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Investment and deposit contracts under costly intermediation and aggregate volatility

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Abstract

This paper examines how volatility affects investment and the form of deposit contracts in a three-period model where capital formation is financed by bank credit and lenders face state verification and enforcement costs. Firms face both idiosyncratic and aggregate shocks, and agents are initially risk neutral. We show that intermediation costs magnify the incidence of macroeconomic volatility on banks' expected losses and have an adverse effect on investment. With risk-averse consumers, the impact of banks' expected losses on investment is mitigated because the equilibrium deposit contract provides partial insurance against adverse macroeconomic shocks.

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1. Introduction

A popular paradigm for explaining the partially contingent nature of financial contracts is the costly state verification (CSV) model proposed by Townsend (1979) and further developed by Bernanke and

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Gertler (1989), Diamond (1984) and Gale and Hellwig (1985).[1] In this setting, lenders cannot observe the outcome, x, of the investment made by the borrower, without incurring a monitoring cost. Incentive compatibility requirements therefore imply that, in the absence of monitoring, repayment cannot depend on x. As shown for instance by Diamond, the optimal financial contract (that is, the efficient, incentive compatible contract) under risk neutrality is a debt contract, in which monitoring takes place only when the outcome is so low that the borrower is unable to comply with the (fixed) agreed repayment—in which case lenders seize part (or the totality) of the realized cash flow.[2]

The present paper contributes to the literature on the CSV framework by examining the impact of costly financial intermediation and macroeconomic volatility on investment and the nature of deposit contracts. Our analysis is particularly relevant for middle- and upper-income developing countries. Indeed, inefficient financial intermediation and high exposure to macroeconomic volatility are important features of these countries (see Agénor and Montiel (1999)) and have been shown to have significant implications for the behavior of private agents and for assessing the impact of government policy decisions. For instance, in Agénor and Aizenman (1999), we examined how volatility and costly financial intermediation affect the welfare benefits of financial market integration, by comparing bank behavior (and the response of private sector borrowers) under financial autarchy and complete openness to world capital markets. For the issue at hand, we focus on an economy where, in the absence of a well-functioning equity market (and, for simplicity, no internal finance), investment is financed by bank loans. We also account explicitly for the underlying sources of shocks to banks' balance sheets, by characterizing the uncertain environment in which bank borrowers operate.

The source of information asymmetry between borrowers and lenders in our model is, as in the conventional CSV framework, the inability of the latter group to observe and verify ex post the outcome of the investment projects for which they lend, without incurring some cost. We investigate, in a dynamic setting that borrows from Diamond and Dybvig (1983), how adverse macroeconomic shocks and financial sector inefficiencies (as characterized by relatively high monitoring and verification costs) affect banks' expected profits from lending, the level of investment, and the nature of deposit contracts.[3] Our analysis shows, in particular, that costly intermediation compounds the losses associated with a high degree of aggregate volatility. We also show that if the bank's markup exceeds (falls short of) the expected yield differential between booms and recessions, the bank will provide full (partial) insurance to depositors. This implies that greater market power by banks would reduce the impact of shocks on banks' expected losses.

The remainder of the paper is organized as follows. The first part presents our basic framework, which assumes two categories of consumers and risk-neutral agents. Production, in this setting, is subject to both idiosyncratic and aggregate shocks, with the latter capturing the effect of business cycle fluctuations. The second part extends the basic framework to consider the case in which consumers are risk averse, and examines the implications of risk aversion for banks' expected losses, the equilibrium

[1] See Freixas and Rochet (1997) for an overview of the costly state verification approach. Chang (1990) provides a two-period extension of the Townsend and Gale–Hellwig models.

[2] However, as shown for instance by Hellwig (2000), with risk aversion by both borrowers and lenders, there is no simple and robust characterization of financial contracts. Moreover, even if agents are risk neutral, standard debt contracts can be dominated if monitoring is stochastic; see Boyd and Smith (1994).

[3] The model presented in this paper dwells on several of our previous contributions (see Agénor and Aizenman (1998, 1999, 2002)), which examined a variety of issues associated with credit market imperfections. But it differs from these earlier studies in several important ways, most notably by its explicit dynamic structure and the consideration of household utility.

deposit contract, and investment. The last part summarizes the main results of the paper and discusses some possible extensions of the analysis.

