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FINANCIAL INTERMEDIATION, MONETARY UNCERTAINTY AND BANK INTEREST MARGINS*

LEONARDO F. HERNANDEZ**
Escuela de Administración, Universidad Católica de Chile

Abstract:

This paper studies a simple model of financial intermediation in order to understand how the lending-borrowing spread (or interest margin) charged by financial intermediaries is determined in equilibrium in a monetary economy. The main conclusion of the paper concerns the effect on the spread of changes in the distribution of monetary innovations. Thus, changes in the monetary-policy-rule followed by the Central Bank which alter the volatility of inflation will have important effects on the interest-margin and also on the amount of credit available to investors. A cross-section empirical analysis strongly supports our hypothesis:

1. Introduction

The role played by financial intermediaries in the transmission of monetary shocks is certainly a critical aspect of our current understanding of the effectiveness of monetary policy. It is surprising, however, that very little is actually known (on a theoretical plane) about the nature of financial institutions. In fact, it is not until recently that a more promising explanation for financial intermediation (based on

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information-related market imperfections) appeared in the literature. This line of research does not only provide with an explanation for financial intermediation, but also explains some of the actual characteristics of intermediaries as we know them. (See Boyd and Prescott (1986), Diamond (1984), Ramakrishnan and Thakor (1984) and Williamson (1986), (1987a)).

It is important to mention that there are many earlier references in the literature concerning financial institutions. However, these earlier papers do not provide with a satisfactory explanation for the existence of financial intermediaries (although the paper by Baltensperger (1972) might be considered an early attempt to do so). Rather, they deal with some important microeconomic aspects of the functioning of intermediaries, such as reserve management, leverage, and portfolio composition. These aspects are not considered in the new line of research we just mentioned. (See the papers by Klein (1971), Poole (1968), Pyle (1971), Sealey (1980), and the surveys by Baltensperger (1980), Pyle (1972) and by Santomero (1984)).

It is surprising that, with the exception of a recent paper by Williamson (1987c), all of the papers mentioned above deal with a real economy where money does not exist. However, even in the paper by Williamson (1987c) money plays no significant role.

It is a fact of life that most financial contracts are set in nominal terms. Thus, in order to understand the way in which monetary policy affects output, an explicit analysis of money and its relation with financial intermediation is needed. However, it is important to make clear that we will not deal with the problem of money-creation by financial intermediaries (i.e., 'inside'-money). Rather, we assume that all money is just cash or 'outside'-money and, therefore, that the money-multiplier is always equal to one.

In this paper we are concerned with the use of money as a numeraire when writing financial contracts. In particular, we study a simple model of financial intermediation in order to understand how the lending-borrowing spread (or interest margin) charged by financial intermediaries is determined in equilibrium.

The main hypothesis to be investigated concerns the changes in the lending-borrowing spread due to changes in uncertainty or risk. In particular, changes in inflation or inflation-risk should have some effect on the lending-borrowing spread. This hypothesis is a natural extension of the models developed by Deshmukh et al. (1983), Jaffee and Modigliani (1969), Jaffee and Russell (1976), Stiglitz and Weiss (1981), and Williamson (1986) and (1987a). This hypothesis is also interesting because of its relevance in analyzing monetary regime shifts, such as the ones occurring in October 1979 and October 1982 in the US.

This paper is among the few that study the effects of price-level variations on financial intermediation. Nevertheless, the papers by Bernanke and Gertler (1989) and by Johnson (1988) deal with different problems and do not incorporate money explicitly into their analysis. More specifically, while Bernanke and Gertler analyze the effects of price-level variations on the distribution of wealth and its relation with financial intermediation, Johnson studies the effects of inflation on financial intermediation when interest-rates ceilings are imposed.

One problem related to this paper which is (at least partially) solved concerns the existence of indexed debt-contracts. In fact, we are going to assume that it is costly to write indexed-contracts and, therefore, all contracts are initially written in nominal terms. It is argued then that indexed contracts might exist only for a highly volatile inflation rate. Nevertheless, this issue is extremely important and should be discussed further in another paper.

The main motivation for this paper is that the lending-borrowing spread appears to be higher in Chile than in the US after the financial liberalization in the former country in 1975. In fact, Edwards (1988) documents that in Chile this spread was around 22 percent on an annual basis in 1978-79, 10 percent in 1980-81, and around 18 percent in 1982. Ramos (1988) documents an average spread of 17 percent for the period 1975-83, while Sjaastad (1983) documents "...that since mid-1979 the spread has been two thirds of 1 percent per month". Our own computations show an average spread of approximately 12 percent for 1978-88, as opposed to 1.78 percent for the US during 1982-89, both on an annual basis.

The remaining sections of the paper are as follows. Section two describes the model while section three studies the effect of changes in uncertainty on the lending-borrowing spread. In section four the empirical analysis is provided while section five summarizes and concludes.

2. The Model

2.1 *The General Setting*

We consider an overlapping-generations model (O.G.M.) where a countable-infinity of investors or firms (i.e., borrowers) and a countable-infinity of households (i.e., lenders) are born every period. We assume that in each generation the number of households is at least L times (L > 1) the number of investors. All economic agents live for two periods and are assumed to be risk neutral, i.e, they maximize expected income or profits. All consumption occurs during the second period.

