The beneficial coexistence of banks and markets: The role of Bank Capital and "Credit Lines"

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Preliminary Version: March 1, 2012

Abstract

We propose a model of financial system architecture that highlights the coexistence and positive interaction between banks and markets in a diversity of opinion setting. Banks emerge endogenously and their interaction with markets is facilitated by the use of credit lines (underwriting) and regulatory bank capital. Bank capital is used as a buffer stock to reassure market investors that the credit line contract will be fulfilled. This leads to an increase in market financing - more positive NPV projects are undertaken. The profits they make on the credit lines enable banks to fund more innovative projects in the future. Thus a two-way complementarity loop is achieved which results in the financing of positive NPV projects that were previously denied credit.

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1 Introduction

Financial system architecture is concerned with the channels through which funds are transferred from savers to entrepreneurs with investment opportunities. Some of the most pressing issues in this field relate to the determinants of the architecture of the financial system - whether it is bank-based or market-based - and of course, the impact that this architecture has on the real sector. There is evidence that not only the size, but also the structure of the financial system matters for economic growth (Tadesse, 2002). Therefore, it is important to identify the determinants of the financial system architecture and study its evolution over time. There is also evidence that banks and markets co-evolve in the lower stages of financial development, whereas competition dominates in the more developed financial systems (Demirguc-Kunt and Maksimovic, 1995).

In this paper we consider a simple model of interactions between banks and markets. Banks emerge endogenously and positively interact with markets. A key feature of our model is diversity of opinion among potential investors. That is, agents may disagree regarding the outcome of a project. Agents pay a cost to learn whether they are optimists or pessimists. Optimists will invest in the project, where as pessimists will refrain from investing. The formation of a coalition saves duplication of this learning cost as learning is delegated to a manager. If agents' opinions are sufficiently correlated (with respect to the outcome of the project), they will coalesce to form a bank and delegate learning to a manager. If, on the other hand, agents are not in sufficient agreement regarding the outcome of the project, each agent will incur the cost independently to learn her type and subsequently enter the market as long as she is an optimist. Thus, relative to market financing, the tradeoff for banks is lower learning cost (advantage) versus disagreement about the project outcome (disadvantage).

We identify two elements which are crucial for the positive interaction between banks and markets: i) Credit lines [1] and ii) Bank capital. In our model, bank capital is not used for direct investment in projects. Instead it is used as a buffer stock to reassure market investors that the credit line contract will be fulfilled. We show that projects that did not previously receive financing by either banks or markets, may do so with the help of credit lines and bank capital.

Consider the case that prior to learning, it is optimal to form a bank. Ex-post however, coalition members may not sufficiently agree with the manager and refuse

[1] What we call "credit line", is basically underwriting. From here on, we use these two terms interchangeably

to provide the investment capital despite the manager being optimistic regarding the project's outcome. That is, because of the disagreement between the bank manager and the bank members, a project with positive net present value (NPV) does not receive financing although there are funds available. In this scenario, the manager can provide a credit line (underwriting) to market investors. The credit line insures the market investors against the realization of the low outcome and incentivizes them to invest in projects that they would not otherwise invest in.

What allows the bank manager to credibly offer the credit line is the bank capital. In the absence of the bank capital, the market investors would not buy the credit line, as according to their perception it could not be fulfilled. Thus, the use of credit lines backed by the bank capital imply that more positive NPV projects receive market financing. Further, the profit from credit lines may be used towards financing other projects by the bank. Therefore, a virtuous cycle starts which leads to a larger financial system and higher growth (because more positive NPV projects receive financing). This is consistent with existing empirical evidence (e.g. Levine, 2001). However, despite its usefulness, bank capital is not provided voluntarily by the bank members and it should be imposed by regulation.

In addition to bank capital regulation, our model has another interesting policy implication. Due to co-ordination failure, an equilibrium with market financing may arise even if bank financing is more efficient than market financing. Furthermore, only banks can kick-start the co-evolution loop (through the provision of credit lines). As a result, there is scope for government intervention. By providing some of the capital needed for the bank formation, the government can mitigate or eliminate the co-ordination failure problem and promote the financial system development and growth.

2 Related Literature

2.1 Existence of Financial Intermediaries

Theories in financial intermediation usually attribute the existence of banks to their informational advantages over others; they facilitate pre contract information production and post contract monitoring in a way that lenders avoid duplication costs and entrepreneurs exert the desired effort level.

