right)} \\
Q &= \frac{N}{N+1} \frac{\overline{r} - \frac{c}{\gamma}}{\left(\frac{\overline{r}}{\gamma}\right)} \\
\pi &= (1-p)\,(\theta + \Delta)\left(\frac{1}{N+1} - \frac{N}{(N+1)^2}\right) \frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)} \\
W_L &= CS_L + N\pi \\
&= (1-p)\,(\theta + \Delta)\left(\frac{N}{N+1}\right)^2 \frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)} + (1-p)\,(\theta + \Delta)\left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right) \frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)} \\
&= (1-p)\,(\theta + \Delta) \frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)} \frac{N^2 + 2N}{N^2 + 2N + 1}
\end{aligned}$$

Proof of Proposition 2: Given a signal s, the benefit from exerting effort in the absence of a loan market is

$$\frac{1}{2\varepsilon}\int_{s-\varepsilon}^{s+\varepsilon} p\theta d\theta - e = ps - e$$

By assumption, there is a signal $s_0 \geq \overline{\theta} + \varepsilon$ such that the foregoing expectation is non-negative. Thus, every agent exerts who receives a signal of s_0 or higher exerts effort. Consider an agent who receives a signal $s < s_0$. This implies $\theta \in [s-\varepsilon, s+\varepsilon]$. Given the assumption that only those agents with a signal above s_0 are exerting effort, the return to the focal agent from exerting effort is:[9]

$$\frac{1}{2\varepsilon}\int_{s-\varepsilon}^{s+\varepsilon}\left(\theta + \Delta \max\left(\frac{\theta+\varepsilon-s_0}{2\varepsilon}, 0\right)\right)\left(p + (1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\right) d\theta - e$$

It is clear that for s sufficiently close to (but less than) s_0, the foregoing expression is positive. Define s_1 as the lowest s for which the foregoing expression is non-negative. We can then construct a decreasing sequence $\{s_n\}$ where s_n is substituted for s_0 above and s_{n+1} is calculated as we calculated s_1. Since the sequence is bounded below by $\underline{\theta}$ and the support of θ is continuous, the sequence must converge to an s^* such that

$$\begin{aligned}
\frac{1}{2\varepsilon}\int_{s^*-\varepsilon}^{s^*+\varepsilon}\left(\theta + \frac{\theta+\varepsilon-s^*}{2\varepsilon}\right)\left(p + (1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\right) d\theta - e &= 0 \\
\left(s^* + \frac{1}{2}\right)\left(p + (1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\right) - e &= 0
\end{aligned}$$

It is clear that $s^* > \underline{\theta}$. Moreover, the uniqueness of s^* is apparent from the fact that the foregoing expression only has one solution. Finally, it is clear that $\theta^* \to s^*$ from below as $\varepsilon \to 0$.

Proof of Proposition 3: As in the proof of Proposition 2, s^{*N} is uniquely determined by the equation:

$$\left(s^{*N} + \frac{1}{2}\right)\left(p + (1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{N}{N+1}\right)^2\right) - e = 0$$

It is immediate that $s^{*N} > s^*$ and that the difference is decreasing in N. This establishes (i) and

[9] The agent can assume that a viable project will be funded, because there is a supply of funds from the measure of agents with a signal greater than s_0 and, perhaps, from proportion p of agents with lower signals who nonetheless decide to exert effort.

(iii). Property (ii) follows because $1 > \frac{1}{2}$ and

$$\left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right) > 0$$

Property (iv) follows because

$$\frac{d}{dN}\left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right) = -\frac{N-1}{(N+1)^3} < 0$$

Proof of Proposition 4: s_C^{*N} is defined by

$$\frac{1}{2\varepsilon}\int_{s_C^{*N}-\varepsilon}^{s_C^{*N}+\varepsilon} (\theta + \Delta) \times$$
$$\left(p + (1-p)\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{1}{2}\left(\frac{N}{N+1}\right)^2 + \frac{\Delta}{\Delta}\left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right)\right)\right) d\theta - e = 0$$
$$\frac{1}{2\varepsilon}\int_{s_C^{*N}-\varepsilon}^{s_C^{*N}+\varepsilon} \left(\theta + \frac{\theta + \varepsilon - s^*}{2\varepsilon}\right) \times$$
$$\left(p + (1-p)\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{1}{2}\left(\frac{N}{N+1}\right)^2 + \left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right)\right)\right) d\theta - e = 0$$
$$\left(s_C^{*N} + \frac{1}{2}\right)\left(p + (1-p)\gamma\frac{\left(\overline{r} - \frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{1}{2}\left(\frac{N}{N+1}\right)^2 + \left(\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2\right)\right)\right) - e = 0$$