In this economy a unique but very large financial intermediary or bank exists. The bank borrows from the households (or lenders) and lends to the firms (or investors). The existence of this financial intermediary is explained below.

At the beginning of every period each new-born household receives one unit of indivisible output. Also, each household j is endowed with a specific technology that allows her to increase her consumption with *certainty* if she decides to keep her endowment until next period. Let us denote this specific technology as $H_j = (1+h_j)$. We assume that H_j is uniformly distributed over the interval $[0, H^{max}]$[1]. Thus, the household can either (i) keep her endowment until next period, (ii) exchange it for fiat-money, or (iii) lend it to the financial intermediary. Fiat-money is supplied every period by the Central Bank and by the households in the old-generation who decided to hold money in the previous period. We also assume that holding fiat-money is costless. However, holding a financial asset issued by the financial intermediary (i.e., a certificate of deposit) costs household j α_j units of output, where α_j is uniformly distributed over the interval $[0, \alpha^{max}]$. α_j can be interpreted as the cost of going to the bank, which is assumed to be proportional to the distance from the bank to household j's home.

Investors are endowed with zero units of output but with an investment technology which is unknown to households and whose outcome is uncertain. All firms face the same investment project which consists of the following: the investment of L units of output in period t will provide with L(1+y) units of output in period t+1, where y is a random term. Letting (1+y) equal Ω, the investment project is fully described by the probability density function (p.d.f) of Ω, $f(\Omega)$ (or alternatively, by the cumulative density function (c.d.f) of Ω, $F(\Omega)$). In our notation Ω satisfies the following: $0 \leq \Omega \leq \Omega^{max}$. Notice that, because all the investment projects are independent but identically distributed, *aggregate* gross-return is certain and constant, i.e., equal to the mean of Ω (the "unlucky" firms are compensated with the "lucky" ones).

Each investor (or firm) is also characterized by a specific parameter, ε_i, which measures the comparative-advantage of firm i in undertaking the project. This parameter, ε_i, does not affect the outcome of the project, but measures the amount of labor ('effort') that firm or investor i has to use in order to implement the project. I assume that ε_i is uniformly distributed over the interval $[0, \varepsilon^{max}]$.

We also assume a costly-state-verification setting as in Townsend (1979). Thus, the actual realization of Ω_i can be freely observed *only* by investor i, and any other agent has to spend resources in order to observe it.

2.2 *The Financial Intermediary*

With all the assumptions made above the existence of a unique but extremely large financial intermediary can be explained as follows.

Because of the costly-state-verification assumption, and ruling-out stochastic monitoring, it can be shown that the optimal incentive-compatible arrangement between borrowers and lenders is a debt-contract. That is, there is a fixed promised payment, and if the investor cannot meet it, the lender pays the monitoring or verification costs, bankruptcy occurs, and the investor consumes zero. (See Townsend (1979), and Williamson (1986), (1987a)).

Within this framework a large and single financial intermediary emerges as a superior form for intermediating funds because of the diversification undertaken by the intermediary. That is, by lending to all the investors the intermediary becomes riskless and will never be monitored by the lenders. Also, duplication of verification-costs is avoided as the cost of monitoring firms is incurred only once (by the intermediary) rather than by all the L lenders to the failing firm. (See Boyd and Prescott (1986), Diamond (1984), and Williamson (1986), (1987a), (1987c), (1989)).

Given this result we can rule-out direct lending and concentrate on the equilibrium when a financial intermediary exists. Notice that if either (i) there is no uncertainty about Ω_i, or (ii) Ω_i is not private information (i.e., it becomes public information), then the financial intermediary is not longer a superior form for intermediating funds. This happens because when either (i) or (ii) is true, then no monitoring is necessary, and therefore no savings in monitoring costs can exist.

In what follows we are going to assume that, because of technological restrictions, it is costly to write indexed contracts and, therefore, all financial transactions are (initially) set in nominal terms. The cost of writing an indexed contract is equal to ß units of output.

2.3 *Lenders*

Each household j has three alternatives of investment: one with a *certain* gross-*real* return of H_j when keeping her endowment, one with an *expected* gross-*real* return of (P_t/P_{t+1}) when holding fiat-money, and one with the financial intermediary which pays an *almost certain nominal* return of $I^* \Sigma$. P_t is the price-level at time t, I^* is the *expected* real return promised to depositors (lenders) by the financial intermediary, and Σ is equal to the inverse of the expected gross-return of money[2], i.e., $\Sigma = [E(P_t/P_{t+1})]^{-1}$, where E( ) stands for the expectations operator. $I^*\Sigma$ is *almost* certain because, as we will see below, when contracts are set in nominal terms the financial intermediary is not longer riskless. However, if we assume that the probability of a bank failure is (very close to) zero, then I^* becomes certain *except* for inflation-risk. Notice also that, because of the risk-diversification (with respect to Ω) undertaken by the intermediary or bank, the latter is still the optimal (i.e., superior) arrangement for intermediating funds, even when contracts are written in nominal terms.

Because of risk-neutrality, household j will compare the certain return H_j with the expected real return of holding money and with the expected ***net*** real return of lending, which is given by $(I^* - \alpha_j)$. At equilibrium, given I^* and $E(P_t/P_{t+1})$, some fraction γ_1 of the population (i.e., households) will hold only fiat-money (those with low H and high α), a fraction γ_2 will hold only financial assets issued by the bank (those with low H and low α), and a fraction γ_3 will invest in their own riskless project (those with high H and high α). Note that the sum of the γ's equals one. Because H_j and α_j are both uniformly distributed, then a continuous and positively sloped aggregate credit supply curve is obtained.