2. A basic framework

Consider a closed economy producing one tradable good, which can be used for either consumption or investment. There are three types of agents: consumers, entrepreneurs, and banks. Consumers make deposits in banks and entrepreneurs borrow from banks to finance investment. There are no reserve requirements and banks hold no liquidity for a purely "precautionary" motive. As in Diamond and Dybvig (1983), liquidation of illiquid assets is not feasible and the good produced in the economy is not storable.[4]

There are three periods, corresponding to time t=0, 1, 2. At t=0, each consumer is endowed with one unit of the good. With probability α $(1-\alpha)$, a consumer is impatient (patient), consuming only in period t=1 (2). To simplify further, we assume a linear utility function, V, given by

$$V = \begin{cases} C_1, & \text{with prob. } \alpha \\ \rho C_2, & \text{with prob. } 1-\alpha \end{cases}, \tag{1}$$

where $\rho \in (0, 1)$ denotes a discount factor.

Entrepreneurs are risk neutral. Each of them is able to invest in a real, long-term project that requires two periods to bear fruit. Each entrepreneur invests in one and only one project. Investment by entrepreneur h, I_h, requires a certain amount of the entrepreneur's effort, ϕI_h, where $\phi>0$ measures the cost effort. The resulting level of output, Y_{2h}, is subject to decreasing returns to scale, and is given by

$$Y_{2h} = (1+\delta+\varepsilon_h)a\sqrt{I_h}, \qquad a>0, \tag{2}$$

where ε_h is the idiosyncratic productivity shock affecting entrepreneur h, which is i.i.d. across all entrepreneurs, with $|\varepsilon_h| \leq \bar{\varepsilon}$and ε a positive constant. δ is the aggregate (macroeconomic) shock, which for simplicity is assumed to take only two values:

$$\delta = \begin{cases} +\bar{\delta}, & \text{with prob. } 0.5 \\ -\bar{\delta}, & \text{with prob. } 0.5 \end{cases}. \tag{3}$$

This specification implies therefore that δ has zero mean.[5] In what follows we will refer to realized states of nature in which $\delta = -\bar{\delta}$ as a "recession" and those in which $\delta = +\delta$ as a "boom."

Entrepreneurs rely on bank credit to finance investment. Loans contracted in period t=0 and invested in period t=1 must be repaid in period t=2. Given the option to default, the repayment in t=2 by entrepreneur h is

$$\min\{\chi Y_{2h};\ (1+r_L)I_h\}, \qquad 0 \leq \chi \leq 1, \tag{4}$$

[4] These assumptions eliminate the possibility of bank runs and allow us to focus on a state-contingent (equilibrium) deposit contract, where bank runs are anticipated in states of nature characterized by low returns on bank assets.

[5] Focusing on only two states of nature for the aggregate shock allows us to simplify considerably our analysis. The qualitative features of our results, however, would hold with more general distributions. We also assume that, if negative, the macro shock is not large enough in absolute value to make period-2 output negative.

where r_L is the contractual interest rate (determined below) and χ measures the fraction of the entrepreneur's realized output that creditors can appropriate or confiscate in case of default. χ can therefore be viewed as capturing the bank's bargaining power.

The idiosyncratic productivity shock, ε_h, is revealed to banks only at a cost. If entrepreneur h chooses to default, the bank would spend real resources μ per unit of currency invested (or lent), I_h, to induce the entrepreneur to repay χY_{2h}. This cost lumps together state verification and contract enforcement costs. Hence, the expected net repayment on the debt, from the point of view of the bank, is

$$E\left\{\min\{\chi Y_{2h};\ (1+r_L)I_h\} - I_h\begin{bmatrix}\mu \text{ if } \chi Y_{2h}<(1+r_L)I_h \\ 0 \text{ if } \chi Y_{2h}>(1+r_L)I_h\end{bmatrix}\right\}. \tag{5}$$