Diamond (1984) considers an environment in which the outcome of the project is not observed (hence not contractible); it is necessary to monitor the entrepreneur to avoid expropriation. A delegated monitor will avoid duplication of effort or a free rider problem, in which case no lender will incur the cost of monitoring. But, who monitors the monitor? Diamond (1984) shows that the intermediary will commit to certain payments to depositors as long as it is able to diversify its portfolio by contracting with many entrepreneurs. The only way that the bank will honour its commitments to depositors is by performing the entrepreneur monitoring task sincerely.

Leland and Pyle (1977) show that intermediaries will credibly signal the information that they have produced regarding assets through investing in these assets themselves. They also consider the appropriability issue inherent in information production - buyers of information will resell it and thus the original information producer will not be able to extract the full value of the information. This is solved if the firm gathering information becomes an intermediary and buys assets on the basis of its private information thereby embodying this information in a private good (portfolio returns). So, intermediaries do not sell the information, instead use it to form a portfolio.

If financial intermediation is driven by asymmetric information , then it should decline with advances in information technology. Coval and Thakor (2005) note that financial information are markedly more accessible at the present date, due to increased transparency and wider set of tools to process information. Despite that, financial intermediaries still continue to thrive in informationally advanced economies like the US. Moreover, if resolution of informational issues was its primary function, intermediaries should really play a more substantial role in developing economies where information access and moral hazard issues are acute. In this view, Coval and Thakor (2005) present a model in which financial intermediaries arise endogenously despite possessing no informational advantages. In a world where optimists need funding for their projects by the pessimists, the rational agents arise as the intermediaries between the two acting as a 'beliefs bridge'.

Allen and Gale (1997) provide an intertemporal risk smoothing explanation for the existence of financial intermediaries. In the pure market equilibrium, agents exchange to achieve cross-sectional diversification; they are still vulnerable to the non-diversifiable macroeconomic shocks. Allen and Gale (1997) show that intermediaries arise to eliminate this risk by way of intertemporal risk smoothing. In a market equilibrium the agent will invest exclusively in the risky asset. A financial intermediary will accumulate safe assets over time to smooth returns to the risky asset and thereby increase overall welfare.

2.2 Interaction between Banks and Markets

Allen (1993) notes that banks and markets perform two unique and separate roles in the economy, thereby emphasizing the importance of each. What distinguishes banks and markets is the structure of institutions as opposed to the instruments they use. Banks individually negotiate contracts and in capital markets there are large numbers of anonymous lenders who take the pre specified contracts. Markets allocate resources efficiently - provided pricing is accurate - because it continuously checks that the manager is working sensibly and that he or she has information close to the true information set or at least the market's perception of the true information set. If a manager is far off from the market's beliefs, prices will reflect that as a lot of different views - those of the market participants - will come together as opposed to a single bank doing the monitoring. In that sense, capital markets provide a way of checking that firms are well run when there are diverse opinions on the information set. When there is no consensus on how firms should be run, banks may not be as effective, as essentially, there is a single check by the bank's manager. Hence banks are a good way to provide financing in traditional industries where technology is well known and there is a wide consensus on how things should be run. Here, the bank can monitor firms effectively and take advantage of scale economies in monitoring. Financing through capital markets is thus desirable in industries where there is high degree of technological innovation.

Boot and Thakor (1997) provided the first formal model that endogenises the existence of both banks and markets by highlighting the uniqueness of each. They study the formation of a financial system in an environment in which all agents are free to choose the way they organize themselves. Projects may be good or bad - good projects stand to gain if they make an additional investment given the appropriate market conditions. Agents looking to invest will have the choice to either inform themselves about these market conditions (where good projects will profit from additional investments) or pick up monitoring skills - acquisition of both skills require incurring a fixed cost. Agents who become informed will compete in the capital markets while the agents who chose to become monitors will coalesce to form a bank. Informed agents will not form a bank as they incur their fixed costs prior to entering into the contract - their cost is sunk and borrower has no incentive to compensate the bank for the information. On the other hand, monitors could not function independently as they will face a free rider problem where no one monitors - hence they enter into a coalition forming a bank. If the moral hazard problem for a borrower is severe, a potentially informed investor is aware that the borrower will not make use of his information, so

he has no incentive to collect that information.
Therefore borrowers with lower observable quality prefer bank financing as banks mitigate the asset substitution problem and these borrowers do not suffer a loss with banks. Borrowers who pose milder moral hazard risk will go directly to capital markets as informed investors are reasonably sure that these borrowers will invest in good projects and make use of their information.