The profits of the banking sector are proportional to Δ, and so is the share of those profits earned by each agent who exerts effort. Thus, the Δ's cancel. It is clear from inspection that $s^{*N} > s_C^{*N} > \underline{\theta}^N$. To conclude the proof, note that the difference between s^{*N} and s_C^{*N} is defined by

$$\frac{N}{N+1} - \left(\frac{N}{N+1}\right)^2 = \frac{N}{(N+1)^2}$$
$$\frac{d}{dN}\frac{N}{(N+1)^2} = -\frac{N-1}{(N+1)^3} < 0$$

Proof of Proposition 5: s^* is determined by

$$\frac{1}{2\varepsilon}\int_{s^*-\varepsilon}^{s^*+\varepsilon}\left(\theta+\frac{\theta+\varepsilon-s^*}{2\varepsilon}\right)pd\theta+\frac{1}{2\varepsilon}\int_{s^*-\varepsilon+\frac{2c}{\overline{r}\gamma}}^{s^*+\varepsilon}\left(\theta+\frac{\theta+\varepsilon-s^*}{2\varepsilon}\right)(1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\frac{2\varepsilon}{\theta+\varepsilon-s^*}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\frac{2\varepsilon}{\theta+\varepsilon-s^*}\right)}d\theta-e=0$$

The foregoing expression will result in a larger gap than in the base case between $\underline{\theta}^N$, which does not change, and s^*. Vis-à-vis the like expression under the base case, the bounds of integration on the right are narrower and multiplying γ by a factor strictly less than 1 reduces the value of the expression inside the integral. (The derivative of $\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}$ with respect of γ is $\frac{1}{\overline{r}\gamma^2}\left(\overline{r}^2\gamma^2-c^2\right)$, which is strictly positive in the relevant range.) To understand where the foregoing expression comes from, note that the proportion of borrowers with viable projects is now $\gamma\frac{\theta+\varepsilon-s^*}{2\varepsilon}$ and that there will be no loan market whenever this expression declines so much that $\overline{r}-\frac{c}{\gamma}\frac{2\varepsilon}{\theta+\varepsilon-s^*}<0$, which occurs whenever $\theta<s^*-\varepsilon+\frac{2c}{\overline{r}\gamma}$.

Proof of Proposition 6: $\underline{\theta}^N$ is now determined as the solution to

$$\left(\lambda\underline{\theta}^N+1-\lambda\right)\left(p+(1-p)\left(\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\left(\frac{N}{N+1}\right)^2\frac{1}{2}+\left(\frac{N}{N+1}-\left(\frac{N}{N+1}\right)^2\right)\right)\right)\right)-e=0$$

and s^{*N} as the solution to

$$\left(\lambda s^{*N}+\frac{1-\lambda}{2}\right)\left(p+(1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{N}{N+1}\right)^2\right)-e=0$$

Define

$$\begin{aligned}\Theta(N) &= p+(1-p)\left(\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{\left(\frac{\overline{r}}{\gamma}\right)}\left(\left(\frac{N}{N+1}\right)^2\frac{1}{2}+\left(\frac{N}{N+1}-\left(\frac{N}{N+1}\right)^2\right)\right)\right)\\ S(N) &= p+(1-p)\frac{\left(\overline{r}-\frac{c}{\gamma}\right)^2}{2\left(\frac{\overline{r}}{\gamma}\right)}\left(\frac{N}{N+1}\right)^2\end{aligned}$$

We then have

$$s^{*N}-\underline{\theta}^N=\frac{1-\lambda}{2\lambda}+e\left(\frac{1}{S(N)\lambda}-\frac{1}{\Theta(N)\lambda}\right)$$

The derivative of this difference with respect to λ is

$$-\frac{1}{2\lambda^2}-\frac{e}{\lambda^2}\left(\frac{1}{S\left(N\right)}-\frac{1}{\Theta\left(N\right)}\right)<0$$

Moreover, we know that $\frac{1}{S(N)}-\frac{1}{\Theta(N)}\longrightarrow 0$ monotonically as $N\longrightarrow\infty$.

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