From the above expressions, it follows that the entrepreneur's expected net profit, $E(\Pi)$, is

$$E(\Pi) = E[y_{2h} - \min\{\chi Y_{2h};\ (1+r_L)I_h\} - \phi I_h],$$

that is, using Eqs. (2) and (3):

$$E(\Pi) = a\sqrt{I_h} - (1+r_L)I_h - 0.5a\chi\Gamma\sqrt{I_h} - \phi I_h, \tag{6}$$

where

$$\Gamma = \int_{-\tilde{\varepsilon}}^{\varepsilon_B^*} (\varepsilon_B^* - \varepsilon) f(\varepsilon_h)\mathrm{d}\varepsilon_h + \int_{-\tilde{\varepsilon}}^{\varepsilon_R^*} (\varepsilon_R^* - \varepsilon) f(\varepsilon_h)\mathrm{d}\varepsilon_h. \tag{7}$$

In the above expression, $f(\varepsilon_h)$ is the density function of ε_h. ε_R^* and ε_B^* are threshold levels of the idiosyncratic shock associated with default in recessions ($\delta=-\bar{\delta}$) and in booms ($\delta=+\bar{\delta}$), respectively. Given the definition of Γ given in Eq. (7), the quantity $0.5a\chi\Gamma\sqrt{I_h}$ in Eq. (6) can be viewed as measuring the borrower's expected "saving" in debt repayments associated with default.

Using Eqs. (2) and (4), the values of ε_R^* and ε_B^* can be defined, in the range of default, by

$$\left(1 - \bar{\delta} + \varepsilon_R^*\right)a\chi\sqrt{I_h} = (1+r_L)I_h,$$

$$\left(1 + \bar{\delta} + \varepsilon_B^*\right)a\chi\sqrt{I_h} = (1+r_L)I_h,$$

or more precisely, given the assumed distribution of ε:

$$\varepsilon_R^* = \max\left[-\tilde{\varepsilon};\ \min\left\{\bar{\delta} - 1 + \frac{1+r_L}{a\chi}\sqrt{I_h};\tilde{\varepsilon}\right\}\right], \tag{8}$$

$$\varepsilon_B^* = \max\left[-\tilde{\varepsilon};\ \min\left\{-\left(1+\bar{\delta}\right) + \frac{1+r_L}{a\chi}\sqrt{I_h};\tilde{\varepsilon}\right\}\right]. \tag{9}$$

The expected yield on the typical bank's loan to entrepreneur h per unit of currency invested, $E(R)$, is

$$E(R) = (1+r_L) - \frac{0.5a\chi\Gamma}{\sqrt{I_h}} - \mu Q, \tag{10}$$

where Q is the probability of default, given by

$$Q = 0.5\left[\int_{-\tilde{\varepsilon}}^{\varepsilon_B^*} f(\varepsilon_h)\mathrm{d}\varepsilon_h + \int_{-\tilde{\varepsilon}}^{\varepsilon_R^*} f(\varepsilon_h)\mathrm{d}\varepsilon_h\right]. \tag{11}$$

Each bank in the economy is assumed to operate with a large number of entrepreneurs and consumers; it therefore diversifies away the idiosyncratic shock. The bank offers a consumer who deposits his (or her) endowment in period 0 a contingent deposit contract, yielding

$$\begin{cases} C_1 = (1 - I_b)/\alpha & \text{in period 1} \\ \text{or} & \\ C_2 = RI_b/(1-\alpha) & \text{in period 2} \end{cases}, \tag{12}$$

where I_b is the share of funds intermediated by the bank, and R is the realized yield on funds lent and invested. To simplify notations, we assume an equal number of consumers and entrepreneurs.

A competitive *lending* equilibrium implies that banks would set the investment level I_b at a rate that would maximize the expected utility of the consumers depositing their resources with the bank. A competitive borrowing equilibrium implies that entrepreneurs would choose a level of investment (and thus a level of bank borrowing) that maximizes their expected profits. Hence, an internal equilibrium (in which the levels of investment chosen by banks and entrepreneurs are the same) is characterized by

$$\max_{I_b} E[(1 - I_b) + \rho RI_b],\ \max_{I_h} E\left[a\sqrt{I_h} - \min\{\chi Y_{2h};\ (1 + r_L)I_h\} - \phi I_h\right],\ I_h = I_b.$$