Song and Thakor (2010) develop a model in which banks and markets co-evolve. In this environment, banks possess unique information processing skills - they have noisy but informative screening technology. A borrower may be authentic or a crook. If the borrower is of a very high quality (authentic with a high pre-screening probability) it is obvious for capital market participants to see that and hence they inflict low valuation discount - high quality borrower receives direct funding in the market; no need to go to the bank as screening is not very valuable to this obviously high quality borrower. A low quality borrower on the other hand, will need to get screened by the bank and bank will extend credit to them only in the event that they find that the low quality borrower may be authentic - when post screening updated probability of being authentic is favourable for the borrower. Intermediate quality borrowers wish to go the capital markets directly but valuation discount is too high and hence they go to banks to get certified off their quality - capital market is now more convinced that the intermediate quality borrower is authentic as they have set themselves apart from the low quality borrowers by undergoing screening. In this way, through the securitization channel, banks increase participation in capital markets. On its part, as the capital market evolves, the bank's cost of raising equity capital falls - lower quality borrowers who did not get funding before, may now get funded as bank's lending scope is expanded. Thus, Song and Thakor (2010) derive a two way feedback loop between banks and markets, such that the two co-evolve.

Demirguc-Kunt and Maksimovic (1995) use aggregated firm level data to examine firm's financing policies in different financial environments (financial environment refers to its degree of development and its architecture). They find contrasting interactions in different stages of financial development. Banks and markets appear to compete in developed financial systems, where further development in already developed markets leads to substitution of debt with equity. However, in less developed financial systems, further development of market leads to a higher debt-equity ratio for firms which translates to more business for banks. That is to say, in countries with developing financial systems, markets and banks play different yet complementary roles.

Demirguc-Kunt and Huizinga's (2000) results provide interesting insights into development of the banking sector within different financial systems. They find that bank performance is significantly affected by the degree of development of the overall financial system of the economy. In underdeveloped financial systems, banks enjoy higher level of profits and margins. However, once the degree of financial development is controlled for, architecture appears to be irrelevant. Further, as the banking sector develops, its profitability decreases as a reflection of increased efficiency due to greater competition. That said, they note that as the market develops (especially at lower levels of financial development), banks enjoy increased profits and margins. This indicates that at least at the lower level of financial development in an economy, banks and markets play a complementary role.

3 The Model

3.1 The Economic environment

Consider a three-date economy ($t = 0, 1, 2$) with universal risk neutrality and a zero riskless interest rate. There are two types of agents: entrepreneurs and investors; all agents consume at $t = 2$. The entrepreneur has access to a project that needs investment, I at $t = 1$ and returns are realized at $t = 2$. The project yields H in the good state and L in the poor state ($H > I > L$). The probability of each state is specific to each project and not a function of the overall economy. The entrepreneur has zero endowment and seeks the capital, I for investing in the project at $t = 1$. There are X investors who are symmetric in beliefs regarding the profitability of the project, to start with. Each of these investors has an endowment of at least, $(I + c + K)$ at $t = 0$. There are also some other agents that have zero endowment and the bank manager will be chosen among these agents. At date $t = 0$, the investor has the choice to incur a fixed cost $c > 0$, to obtain further information prior to deciding whether or not to invest. By incurring the fixed cost, c, the investor learns her type: if she is an optimist, she perceives the return from the project at $t = 2$ as H and if she is a pessimist she perceives the return from the project as L. Learning is therefore perfect in this model. The ex-ante probability that an informed investor is an optimist is given by α. Given an informed investor is an optimist, the probability that another randomly selected investor will agree with her is denoted by β. The β is thus a conditional probability, which is a measure of the correlation among the investors beliefs; $(1 - \beta)$ is the measure of diversity of opinion. β lies in the region, $[\alpha, 1]$; if being an optimist is perfectly correlated across agents, we have ($\beta = 1$), and on the other end of the spectrum, if being an optimist is perfectly noisy across agents, we have ($\beta = \alpha$). A project is characterized by these two parameters, (α, β).

Manager has zero endowment and may not join the bank as an equity holder. As the delegated information gatherer, manager is compensated for his time and effort in collecting the learning cost and learning his type. Compensation is a positive function of the ex-post bank profit and is paid at $t = 2$. We fix the compensation at an infinitesimally small amount (manager's outside option is normalized to 0) and generally ignore it in our analysis as we do not have any quantitative implications for/from it.

Assumption 1: A project has constant returns to scale and its scale is capped. The maximum investment in one project is YI. There are a finite number of projects, F in the economy. The total investment that can be absorbed by all projects taken together is FYI. We assume that $FY > X$, where X is the population of investors with endowments.

This assumption implies that the financiers (individual investor or the bank) have all the bargaining power and so the full surplus (the NPV of the project) accrues to the financiers.