2.4 *The Price-Level*

In steady-state equilibrium the price level is determined by the following: $\gamma_1 Y_t P_t = M_t$, where Y_t is the total endowment received by households born in period t, and M_t is the total stock of fiat-money supplied in period t. Letting (M_{t+1}/M_t) equals δ_{t+1}, then (P_{t+1}/P_t) is given by (δ_{t+1}/K), where K is one plus the growth rate of the population, and where δ satisfies the following: $0 < \delta \leq \delta^{max}$. The p.d.f (c.d.f) of δ is known and is represented by $g(\delta)$ $(G(\delta))$[3].

2.5 *The Optimizing Investor*

In order to undertake the project, firms have to borrow LP_t units of the currency (or L units of output) from the financial intermediary, who charges an *expected* gross-real return of R (R = 1+r). Alternatively, the bank charges a nominal return of $R\Sigma$, where Σ is defined above. Note that R is the *expected* gross-real return, which might be different than the actual *ex-post* real return due to changes in inflation (i.e., due to unexpected inflation).

At the end of the period the firm will observe the actual return on its own project, Ω_i, and the actual inflation, π_t, and will either default or pay-back the loan. This occurs depending on $\Omega_i(1+\pi_t) \geq R\Sigma$ (repayment occurs) or $\Omega_i(1+\pi_t) < R\Sigma$ (default occurs).

The expected real profit of investor i can be calculated as follows:

$$E(\text{profits firm i}) = L\int_0^{\infty}\int_{R\Sigma K/\delta}^{\infty} \{[\Omega - (R\Sigma K/\delta)]\, f(x)\, dx\}\, g(z)\, dz - \varepsilon_i \qquad (1)$$

which is equal to L times the expected value of Ω, minus L times the expected real return paid to the bank, when default does not occur, and finally, minus the effort or labor spent in implementing the project.

After integrating by parts equation (1) can be written as follows:

$$E(\text{profits firm i}) = L\left[(\Omega^{max} - R) - \int_0^{\infty}\int_{R\Sigma K/\delta}^{\infty} [F(x)\,dx]\, g(z)\,dz\right] - \varepsilon_i \quad (2)$$

2.6 *The Optimizing Bank*

The real pay-off for the financial intermediary is summarized as follows. The intermediary will receive:

(i) $LR\Sigma/(1+\pi_t)$ when default does not occur,

(ii) $L\Omega + Lc[\Omega - R\Sigma/(1+\pi_t)] - M$ when default occurs,

(iii) $- LI^{*}\Sigma/(1+\pi_t)$ in any event,

where M are the monitoring costs, and $Lc[\Omega - R\Sigma/(1+\pi_t)]$ are bankruptcy costs which are assumed to be proportional to the difference between what is due to the bank and what is actually paid. (Note that when default occurs Ω is less than $R\Sigma/(1+\pi_t)$, and therefore, their difference is negative).

The expected profits to the bank of granting a loan to any firm is given by the following:

$$E(\text{Profits-Bank}) = LR\Sigma K \int_0^{\infty}\left(\int_{R\Sigma K/\delta}^{\infty} f(x)dx\right) 1/\delta\, g(z)\,dz + \quad (3)$$

$$L\int_0^{\infty}\left(\int_0^{R\Sigma K/\delta} \Omega f(\Omega)\, d_{\Omega}\right) g(z)dz - M \int_0^{\infty} F(R\Sigma K/\delta)\, g(z)\,dz$$

$$+ Lc\int_0^{\infty}\left(\int_0^{R\Sigma K/\delta} (\Omega - R\Sigma K/\delta)\, f(x)\,dx\right) g(z)\,dz - LI^{*}$$

where the first term on the right-hand-side corresponds to (i) above, and the second, third and fourth terms correspond to (ii) above.

After integrating by parts equation (3) can be reduced to the following:

$$E(\text{Profits-Bank}) = L\,(R-I^{*}) - M\int_0^{\infty} F(R\Sigma K/\delta)\, g(z)\,dz \quad (4)$$

$$- L(1+c)\int_0^{\infty}\left\{\int_0^{R\Sigma K/\delta} F(x)\,dx\right\} g(z)\,dz$$

Notice that when contracts are nominal the financial intermediary is not longer riskless, i.e., a large *unexpected* deflation might cause a bank failure. However, when calculating expected profits in equation (3) or (4), the financial intermediary assumes that he/she never fails as reflected in (iii) above.

3. **Changes in Uncertainty**

It should be clear at this point that in this setting the level of inflation is not important as long as it is known with certainty. Thus, if agents could forecast inflation without error, then all real returns would be certain (rather than expected) and inflation would not play any role[4]. What really matters in our setup is the volatility of inflation. However, it does so not because of risk aversion (as in Giovannini (1989) or in Sealey (1980)) but because of the asymmetrical pay-off between borrowers and the bank. The effects of inflation-volatility are studied below.