Under competition, entrepreneurs face the market-determined interest rate, r_L, and each bank faces the market-determined expected return $E(R)$. Thus, the first-order conditions characterizing the internal equilibrium are

$$\rho E(R) = 1, \tag{13}$$

$$0.5a/\sqrt{I_h} - (1 + r_L) - \phi + 0.5\frac{\mathrm{d}\left[\chi a\Gamma\sqrt{I_h}\right]}{\mathrm{d}I_h} = 0, \tag{14}$$

where, using Eqs. (7) and (11),

$$\frac{\mathrm{d}\left[\chi a\Gamma\sqrt{I_h}\right]}{\mathrm{d}I_h} = \frac{0.5a\chi\Gamma}{\sqrt{I_h}} + (1 + r_L)Q.$$

Recalling that each bank diversifies away the idiosyncratic risk, we infer that

$$R = \begin{cases} R_B = 1 + r_L - \frac{\chi a}{\sqrt{I_h}}\int_{-\tilde{\varepsilon}}^{\varepsilon_B^*}(\varepsilon_B^* - \varepsilon)f(\varepsilon)\mathrm{d}\varepsilon - \mu\int_{-\tilde{\varepsilon}}^{\varepsilon_B^*} f(\varepsilon)\mathrm{d}\varepsilon & \text{if } \delta = +\bar{\delta} \\ R_R = 1 + r_L - \frac{\chi a}{\sqrt{I_h}}\int_{-\tilde{\varepsilon}}^{\varepsilon_B^*}(\varepsilon_R^* - \varepsilon)f(\varepsilon)\mathrm{d}\varepsilon - \mu\int_{-\tilde{\varepsilon}}^{\varepsilon_R^*} f(\varepsilon)\mathrm{d}\varepsilon & \text{if } \delta = -\bar{\delta} \end{cases} \tag{15}$$

It is straightforward to verify that for a low enough degree of volatility, no default would take place. This would be the case if, even in the worst state of nature ($\delta = -\bar{\delta}$ and $\varepsilon = -\tilde{\varepsilon}$), the entrepreneur has the incentive to repay fully, that is, if

$$\left(1 - \bar{\delta} - \tilde{\varepsilon}\right) a\chi\sqrt{I_h} > (1 + r_L) I_h.$$

Solving for the equilibrium investment level and the corresponding interest rate, we infer that the above condition holds only if

$$\frac{\phi\rho}{1 + \phi\rho} > \bar{\delta} + \tilde{\varepsilon}, \tag{16}$$

which implies that the higher the cost of effort, ϕ, the less likely it is that the entrepreneur will choose to default, even in the worst circumstances. The lower the degree of volatility (as measured by $\bar{\delta}$), the more likely it is that the entrepreneur will choose to repay.

If Eq. (16) indeed holds, then

$$R_{\mathrm{b}} = R_{\mathrm{R}} = 1/\rho,$$

and the bank's contract is non-contingent. But if condition (16) is reversed–which is the case for instance if the cost of effort is zero–default and partial repayment would occur with positive probability, and the bank's return in recessions would be below the return in booms. The bank would then offer a contingent contract–with a yield of R_{B} (R_{R}) in booms (recessions), as indicated in Eq. (15). In such conditions, the bank's expected loss (per unit of currency invested), L, would be

$$L = 0.5(R_{\mathrm{B}} - R_{\mathrm{R}}), \tag{17}$$

that is, using Eq. (15):

$$L = \frac{0.5a\chi}{\sqrt{I_h}}\left[\int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{R}}^*} (\varepsilon_{\mathrm{R}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon - \int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{B}}^*} (\varepsilon_{\mathrm{B}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon\right] + 0.5\mu \int_{\varepsilon_{\mathrm{B}}^*}^{\varepsilon_{\mathrm{R}}^*} f(\varepsilon)\mathrm{d}\varepsilon. \tag{18}$$

The above results allow us to derive the following proposition.

Proposition 1. *More costly intermediation and greater volatility of aggregate macroeconomic shocks increase the bank's expected loss ($dL/d\mu > 0$ and $dL/d\delta > 0$).*