3.1.1 Regulatory Capital Requirements

Government imposes a capital requirement K per member on the intermediary. In forming a coalition investors will deposit an additional amount K, on top of the learning cost, c. This excess capital will sit on the bank's balance sheet and manager cannot use it for direct investment. Capital requirements have been put in place by the government to buffer the bank against unexpected losses and allow the manager to carry out off-balance sheet activities, such as underwriting. At $t = 2$ coalition members get their capital back in full, as long as no losses have been incurred through off-balance sheet activities.

3.2 Benchmark model

As a benchmark, we consider the case with a single project, no bank capital, and no credit lines.

Assumption 2: $\alpha H + (1-\alpha)L - I < 0$ i.e. it is never optimal for the uninformed agent to invest.

3.2.1 Market Finance

Market finance occurs when investors incur the cost of learning their type and then decide individually whether or not to fund the project. Because $H > I > L$, an individual invests only if she is an optimist and perceives return as H. The expected payoff at $t = 0$ to an individual investor in the market to being informed is,

$$V_M = \alpha(H - I) - c$$

If an investor decides to invest c at $t = 0$, at $t = 1$ she learns her type. Therefore at $t = 0$, an individual investor incurs the learning cost if and only if,

$$V_M = \alpha(H - I) - c > 0$$

3.2.2 Bank Finance

Intermediated finance is the case when N investors will coalesce to share the learning cost, c; each member of the coalition will contribute $\frac{c}{N}$ towards the learning cost at $t = 0$ and if at $t = 1$ perceives it as a profitable investment, she will provide I units of capital. Information gathering is delegated to a manager who is randomly selected from the population - manager has no endowment which may be invested. The manager will get informed and truthfully reveal his findings to the members at $t = 1$, who then decide whether to provide the investment capital or not. Members do not learn their own types - manager can only reveal to them his own opinion on the outcome of the project. If the manager is optimistic, the expected return to investment for an uninformed investor is $\beta H + (1-\beta)L$; with probability β, members will agree with an optimistic manager and with probability $(1-\beta)$, members will disagree.
The expected payoff at $t = 0$, to an individual investor in the intermediary coalition is,

$$V_B = \alpha(\beta H + (1-\beta)L - I) - \frac{c}{N}$$

At $t = 0$, coalition formation is feasible as long as expected return is weakly positive. Each member provides her share of the learning cost, $\frac{c}{N}$ if and only if,

$$V_B = \alpha(\beta H + (1-\beta)L - I) - \frac{c}{N} > 0$$

If this condition is satisfied and the manager is optimistic after investing in learning his type, all coalition members provide the investment amount at $t = 1$ because the above condition implies that,

$$\beta H + (1 - \beta)L - I > 0$$

The learning cost is treated as sunk at $t = 1$. Note that if being optimistic is perfectly correlated among agents i.e. ($\beta = 1$), intermediated finance strictly dominates market financing, as duplication of learning costs is costlessly avoided (the bank disadvantage disappears).

3.2.3 Market vs Bank Finance

At $t = 0$ individual investors simultaneously decide whether they will incur the learning cost and invest on their own or they will coalesce with other investors and share the learning cost. We look for pure strategy Nash Equilibria in this game. The agents choose their strategies to maximise their expected payoffs and this determines the form of financing.

Depending on parameter value, there are four cases to be be considered:

Case 1: $V_B < 0$ and $V_M < 0$
Case 2: $V_M > 0$ and $V_M > V_B$
Case 3: $V_B > V_M > 0$
Case 4: $V_B > 0 > V_M$

Below, we analyze each of these cases.

Lemma 1: *Let $V_B < 0$ and $V_M < 0$. The unique Nash equilibrium is one in which there is no financing.*

Proof: Trivially true. Given risk-neutrality, rational agent will not invest in a project with negative expected returns.

Lemma 2: *Let $V_M > 0$ and $V_M > V_B$. There is an unique Nash equilibrium in which only market financing exists.*

Proof: Because $V_M > 0$, no financing is not an equilibrium, as any individual investor can profitably deviate by incurring the learning cost and potentially investing, depending on her type. Also, because $V_M > V_B$, bank financing cannot be an equilibrium. Finally, $V_M > V_B$ implies that agents cannot profitably deviate from the market equilibrium, either individually or by coalescing with other agents.

Given a sufficiently high degree of diversity of opinion, the market outcome is more efficient than the bank outcome; i.e. $V_M > V_B$ which implies $\alpha(1-\beta)(H-L) > c - \frac{c}{N}$. As the diversity of opinion, represented by $(1-\beta)$ increases, ceteris paribus, market financing becomes relatively more attractive than bank financing. If a project has a high degree of diversity of opinion, a member of the coalition is less likely to agree with the optimist manager and her expectation of the return from the project will be lower.