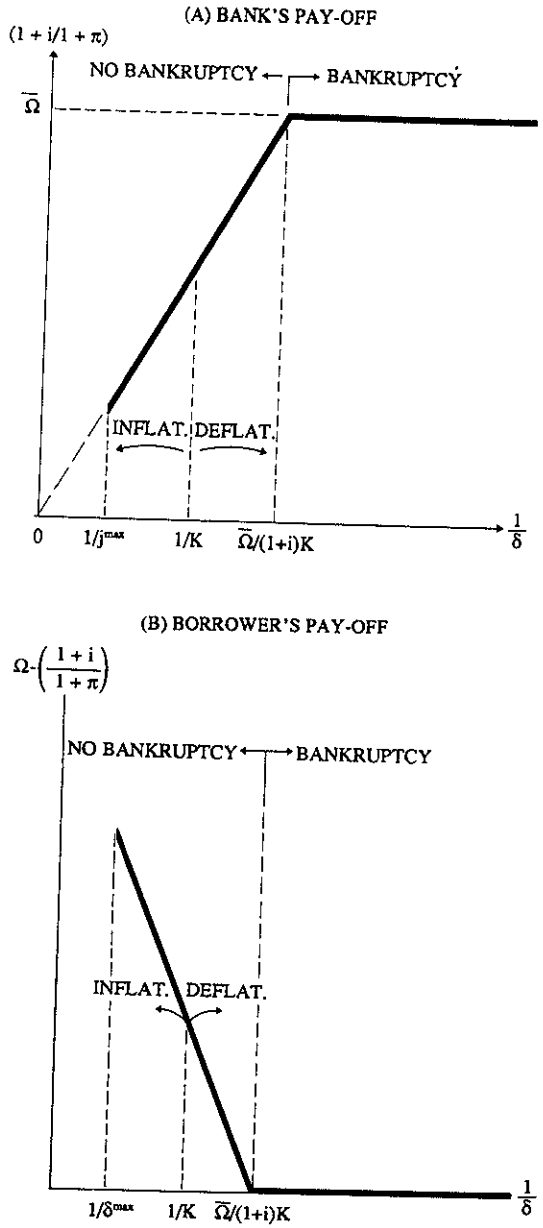
3.1 *Intuition*

Before we proceed with a more rigorous analysis, an intuitive and clarifying example may be helpful to understand what will be developed next. Figure 1 below shows both, the bank's pay-off of lending to an investor (top portion of the figure), and the investor's pay-off of borrowing from the bank (bottom portion of the figure), both for the case *without* bankruptcy-costs. The figure is drawn for a specific Ω and i (nominal interest rate). Along the horizontal axis we measure the inverse of the growth-rate of money, and K is the rate of growth of the population.

In the figure we show the areas when inflation occurs and when deflation occurs. Notice that the bank's pay-off increases with deflation (or decreases with inflation), while the borrower's pay-off increases with inflation (or decreases with deflation), both for a given i and Ω. Notice also that, while the borrower's pay-off has a LOWER-bound (equal to zero) which is reached when bankruptcy occurs, the bank's pay-off has an UPPER-bound (equal to Ω) which is also reached when bankruptcy occurs.

It is clear from the figure why the bank is worse-off (and the borrower is better-off) when there is a higher volatility of nominal shocks. Thus, while the borrower's pay-off is a convex function of M_t/M_{t+1}, the bank's pay-off is a concave function of the same variable. Indeed, an increase in the variance of M_t/M_{t+1} will make the bank worse-off and the borrower better-off.

FIGURE 1



3.2 *The Demand for Credit*

It follows from equation 2 above that expected profits for firm i are a decreasing function of the expected real return charged by the bank, R. In fact, the derivative of expected profits in equation 2 with respect to R is given by:

$$E_R(\,) = L\left(\int_0^{\infty} F(R\Sigma K/\delta)\,(\Sigma K/\delta)\,g(z)\,dz - 1\right) \tag{5}$$

$$= L\,(\,\Sigma K\,E\{\,F(R\Sigma K/\delta)\,(1/\delta)\} - 1) < 0$$

which is less than zero because of the fact that $E(1/\delta)=1/K\Sigma$ and because $0 \le F(\,) \le 1$. Therefore, the higher is R the lower is the number of potential investors or firms who will apply for a loan. For a given R, investors will apply for a loan only if expected profits are positive, or alternatively, only if ε_i is less than the first term in equation (2) above. This implies a negatively sloped demand for credit.

Notice also that (2) can be written as follows:

$$E(\text{profits firm } i) = L\left[(\Omega^{max} - R) - E[H(\delta)]\right] - \varepsilon_i \tag{2'}$$

where $H(\delta)$ is given by $H(\delta) = \int_{R\Sigma K/\delta}^{\infty} F(x)\,dx$

It is easy to show that $H(\delta)$ is concave in $(1/\delta)$ and, therefore, expected-income is a convex function of $(1/\delta)$. It follows that expected profits for the firm increases with uncertainty about inflation, i.e., a mean-preserving spread (m.p.s) on the p.d.f. of $(1/\delta)$ –in the sense of Rothschild and Stiglitz (1970)– increases the expected profits for the firm[5-6].