This proposition follows from the observation that $\mathrm{d}I_h/d\mu < 0$, $\mathrm{d}I_h/\mathrm{d}\delta < 0$, and that, from expression (17),

$$\frac{\mathrm{d}L}{\mathrm{d}\mu} = -\left(\frac{\mathrm{d}I_h}{\mathrm{d}_\mu}\right)\frac{0.5a\chi}{2\sqrt{I_h}}\left[\int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{R}}^*} (\varepsilon_{\mathrm{R}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon - \int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{B}}^*} (\varepsilon_{\mathrm{B}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon\right] + 0.5 \int_{\varepsilon_{\mathrm{B}}^*}^{\varepsilon_{\mathrm{R}}^*} f(\varepsilon)\mathrm{d}\varepsilon,$$

$$\begin{aligned}\frac{\mathrm{d}L}{\mathrm{d}\delta} &= 0.5[F(\varepsilon_{\mathrm{R}}^*) + F(\varepsilon_{\mathrm{B}}^*)]\left\{\frac{0.5a\chi}{\sqrt{I_h}} + \mu\right\} - \left(\frac{\mathrm{d}I_h}{\mathrm{d}\delta}\right)\frac{0.5a\chi}{2I_h\sqrt{I_h}} \\ &\quad \times \left[\int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{R}}^*} (\varepsilon_{\mathrm{R}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon - \int_{-\tilde{\varepsilon}}^{\varepsilon_{\mathrm{B}}^*} (\varepsilon_{\mathrm{B}}^* - \varepsilon) f(\varepsilon)\mathrm{d}\varepsilon\right]\end{aligned}$$

where

$$F(\varepsilon_s^*) = \int_{-\tilde{\varepsilon}}^{\varepsilon_s^*} f(\varepsilon)\mathrm{d}\varepsilon, \qquad s = \mathrm{B}, \mathrm{R}.$$

It is also straightforward to establish the following related proposition:

Proposition 2. *More costly intermediation compounds the losses associated with greater macroeconomic volatility ($dL^2/d\mu d\delta$)>0).*

Further insight in understanding these results can be obtained by considering the case where the idiosyncratic shock follows a uniform distribution, so that $f(\varepsilon_h)=1/2\tilde{\varepsilon}$, and $Pr(\varepsilon_h>x)=(\tilde{\varepsilon}-x)/2\tilde{\varepsilon}$. In these circumstances, the equilibrium can be characterized by two quadratic equations in the contractual lending rate and the level of investment, given by

$$\rho\left[1 + r_L - \frac{0.5a\chi\Gamma}{\sqrt{I_h}} - \mu Q\right] = 1,$$

$$\frac{0.5a}{\sqrt{I_h}} - (1 + r_L) - \phi + 0.5\left[\frac{0.5a\chi\Gamma}{\sqrt{I_h}} + (1 + r_L)Q\right] = 0,$$

with Γ (defined in Eq. (7)), given now by

$$\Gamma = \frac{1}{4\tilde{\varepsilon}}\left[(\varepsilon_{\mathrm{B}}^* + \tilde{\varepsilon})^2 + (\varepsilon_{\mathrm{R}}^* + \tilde{\varepsilon})^2\right].$$

The bank's expected loss can thus be reduced to

$$L = \left[\frac{a\chi}{\sqrt{I_h}}Q + \frac{\mu}{2\tilde{\varepsilon}}\right]\delta, \tag{19}$$

where Q is again the probability of default by producer h, given now by

$$Q = 0.5\left[\frac{\varepsilon_{\mathrm{B}}^* + \tilde{\varepsilon}}{2\tilde{\varepsilon}} + \frac{\varepsilon_{\mathrm{R}}^* + \tilde{\varepsilon}}{2\tilde{\varepsilon}}\right].$$

The panel on the left-hand side in Fig. 1 displays the relationship between investment and the degree of volatility of the macroeconomic shock, as measured by $\tilde{\delta}$. Similarly, the panel on the right-hand side in

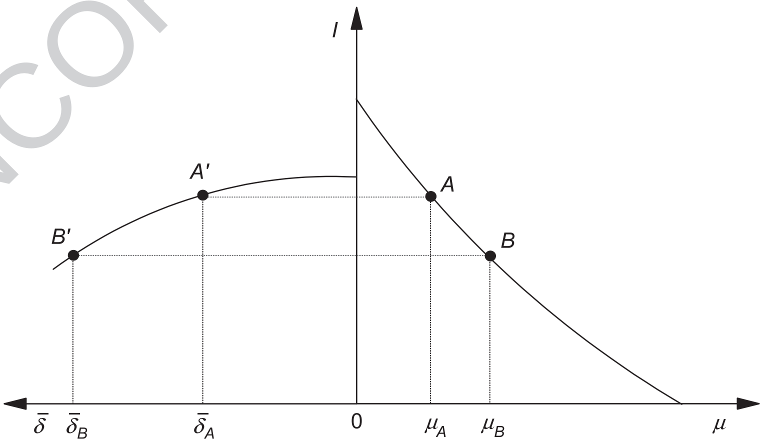

Fig. 1. Investment, aggregate volatility and intermediation costs.