Lemma 3: *Let $V_B > V_M > 0$.*
a. *If $V_B > V_M$ for $N \geq 2$, there exists an unique Nash equilibrium with bank financing and the bank size NI, equals the size of the project YI. (There is just one bank)*
b. *If $V_B > V_M$ for $N \geq 3$, either a bank equilibrium with only one bank or a market equilibrium may arise.*

Proof: Because $V_M > 0$, no financing is not an equilibrium, as any individual investor can profitably deviate.
a. $V_B > V_M$ for $N \geq 2$: We first show that market financing is not an equilibrium in this case. Suppose that we start with a market financing equilibrium. Then, any market investor can coalesce with any other and form a bank as this is a strictly profitable strategy. We now show that there cannot exist an equilibrium in which the bank size (NI) is less than the scale of the project (YI). Consider the case where there are two banks of equal size $(\frac{YI}{2})$. In this case, a member of either bank can increase her profit by joining the other bank because now she shares the cost, c with more members. By a similar argument, we can rule out any bank size but, YI. Suppose now that there is one bank with size $NI = YI$. Then the deviation of any member of this bank would imply a lower profit for her since, $(V_B > V_M)$. Therefore, the equilibrium with bank financing with one bank is unique.
b. $V_B > V_M$ for $N \geq 3$: Suppose we start with a market financing equilibrium. Consider then, a market investor who deviates and joins another individual investor to share the learning cost. Because $V_B > V_M$ for $N \geq 3$, this is not a profitable deviation. Therefore, market financing is a Nash equilibrium. We now show that the other possibility is bank financing with just one bank. By a similar argument as in

part a, the equilibrium bank size cannot be less than YI. Thus, if a bank equilibrium exists, it involves only one bank. Suppose now that there is one bank with size $NI = YI$. Then the deviation of any member of this bank would imply a lower profit for her since, $(V_B > V_M)$. Therefore, bank financing involving just one bank is a Nash equilibrium.

$V_B > V_M$ is a necessary but not a sufficient condition for bank formation. We need to account for coordination issues. If bank formation is strictly preferred for $N = 2$, bank financing arises as a unique equilibrium (with size of the bank, $NI = YI$). If $V_B > V_M$ holds for $N \geq 3$, there is a coordination failure problem and market financing can arise as an equilibrium, despite the fact that bank financing is more efficient.

Lemma 4: *Let $V_B > 0 > V_M$.*
a. *If $V_B > 0$ for $N \geq 2$, there exists an unique Nash equilibrium with bank financing and the bank size NI, equals the size of the project YI. (There is just one bank).*
b. *If $V_B > 0$ for $N \geq 3$, either a bank financing with just one bank or a no financing equilibrium may arise.*

Proof: Same arguments as above (Lemma 3).

Proposition 1: The mode of financing is determined as follows:

Consider $V_M > 0$.
i) If $V_B > V_M$ for $N \geq 2$, there exists a unique Nash equilibrium, where there is only bank financing with just one bank.
If $V_B > V_M$ for $N \geq 3$, either a bank financing equilibrium with just one bank or a market financing Nash equilibrium may arise.
ii) If $V_M > V_B$ for any N, there is a unique Nash equilibrium with just market financing.

Consider $V_M < 0$.
iii) If $V_B > 0$ for $N \geq 2$, there exists a unique Nash equilibrium, where there is only bank financing with just one bank.
If $V_B > 0$ for $N \geq 3$, either a bank financing equilibrium with just one bank or a no financing Nash equilibrium may arise.
iv) If $V_B < 0$, there is a unique Nash equilibrium with no financing.

3.3 Extension

In this section we extend the model in two dimensions:
i) the project's β is not known with certainty at $t = 0$. We assume that β is uniformly distributed in the continuum, $[\underline{\beta}, \overline{\beta}]$; the bounds on β are still α and 1
ii) manager may undertake in off-balance sheet activities such as underwriting or extending a credit line.

Payoffs to market financing are exactly the same as in the previous section. We consider bank financing for the two cases:
i) there are no capital requirements and
ii) regulators impose a capital requirement

3.3.1 Market Finance

Payoff to direct financing in the market is as before. The expected payoff to an individual investor in the market to being informed is,

$$V_M = \alpha(H - I) - c$$

We assume that $V_M < 0$. Market financing in infeasible.

3.3.2 Bank Finance with No Capital Requirements:

First, we consider the case in which there are no regulatory capital requirements. At $t = 0$, it is observed that the project's β is uniformly distributed in $[\underline{\beta}, \overline{\beta}]$, and the β is realized at $t = 1$ (denote as β_R).