3. *Equilibrium in Financial Intermediation*

In this model a single financial intermediary emerges as a superior form for intermediating funds, but no investment is required to become an intermediary. (See Diamond (1984) and Williamson (1986), (1987a), (1987c)). Indeed, any agent may become an intermediary if profits are expected to be positive. Therefore, the long run equilibrium condition requires that expected profits in intermediation be equal to zero. This is equivalent to say that the lending-borrowing spread should satisfy the following:

$$L(R-I^*) = M \int_0^\infty F(R\Sigma K/\delta)\, g(z)\, dz + L(1+c) \int_0^\infty \int_0^{R\Sigma K/\delta} F(x)\, dx\, g(z)\, dz \qquad (6)$$

Notice that equation (6) can be written as follows:

$$L(R-I^*) = M\, E\left[F(R\Sigma K/\delta)\right] + L(1+c)\, E\left[J(\delta)\right] \qquad (6')$$

where $J(\delta) = \int_0^{R\Sigma K/\delta} F(x)\, dx$

It is easy to show that $J(\delta)$ is always convex in $(1/\delta)$, while $F(R\Sigma K/\delta)$ is convex in $(1/\delta)$ only for those values of δ such that the slope of $f(x)$ is positive, i.e., $f'(x) > 0$. For other values of δ $F(R\Sigma K/\delta)$ will be concave in $(1/\delta)$.

If we assume that in equilibrium the *expected* real return, R^*, is such that $f'(R^*) > 0$, then we may conclude the following:

(1) If at equilibrium an increase in nominal uncertainty occurs, i.e., a m.p.s. of $g'(1/\delta)$ in the sense of Rothschild and Stiglitz (1970), then the interest-margin charged by the banks should increase.

(2) Countries facing higher nominal uncertainty should also, at equilibrium, show a larger lending-borrowing spread than those countries with lower monetary-inflation variability.

(3) Changes in expected inflation which occur simultaneously with changes in uncertainty about inflation, like reported by Christie (1982) and by Pindyck (1984), will also produce an increase in the (expected) interest margin.

Although the requirement that $f'(x)$ has to be greater than zero is not mandatory for our conclusions to hold[7], this condition will be certainly satisfied in the case of a symmetric distribution where $R^* \leq E(\Omega)$.

Also, notice that if we think of our bankruptcy costs as a special case of monitoring costs, as suggested by Williamson (1987c), then the following is true:

(4) If in our model monitoring costs are zero ($M = 0$) but bankruptcy costs are positive ($c > 0$), then it is *always* true that an increase in nominal uncertainty implies an increase in interest-margins. (The first term on the right-hand-side of 6' disappears).

Finally, it is important to note that our setting is perfectly consistent with an equilibrium where credit-rationing occurs. Indeed, when either bankruptcy costs or monitoring costs are nonzero, the expected profits for the financial intermediary will

not be monotone-increasing in the real expected return, R. From equation (4) it is easy to verify that the change in expected profits when R changes is given by:

$$E_R = L\left[1 - (1+c)\, \Sigma K \int_0^\infty F(R\Sigma K/\delta)(1/\delta)\, g(z)\, dz\right] - \qquad (7)$$

$$M\, \Sigma K \int_0^\infty f(R\Sigma K/\delta)(1/\delta)\, g(z)\, dz$$

from where it follows immediately that there is some R^*, $0 \leq R^* \leq \infty$, such that the expected profits for the financial intermediary are maximized[8]. If at this rate R^* the number of firms applying for a loan is large enough, then the equilibrium might result in credit-rationing. (See Stiglitz and Weiss (1981)).

3.4 *An Example*

Here we consider a particular case of the one mentioned above, i.e., one where monitoring costs are zero ($M = 0$) but bankruptcy costs are not ($c > 0$). Again, we can think of bankruptcy costs in our model as part of the monitoring costs in Williamson (1987c).

When $M = 0$ and $c \neq 0$ the long run equilibrium condition in the intermediation activity (equation 6') can be written as follows:

$$I^* = R - (1+c)\, E\, \{J(\delta)\} \qquad (6'')$$

where $J(\delta)$ is defined above. This relation is drawn in the second cuadrant of figure 2 as the function R-I. Notice that this function is increasing in R, reaches a maximum at R_A^{**}, and then decreases with R, where R_A^{**} is the expected real return which maximizes expected profits for the financial intermediary. (R_A^{**} is obtained from equation 7). Notice that the interest-margin (or lending-borrowing spread) can be measured as the distance between the R-I function and the 45° line in the second cuadrant of the figure.

In the fourth cuadrant of figure 2 the supply of loanable funds is drawn. This is an increasing function of I^*, the expected return paid to depositors, as we already discussed.

Using the 45° line in the third cuadrant it is possible to obtain the supply of loanable funds offered by the financial intermediary, which is drawn as the function SI_A in the figure. Note that this function is increasing in R for R less than R_A^{**} but decreasing thereafter. (The negatively-sloped section of this curve is drawn only for illustrative purposes, but in fact the financial intermediary will never charge a return higher than R_A^{**}).

The equilibrium is obtained where the demand for loanable funds equals the supply for loanable funds, if and only if $R_{EQ} \leq R_A^{**}$ (which is the case of D_0 in the figure), or at R_A^{**} with credit rationing if the demand is large enough (which is the case of D_1 in the figure). In the latter case the amount of rationing may be measured as the difference between the supply and the demand at R_A^{**} ($L_{D1} - L_{MAX}$ in the figure).