Fig. 1 illustrates the relationship between investment and the intermediation cost, μ. The figure shows that higher macroeconomic volatility (an increase in δ from δ_A to δ_B, for instance) and higher financial intermediation costs (an increase in μ from μ_A to μ_B) reduce investment, and may increase significantly the bank's expected loss.

3. Risk aversionand deposit contracts

We now extend our framework to account for risk aversion among consumers and examine its impact on the optimal deposit contract. Specifically, suppose that each consumer's utility function is now given by, instead of Eq. (1):

$$V = \begin{cases} \sqrt{C_1} & \text{with prob. } \alpha \\ \rho\sqrt{C_2} & \text{with prob. } 1-\alpha \end{cases}. \tag{20}$$

Banks remain risk neutral but now we also assume that they possess some degree of market power, with each bank's expected markup (per unit of currency invested) remaining constant over time at $\omega \geq 0$.[6] With the exception of these two modifications, we maintain all our previous assumptions.

With risk-averse consumers, banks compete by offering contracts that provide insurance, stabilizing depositors' income in period t=2. Banks would provide this insurance as long as their net income in that period is positive (hence, we focus on the case of limited liability, assuming that banks' own capital is zero). This insurance is provided via a state-contingent transfer scheme (τ_B; τ_R). We denote by $\tilde{R}$ the return to depositors (per unit of currency invested) in period t=2. Hence the deposit contract provides

$$\begin{cases} C_1 = (1-I_b)/\alpha & \text{in period 1} \\ \text{or} & \\ C_2 = \tilde{R} I_b/(1-\alpha) & \text{in period 2} \end{cases},$$

where

$$\tilde{R} = \begin{cases} \tilde{R}_B = R_B + \tau_B & \text{if } \delta = +\bar{\delta} \\ \tilde{R}_R = R_R + \tau_R & \text{if } \delta = -\bar{\delta} \end{cases},$$

and

$$E(\tau) = -\omega.$$

The bank's contract is thus modified by adding a state-contingent transfer, τ; the expected value of this transfer is (minus) the bank's markup.

The bank's net income is

$$\begin{cases} -\tau_B & \text{if } \delta = +\bar{\delta} \\ -\tau_R & \text{if } \delta = -\bar{\delta} \end{cases}.$$

[6] A similar analysis would apply to the case of competitive banks if, in addition to verification costs, financial intermediation involves administrative or operational costs. In such conditions, ω would represent the associated expected cost per dollar invested.

Hence, limited liability in this setting implies that $\min(-\tau_B; -\tau_R) \geq 0$. If the limited liability constraint does not bind, then the transfers are designed to provide full insurance:

$$R_R + \tau_R = R_B + \tau_B; \quad 0.5(\tau_R + \tau_B) = -\omega,$$

implying that

$$\tau_R = L - \omega, \quad \tau_B = -L - \omega, \tag{21}$$

where L is the bank's expected loss defined in Eq. (18). Eq. (21) implies that the limited liability constraint is non-binding only if $\omega > L$. Applying this reasoning, it follows that the equilibrium deposit contract can be characterized as follows.

Proposition 3. *If the bank's markup exceeds the expected yield differential between booms and recessions (that is, if $\omega > L$), then the equilibrium deposit contract is such that*

$$\tilde{R}_B = \tilde{R}_R = E(R) - \omega,$$

whereas if the markup is less than the expected yield differential, then

$$\tilde{R} = \begin{cases} \tilde{R}_B = R_B - 2\omega & \text{if } \delta = +\bar{\delta} \\ \tilde{R}_R = R_R & \text{if } \delta = -\bar{\delta} \end{cases}.$$