Definition: There is a threshold, β^*, where $\underline{\beta} < \beta^* < \overline{\beta}$, for which payoff to providing investment capital to manager at $t = 1$ is $V_B = 0$ (after treating learning costs as sunk),

$$\beta^* = \frac{I - L}{H - L}$$

At $t = 0$, members provide learning cost if and only if,

$$V_B = \alpha[\frac{\beta^* + \overline{\beta}}{2} H + (1 - \frac{\beta^* + \overline{\beta}}{2}) L - I] - \frac{c}{N}$$

Consider the case that manager is optimistic. If $\beta_R > \beta^*$, members provide capital at $t = 1$ since,

$$\beta_R H + (1 - \beta_R) L - I > 0$$

If however, $\beta_R < \beta^*$, members do not provide capital at $t = 1$ since,

$$\beta_R H + (1 - \beta_R)L - I < 0$$

Thus at $t = 1$, if $\beta_R < \beta^*$, manager cannot invest in the project, despite being optimistic regarding its outcome. Manager wishes to maximize ex-post profit for the bank to maximize his own compensation. To that end, given that he perceives outcome as high with certainty, he offers a credit line contract to the market investors.

Definition: A credit line is a commitment at $t = 1$ of the bank to the market investor that in the event that the low state, L occurs at $t = 2$, bank will transfer some funds to the investor, such that return to market investor in the low state is $L' > L$. To avail of this credit line, investor pays a fee, Z to the bank at $t = 2$, whether or not she drew the line. The expected payoff of the investor in the market from a credit line financed project is denoted V_C and given the fee Z,

$$V_C = \beta_R H + (1 - \beta_R)L' - I - Z$$

An optimistic manager offers a credit line in the event that coalition members do not provide the investment capital and he extends the credit line without seeking the financial backing of the coalition members, who perceive the credit line as a loss making contract and do not endorse it.

Market investors do not find manager's promise credible. In their perception, the bad state may occur in which case, the manager will not be able to fulfill his promise. Thus, no market investor avails of the credit line. Coalition members are aware of this outcome and are therefore not worried about potential loss from credit lines when providing the learning cost, c at $t = 0$.

Recap 1: We have considered a project that is not financed in the market ($V_M < 0$). A coalition is formed at $t = 0$ since payoff from forming a coalition is weakly positive in expectation; learning is delegated to a manager. At $t = 1$, manager is optimistic and he perceives outcome as H with certainty. However, since $\beta_R < \beta^*$ coalition members treat the learning cost as sunk and refrain from providing further capital to fund the project. This occurs since coalition members do not sufficiently agree with the manager; i.e. β_R is too low. Manager offers a credit line contract to market investors in order to derive some value out of his information. However, he fails to signal credibility of his promise and market investor does not buy the line. The project is denied credit from all quarters.

3.3.3 Bank Finance with Capital Requirement:

Consider that regulatory capital requirements are in place. In forming a coalition member puts an additional amount K, on top of the learning cost, c. Manager cannot use this excess capital for direct investment.

At $t = 0$, members evaluate the project with the average β over its full interval, (say β_A),

$$\beta_A = \frac{1}{2}(\underline{\beta} + \overline{\beta})$$

Thus ex-ante, bank is formed and each member provides the learning cost, $\frac{c}{N}$ and the regulatory capital K if and only if,

$$V_B = \alpha[\beta_A H + (1 - \beta_A)L - I] - \frac{c}{N} \geq 0$$

Note that, with capital requirements in place, the condition for bank financing is stricter (since $\beta_A < \frac{\beta^* + \overline{\beta}}{2}$). If $\beta_R > \beta^*$, same mechanism as the no capital requirements case goes through. Lets reconsider the case that $\beta_R < \beta^*$. Suppose that the manager is optimistic. Coalition members do not sufficiently agree with the manager and do not provide the investment capital, I. Manager offers the credit line contract to market investors. With regulatory capital in place, manager's promise is credible, since he has access to the bank capital and if the bad state occurs, he can resort to this capital to make the promised payments. Thus, market investors buy some credit line contract (pricing of the contract and number of credit lines extended are considered below). The coalition members take this into account at $t = 0$ when she provides the learning cost ($t = 0$) and the regulatory capital to form the bank. The condition for bank formation becomes stricter as investors explicitly take into account the (ex-ante perceived) losses that they incur if credit line is extended.
If $\beta_R < \beta^*$, members do not provide capital and manager extends a credit line. At $t = 0$, members perceive the return on investment as,

$$\alpha[\frac{\underline{\beta} + \beta^*}{2}H + (1 - \frac{\underline{\beta} + \beta^*}{2})L - I] - \frac{c}{N}$$

Here we have assumed that all surplus (deficit as perceived by the members) from the credit line accrue to the bank. We later allow for the surplus to be split between the bank and market investors, without any qualitative implications on the bank financing conditions.