An increase in nominal uncertainty, i.e., a m.p.s in g'(1/δ) in the sense of Rothschild and Stiglitz, will have the following effects:

(1) The long-run equilibrium condition in the intermediation activity will shift to the right because of the convexity of J(δ). This is shown as the shift from R-I towards R-I' in figure 2.

(2) The optimal return charged by the financial intermediary, R^*, will either increase or decrease depending on the concavity or convexity of $F[R\Sigma K/\delta](1/\delta)$ in equation (7) with respect to $(1/\delta)^9$. In figure 2 we assumed that the latter is true. This is shown as the fall from R_A^{**} to R_B^{**} in figure 2.

(3) The demand for loanable funds will shift to the right because of the convexity of expected profits for investors, as we already discussed above. This effect is shown in figure 2 as the shift from D_0 to D_0' (or D_1 to D_1').

The final effect of (1), (2) and (3) on the equilibrium return and the availability of credits is summarized below.

(A) If the optimal return charged by the financial intermediary (R^*) *decreases*, then the following applies:

(A.1) If credit rationing initially existed, then a m.p.s in g'(1/δ) will make loans even more scarce and the equilibrium interest rate, $R_{EQ} = R_B^{**}$, will decrease. This may be shown in panel A of figure 3 as the old equilibrium occurring along AB, and the new equilibrium occurring along DE but to the right of the previous one.

(A.2) If credit rationing did not exist initially, and credit rationing does not occur at the new equilibrium, then the new equilibrium return (R_{EQ}) will be higher than the old one, but the number of loans granted will be either larger or smaller than the previous one. This corresponds in panel A of figure 3 as the new equilibrium occurring along OC with the old equilibrium occurring along OF.

(A.3) If credit rationing did not exist initially, but credit rationing occurs at the new equilibrium, then both, the new equilibrium return (R_{EQ}) and the number of loans granted, will be either larger or smaller than the previous figures. This corresponds in panel A of figure 3 as the new equilibrium occurring along CDE and the old equilibrium occurring along OFA.

(B) If the optimal return charged by the financial intermediary (R^*) *increases*, then the following applies:

(B.1) If credit rationing initially existed, then the new equilibrium will be with a higher return ($R_{EQ} > R_A^{**}$) and with a smaller number of credits granted. However, at the new equilibrium credit rationing may not exist. This corresponds, in panel B of figure 3, as the old equilibrium occurring along AB and the new equilibrium occurring along FCDE.

(B.2) If credit rationing did not exist initially, then at the new equilibrium R_{EQ} will be higher, credit rationing may not occur, and the amount of credit intermediated may be either larger or smaller than at the initial equilibrium. This corresponds,

in panel B of figure 3, as the old equilibrium occurring along OA and the new equilibrium occurring along OFCDE (although the new equilibrium will always be above the original one).

(C) The only general conclusion (i.e., the one which does not depend on whether R^* increases or decreases) is that the interest-margin (or spread) enlarges with the increase in nominal uncertainty.

FIGURE 2

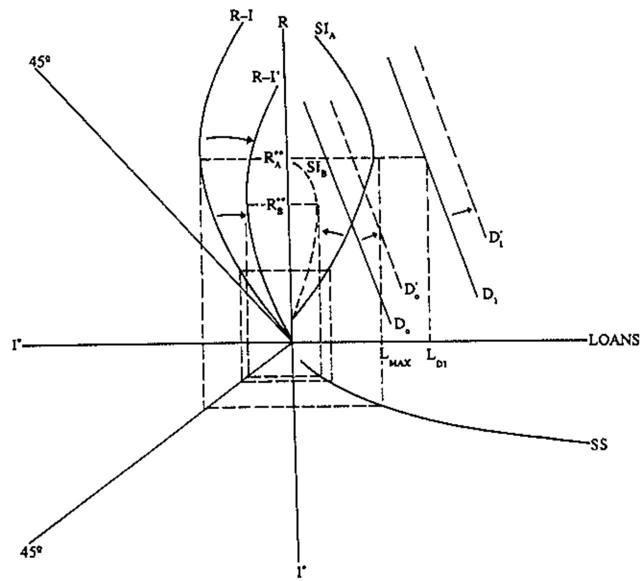
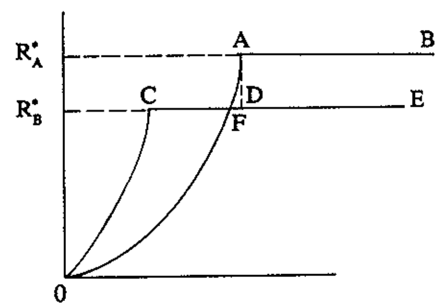
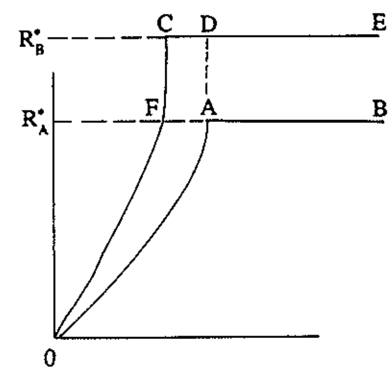


FIGURE 3

(A)



(B)



3.5 *Additional Remarks*

Before closing this section some remarks are in order. First, an interesting result of our analysis is that a mean-preserving-spread in $g'(1/\delta)$ may cause either an increase or a fall in the equilibrium (expected) gross-real return, R^*. This result complements one of the results in Williamson (1986) and (1987a), where a m.p.s in $f(x)$ –the distribution of returns on the investment project– causes an increase in the equilibrium return, R^*.