Applying the logic of our previous discussion, the economy's internal equilibrium is now characterized by

$$\max_{I_b} E\left[\sqrt{1 - I_b} + \rho\sqrt{\tilde{R} I_b}\right],$$

$$\max_{I_h} E[a\sqrt{I_h} - \min\{\chi Y_{2h}; (1 + r_L) I_h\} - \phi I_h\}],$$

$$I_h = I_b.$$

The corresponding first-order conditions are now

$$\sqrt{\frac{I_b}{1 - I_b}} = \rho E\left(\sqrt{\tilde{R}}\right), \tag{22}$$

$$0.5a/\sqrt{I_h} - (1 + r_L) - \phi + 0.5\frac{\mathrm{d}\left[\chi a \Gamma \sqrt{I_h}\right]}{\mathrm{d}I_h} = 0. \tag{23}$$

Note that having risk-averse consumers and depositors does not modify the first-order condition characterizing the entrepreneur's behavior; thus Eq. (23) is identical to Eq. (14). The bank's investment pattern, however, is modified, as banks offer now a contract that maximizes depositors' expected utility (subject to the limited liability constraint discussed above).

The bank's investment pattern (22) can be reduced to

$$\sqrt{\frac{I_{\mathrm{b}}}{1-I_{\mathrm{b}}}}=\begin{cases}0.5\rho\left[\sqrt{R_{\mathrm{B}}-2\omega}+\sqrt{R_{\mathrm{R}}}\right] & \text{if } \omega<L\\ \rho\sqrt{0.5(R_{\mathrm{B}}+R_{\mathrm{R}})-\omega} & \text{if } \omega>L\end{cases}. \tag{24}$$

This result leads to the following proposition:

Proposition 4.

a) *If the bank's markup exceeds (falls short of) the expected yield differential between booms and recessions, the bank will provide full (partial) insurance of depositors' income in period t=2. This implies that greater market power by banks reduces the impact of volatility on banks' expected losses.*
b) *Full insurance increases the level of deposits, inducing a lower equilibrium interest rate and a higher level of investment.*

The analysis can be readily extended to consider preferences characterized by constant relative risk aversion. Specifically, let the modified version of Eq. (1) be, instead of Eq. (20),

$$V=\begin{cases}C_1^{1-\zeta}/(1-\zeta) & \text{with prob. } \alpha\\ \rho C_2^{1-\zeta}/(1-\zeta) & \text{with prob. } 1-\alpha\end{cases}, \tag{25}$$

where $0<\zeta<1$. The modified first-order condition (22) becomes

$$\left(\frac{I_{\mathrm{b}}}{1-I_{\mathrm{b}}}\right)^{1-\zeta}=\rho E\left(\tilde{\mathrm{R}}^{1-\zeta}\right),$$

which in turn implies that a higher degree of risk aversion (lower ζ) magnifies the results reported in Proposition 4b.

If the bank's markup exceeds the expected yield differential between booms and recessions, the bank will provide full insurance of depositors' income in period t=2. This is accomplished by state-contingent transfers, as given in Eq. (21). This has two effects. First, the yield is reduced by the markup. Second, the yield in recessions (booms) is increased (reduced) by the expected yield differential, which determines the expected loss, L. If the bank's markup falls short of this expected yield differential, the limited liability constraint will bind, and the bank's contract will provide only partial insurance. This is done by raising the markup charged in boom times. The resulting expected yield differential from the typical depositor's point of view is

$$\tilde{L}=\max(L-\omega;0)=\begin{cases}L-\omega & \text{if } \omega<L\\ 0 & \text{if } \omega>L\end{cases} \tag{26}$$

Eq. (26) implies that a higher markup and lower volatility will reduce the bank's expected loss.

The macroeconomic impact of the insurance provided via the bank's contract can be traced with the help of Eqs. (22), (23) and (24). Suppose that, starting from a binding limited liability constraint, we switch to a full insurance contract. Consumers' risk aversion implies that stabilizing the yields across the

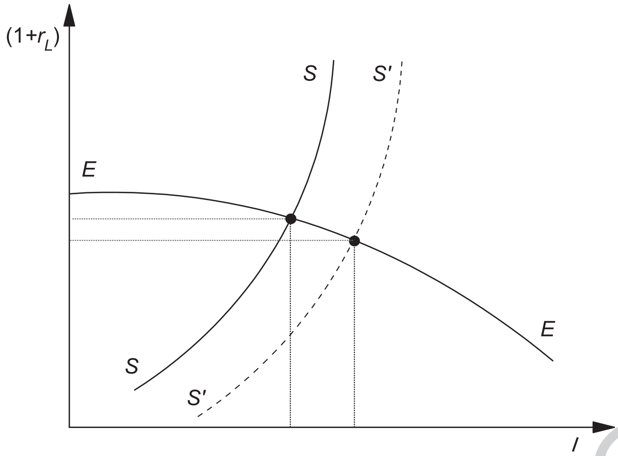

Fig. 2. Risk aversion and investment with limited insurance.

states of nature would increase the expected utility-weighted yields, $E\left(\sqrt{\tilde{R}}\right)$, which in turn would imply higher investment.