Combining the two cases ($\beta_R < \beta^*$ and $\beta_R > \beta^*$), we get that when there are capital requirements in place, coalition members evaluate the project using the average β over its interval, β_A.

Recap 2: We have considered a project that will not be financed in the market, $V_M < 0$. A coalition is formed at $t = 0$ since payoff from forming a coalition is weakly positive in expectation; learning is delegated to a manager. At $t = 1$, manager is optimistic. However, $\beta_R < \beta^*$ and coalition members do not provide the investment capital, I. The bank manager extends the credit line, which is a credible contract due to the presence of regulatory capital in the bank's balance sheet. With the credit line, the market investor is fully insured against the bad outcome and thus it is incentive compatible for her to invest ($V_C \geq 0$), even though it was not so previously ($V_M < 0$). Thus, the bank manager secures funding for a project that was previously denied credit from both the market and the bank.

3.3.4 Pricing the Credit Line

At $t = 1$ it is learnt that $\beta_R < \beta^*$. Coalition members do not provide the investment capital, despite the fact that manager is optimistic. Manager extends the credit line, enabling market investors to undertake the project. Thus the credit line comes into play, only if neither the market nor the bank financing is sufficient on its own. We assume without loss of generality that the bank manager has all the bargaining power; later we relax this assumption. The market investors simply earn zero profit. Hence, the credit line fee will be determined in a monopolistic way. The manager will maximize the fee as long as the market investor's participation constraint is satisfied i.e $V_C = 0$.

Given that the bargaining power has been assigned to the manager, the bank enjoys the full surplus from the project. The credit line contract stipulates that the payment will be made in the event of poor outcome. To that end, manager perceives no future payments related to the credit line. Given $L' > L$ and $L' \leq H$, manager will guarantee poor state outcome to market investor as H; i.e. $L' = H$. Manager maximizes fee, Z given participation constraints.

$$V_C = H - I - Z = 0$$
$$Z = H - I$$

However, there is no reason to assume that the bargaining power of the credit line lies entirely with the bank. In pricing the credit line, the market investors may have

some bargaining power. The bank manager retains only a fraction of the surplus as the rest goes to the market investors.
The bank retains a fraction, ϕ of the surplus and so, the fee is given by $Z = \phi(H - I)$.

The number of credit lines that are extended is determined by the amount of regulatory capital in the bank's balance sheet. One credit line is extended if the total regulatory capital is, $NK = H - L$. As before, the maximum capacity of the project is capped at YI, so at most Y credit lines are extended.

3.3.5 What drives the result?

The key to our model is that agents agree to disagree regarding the outcome of the project. The credit line is a costless exercise for the manager who perceives the outcome as high while, it is valuable to the market investor; trade occurs due to this difference in perceptions.

4 Analysis of the model

Dividend Policy: We specify a payout policy rule for the bank. It states that the bank retains a fraction δ of the profits.
In the model above, there is a single project which is funded by the market, aided by the credit line. Bank's profit is made up of credit line profits exclusively; retained bank profit is given as $\pi = \delta\phi(H - I)$, where ϕ is the bank's bargaining power in negotiation of the credit line contract.

4.1 Results

Proposition 2: *Bank aids the evolution of Market, by expanding its lending scope to riskier (lower α) projects through the provision of credit lines.*

Proof: The bank extends a credit line (made credible by the regulatory capital) to make it incentive compatible for the market investor to invest in a project, which it previously denied credit to. Clearly, there is an increased participation in the market. The market evolves and funds more innovative projects (lower α) than it did without the positive interaction between the bank and markets - there is entry into previously unchartered territories.

Proposition 3: *Credit lines increase ex-post bank profit. The partial retention of profit leads to the evolution of the bank over time by expanding its lending scope to more innovative (lower β) projects.*

Proof: Bank evolution stems from the retained profits. Profit retention is there to ensure that bank will accumulate capital over time and this will ease its future investment constraints.
Given the retained profits, $\pi = \delta\phi(H - I)$, payoff to an individual in the coalition to investing in a new project (in a subsequent round of investing) is given as,

$$V_B = \alpha(\beta H + (1-\beta)L - I) - (\frac{c}{N} - \frac{\delta\phi(H-I)}{N})$$

Necessary condition for bank financing is $V_B > 0$. The profit carried forward eases this constraint. As a result, bank evolves over time, as its lending scope extends to more innovative firms.