Second, it is important to mention that the increase in the lending-borrowing spread we just analyzed occurs because of the higher probability that a large deflation –and therefore more bankruptcies– might occur. Thus, the non-failing firms have to pay a higher return in order to allow the bank to compensate for having larger losses when a larger deflation occurs. It is worth mentioning that the existence of an options (or futures) market, where the bank can buy insurance against future (unexpected) inflation, doesn't destroy the main result of the paper. In fact the bank is selling a put option to the borrower (recall the pay-off functions in section 3.1) and charges a fee in terms of a larger spread. By using an options market the inflation risk will be transferred to a third party, but this agent (whoever he is) will also charge a fee to the bank in order to provide the insurance.

Third and most important, notice that the previous analysis fails if we assume now that indexation becomes costless, i.e., that the financial intermediaries are able to issue indexed debt costlessly. Also, the assumption that indexation is costly is not fully consistent with our one-good economy model.

Nevertheless, the rationale for this assumption is based on the observation that in real life indexation is not very common. In fact it doesn't exist in many countries where, like the U.S., inflation has been low and stable for many years. Furthermore, in many countries where it exists it has shown to be a problem for stabilization purposes[10]. Thus, one of the (social) costs of indexation concerns the fact that, from a macrolevel perspective, it seems to impose some rigidities to the economy.

From a microlevel perspective and much more related to our problem, the main issue has to do with the fact that there is no unique price index to rely on for indexation purposes. In fact, whenever there is more than one good in the economy, there is an infinite number of price indexes to which debt contracts can be tied to, and each one of them presents the problem of being a measure of a relative price change in addition to an aggregate price increase (or decrease).

Although there is a unique *theoretical* aggregate price level, it is almost impossible we can really measure it, i.e., it is very costly to do so. The latter is particularly true in a dynamic setting where the patterns of consumption and production are allowed to change from one period to the next. Therefore, any price index we can actually use will only be a *proxy* for the right one. Notice also that in order to measure any of these proxies we have to spend resources doing surveys in the marketplace. Furthermore, as long as every contract is tied to the same price index, a non-diversifiable risk appears which is related to the quality of the chosen index. That is, if the chosen index is a bad *proxy* for the right one, the changes in relative prices (that are zero in the theoretical index) will be the source of an additional non-diversifiable risk[11].

All these remarks concerning indexation, although not fully related to our one-good economy model, provide the rationale for assuming the existence of indexation costs.

Finally, notice also that in our model the increase in the lending-borrowing spread may be large enough to compensate for the cost of writing indexed contracts, ß. When

this is the case, the financial intermediary will offer an indexed contract to lenders and borrowers. This result might help to explain why indexed contracts are observed only in some countries or only for long-term contracts.

4. **Empirical Evidence**

The theoretical analysis in the previous section indicates that an increase in nominal uncertainty should be reflected in a higher lending-borrowing spread. In this section we analyze this hypothesis by studying a sample of 43 countries during the 1980's and/ or early 1970's. The list of all the countries (with their specific periods) included in the sample is given in the appendix.

For each country we calculated the average spread and the standard deviation of money-growth and inflation during the sample period. All data was obtained from IFS tapes on a quarterly basis and then annualized. Inflation was computed as the percentage-change in the Consumer Price Index (line 64) and money-growth as the percentage change in M1 (line 34). The spread was computed as the difference between the lending-rate (line 60p) and the deposit-rate (line 60l).

Because our model does not provide us with any specific functional form or equation for the relationship between nominal uncertainty and the spread, we proceed by testing for a very general positive relationship between these two variables. Table 1 presents the results of four tests of this sort. The first test strongly rejects the null hypothesis that the correlation coefficient (Rho) is zero when both variables (the spread and our measure for nominal uncertainty) are jointly-normally distributed. The second test obtains the same conclusion when correcting for the small-sample problem, i.e., when using a t-student statistic rather than the standard normal distribution. Notice that the rejection is even stronger when using inflation as a measure of nominal uncertainty than when using money-growth.

The third and fourth tests are less restrictive because they do not assume a binormal distribution. The third test concerns Spearman's Rank-Correlation coefficient while the fourth concerns Kendall's Rank-Correlation coefficient. Again we find a strong rejection of the null hypothesis that both variables are not positively related. However, when using Kendall's test the rejection is even stronger in the case of money-growth than in the case of inflation.

Table 2 presents the average spread and the standard deviation of money-growth and inflation for a selected group of countries during specific sub-periods. These countries were selected based on availability of data. Notice that, when using money-growth as our measure for nominal uncertainty, in only one case out of seven (i.e., the United Kingdom) an increase (decrease) in average-spread does not occur with an increase (decrease) in nominal uncertainty. The case when using inflation as a measure for nominal uncertainty behaves as expected only in the case of Israel, Japan (period 3), and the United Kingdom.

In sum, the empirical results partially support our hypothesis, and particularly so when using money-growth as a proxy for nominal shocks. However, in order to perform a more specialized test of our hypothesis a particular functional form would be required.