To appreciate the full effect of this adjustment, we show in Fig. 2 the first-order equilibrium conditions, Eqs. (22) and (23). Curve EE corresponds to the configurations of investment and the contractual interest rate that maximize entrepreneurs' profits, providing us with the demand for loanable funds, as given by Eq. (23). The funds channeled to investment via the banking system are summarized by curve SS (S′S′) for the case where the limited-liability constraint does not bind (binds). These curves correspond to Eq. (24), which describes equilibrium lending (and deposit) behavior. Stabilizing depositors' yield would shift the savings schedule S′S′ rightward, inducing a lower equilibrium interest rate and a higher level of investment.

4. Concluding remarks

The purpose of this paper has been to examine the impact of costly financial intermediation and macroeconomic volatility on bank behavior, investment, and the nature of financial contracts. To do so we developed a framework that combines some elements of the seminal model of Diamond and Dybvig (1983) with the costly state verification approach pioneered by Townsend (1979). The first part of the paper presented the basic framework and showed that the presence of financial sector inefficiencies (as characterized by high monitoring and verification costs) can magnify the incidence of a high degree of volatility of aggregate macroeconomic shocks on bank's expected losses. The second part extended the basic framework to consider the case of risk-averse consumers, and examined the implications of risk aversion for the optimal deposit contract. We showed that in this setting (with banks being risk neutral and having some degree of market power) the equilibrium deposit contract would provide partial insurance against adverse macroeconomic shocks. In these circumstances, adverse effects on banks' losses would occur only when the macroeconomic shock is "bad" enough. We also showed that if the bank's markup exceeds (falls short of) the expected yield differential between booms and recessions, the bank will provide full (partial) insurance to depositors.

This implies that greater market power by banks would reduce the impact of volatile shocks on banks' expected losses. This result is quite important in the context of the ongoing debate regarding the benefits and costs of financial liberalization and openness to world capital markets (see, for instance, Agénor (2003) and Agénor and Aizenman (1999)). It does not, of course, imply that financial openness is "bad" (particularly if the cost of accessing foreign funds is lower as a result), but rather that the benefits of liberalization are mitigated in the presence of domestic credit market imperfections.

Our framework can be extended in a variety of ways. One avenue would be to endogenize monitoring costs. While we treated monitoring costs as given, it may be argued that these costs may be higher in expansions, as all projects look "healthier" in good times. This in turn suggests the possibility of over-lending in good times, exacerbating business cycle fluctuations. Modeling this possibility would require a more careful treatment of the signaling problems associated with monitoring. A second avenue would be to investigate the impact of policies aimed at improving the efficiency of the banking system; as can be inferred from our analysis, such policies can be quite effective. A particular issue to consider in this context is that of entry by foreign banks, because output diversification may not be achievable quickly, allowing more efficient foreign banks to enter the credit market and impose greater competition on domestic banks may lead to a rapid fall in intermediation costs. In addition, foreign banks may be able to diversify away part of the domestic macroeconomic shocks, effectively reducing the incidence of "bad" states of nature on their expected profits.

These extensions are, nevertheless, unlikely to alter the main message of this paper. It has become clear to economists and policymakers (particularly in the aftermath of the East Asia crisis) that a weak financial system can exacerbate underlying macroeconomic instability and that, in turn, macroeconomic instability may exacerbate the type of adverse incentives and moral hazard problems that are inherent to banking. The contribution of our paper is to show that, in addition, financial sector inefficiencies may magnify the impact of macroeconomic shocks by increasing expected losses of financial intermediaries and by lowering investment. More broadly, it highlights the 16 importance, for many developing countries, of legal reforms (such as procedures for seizure of collateral in case of default) for improving the performance of their banking systems and the contribution of financial intermediation to capital formation and growth.

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