Proposition 4: *Co-evolution is a feature in the lower stages of development of the Financial System.*

Proof: Profits carried forward each period is given by $\pi = \delta\phi(H - I)$. After T rounds of investments, the accumulated capital of the bank will equal YI; $T\pi = YI$. This implies that the capital accumulation over time will allow the bank to undertake the project by itself, to its maximum capacity. At this stage, the manager no longer extends a credit line and invests using accumulated capital instead. The co-evolution cycle comes to a halt in the higher stages of financial system development.
Beyond a point , bank would accumulate enough profit to undertake the project by itself, to its maximum scale. Further, since surplus from the credit line is split, bank prefers to invest by itself if it can, as opposed to extending a credit line and sharing the surplus.

Proposition 5: *Banks trigger markets.*

Proof: We claim that banks may trigger markets, but the reverse is not true. Consider the case that it is feasible to learn individually in the market, i.e. ($V_M > 0$). If she is an optimist, individual investor will invest her own money in the project. Additionally, she may wish to extend credit lines to uninformed or pessimistic investors to extract the full value of her information. However, she has no free endowments with which she can make her promise credible. Therefore, we see that the market cannot kick start the bank. Where as, this is precisely what the bank is able to achieve for the market through extension of the credit line - kick start investment in the market.

4.2 Government Intervention

Proposition 6: *Let $V_B > 0 > V_M$ or $V_B > V_M > 0$ for $N \geq 3$. Despite the potential coordination failure problem, there exists a balanced-budget intervention which ensures that the efficient outcome (bank financing) arises as a unique Nash equilibrium. The bank size NI, equals the size of the project YI. (There is just one bank).*

Proof: As an example, suppose that $V_M < 0$ and that $V_B > 0$ for $N \geq 3$. As we saw above, in this case, the inefficient no financing equilibrium may arise due to coordination failure. One way the government (regulator) can intervene and eliminate this problem is as follows: the government contributes the full learning cost, c in the bank and it announces that any individual who joins the bank will pay a fee, $\frac{c}{Y}$. If the learning cost for each individual is $\frac{c}{Y}$, then for each individual $V_B > 0$, regardless of the other individual's strategies. So, joining the bank becomes a strictly dominant strategy for all individuals. As a result the no financing equilibrium cannot exist and the bank financing equilibrium is unique.

5 Implications for the financial system

Our analysis generates the following empirical predictions:

1. In the developed financial systems more positive NPV projects are funded, which were previously denied credit on the grounds of being too risky or innovative. Bank aids the market to finance low α projects, which were too risky for it previously. In turn, banks use profits generated from credit lines to invest in more innovative (lower β) projects in subsequent rounds of investment. This is consistent with empirical evidence by Levine, 2001.

2. Regulatory capital requirements allows the bank manager to undertake in off balance sheet activities and sets in motion the evolution of the financial system.

3. Co-evolution is a feature only in the lower stages of financial development. Beyond

a point, bank will accumulate enough capital to invest directly, as opposed to extending credit lines. The surplus from the project is split when using a credit line; if it has the capital, bank invests by itself to capture the full surplus.

4. Further we have implications for the payout policy of banks on the evolution of the financial system. Higher the profits paid out, one can expect a slower development of the overall financial system.

5. Finally, the critical implication of the model is that banks trigger the co-evolution cycle. Banks are able to cushion market investors (through credit lines in the above model). Policy-makers are obviously concerned with development of the overall financial system. This may be achieved by alleviating the co-ordination failure problem of bank formation and subsequently, encouraging interactions between the bank and the market.

6 Conclusion

We analyze a simple model of financial systems characterized by diversity of opinion between agents. In our model banks emerge endogenously and there is positive interaction between banks and markets. This interaction is facilitated by the use of credit lines (underwriting) and regulatory bank capital. Bank capital is not used for direct investment in projects. Instead it is used as a buffer stock to reassure market investors that the credit line contract will be fulfilled.This leads to an increase in market financing - more positive NPV projects are undertaken. The surplus from the project using credit lines is split between the bank and the market investors. The retained profits enable banks to fund more innovative projects in the future - a co-evolution cycle is thus kicked off. We highlight the role that the regulatory capital requirements plays - without the regulatory capital, credit lines are infeasible as manager cannot make credible promises regarding payments if the poor outcome occurs.

In our model, we have used a perfect learning technology. Agents pay a cost c and see the future outcome, H or L. The results still go through in an environment of noisy learning in which instead of learning what the future state is, agents learn the probability of high state or low state at some cost. To reiterate, the key to the results is the diversity in perceptions. Bank managers and market investors perceive the value of the credit line differently. This is what makes trade valuable and a project that did not get funding previously, does so now.

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