TABLE 1

RELATIONSHIP BETWEEN AVERAGE SPREAD (S)
AND NOMINAL UNCERTAINTY (NU), 43 COUNTRIES

	St.Dev.Inflation	St. Dev.Money-Growth
Correlation Coeff. $\sigma_{S,NU}$ (Rho)	0.683	0.372
TEST 1		
$Z \sim N(0,1)$	4.427	2.409
Mg. Sig. Level	0.000	0.008
TEST 2 (Small-Sample Problem)		
$T \sim t$ (41 d.f.)	5.988	2.564
Mg. Sig. Level	0.000	0.005
Spearman's Rank Correlation Coeff. (θ)	0.495	0.575
σ_θ	0.154	0.154
TEST 3		
$Z \sim N(0,1)$	3.207	3.726
Mg. Sig. Level	0.000	0.000
Kendall's Rank Correlation Coeff. (γ)	0.290	0.397
$R = P - Q$ [a]	262	359
$N(N-1)1/2$	903	903
σ_R	95.55	95.55
TEST 4		
$Z \sim N(0,1)$	2.731	3.746
Mg. Sig. Level	0.003	0.000

Notes: a/ P and Q are the summation of all the observations which are "correct" and "wrong" in the rank-ordering of the second series respectively. Kendall's statistical test is based on R rather than γ.

TABLE 2

AVERAGE SPREAD AND NOMINAL UNCERTAINTY

	Selected Countries				
Country	N	Period	Spread	$\sigma_{inf.}$	$\sigma_{money\text{-}growth}$
Australia					
	29	76:3-83:3	2.096	3.993	20.34
	22	84:1-89:2	5.776	3.062	24.76
Germany					
	14	77:4-81:1	4.010	2.900	19.58
	29	81:4-88:4	5.257	2.053	20.86
Greece					
	73	61:2-79:2	2.891	11.97	33.12
	36	80:3-89:2	5.867	10.11	58.85
Israel					
	8	84:1-85:4	354.6	194.2	201.6
	11	86:1-88:3	38.53	8.100	120.4
Japan					
	31	57:2-64:4	3.989	4.715	44.68
	20	74:1-78:4	3.753	9.228	29.37
	34	81:1-89:2	3.380	2.914	19.99
Sweden					
	43	70:2-80:4	3.800	4.866	30.24
	24	81:1-86:4	4.946	3.559	314.6
U. Kingdom					
	14	66:4-70:1	0.893	3.653	16.19
	28	81:2-88:1	3.490	4.626	10.10

5. Conclusions

This paper presents an overlapping generations model where economic agents live for two periods. In this model borrowers and lenders sign nominal contracts with a unique but very large financial intermediary who faces nominal uncertainty. The possibility of a bank failure, due to an unexpected negative nominal shock (i.e.,deflation), translates into a larger banking spread. The main conclusion of the paper is that a mean-preserving-spread in the distribution of nominal shocks, in the sense of Rothschild and Stiglitz (1970), should increase the spread charged by large and well diversified financial intermediaries. The empirical evidence presented in section 4, although based on simple sample correlations, supports this hypothesis. A more specialized empirical test would require of a more specialized model, which should be the task of future research.

APPENDIX

COUNTRIES AND PERIODS INCLUDED IN THE SAMPLE

Country	Period	Nº observations
Argentina	85:3-86:3	5
Australia	84:1-89:2	22
Canada	81:4-89:2	31
Chile	78:2-84:3/85:1-88:3	41
Costa Rica	82:2-89:2	29
Denmark	80:3-89:3	37
Finland	81:2-89:2	33
France	82:1-89:3	31
Germany	81:1-89:2	34
Greece	80:1-89:2	38
Netherlands	82:1-88:4	28
Iceland	83:3-89:3	25
Indonesia	86:4-89:1	10
Ireland	79:3-89:2	40
Israel	86:1-88:3	11
Italia	82:4-84:4/85:2-89:2	26
Jamaica	80:2-86:4	27
Japan	81:1-89:2	34
Kenia	82:1-86:4	20
Korea	81:1-84:4/88:4-89:3	20
Lesotho	81:1-83:4	12
Malta	77:2-82:4/84:1-89:2	45
Malawi	80:2-89:2	37
Malaysia	80:1-80:4/82:4-84:4/85:2-87:4/88:2-89:2	29
Mexico	82:1-82:4/83:3-84:4/88:1-88:1	11
Morocco	78:4-85:1/86:2-88:4	37
Neth. Antilles	84:2-89:1	20
Nigeria	80:2-87:4	31
Norway	81:1-85:4	20
Philippines	79:1-80:2/81:4-88:4	35
Portugal	80:2-83:4	15
South Africa	83:1-89:2	26
Singapore	78:2-83:4/84:2-89:2	44
Spain	82:2-89:2	29
Sweden	81:1-86:4	24
Switzerland	82:2-88:4	27
Tanzania	82:4-86:1	14
Thailand	82:2-89:1	28
Turkey	79:2-81:2/85:1-87:4	21
United Kingdom	81:1-88:1	29
Uruguay	81:4-85:3	16
USA	82:2-89:3	30
Yugoslavia	82:2-88:2	25

Notes:

1 This assumption does not play any significant role in our analysis. In fact it could be assumed that all households have no specific alternative riskless technology for investment, and that the endowment is either perishable (H_j is zero for all j) or non-perishable (H_j is equal one for all j). It is included just for the sake of completeness.

2 The return of money is equal to one plus the change in the purchasing power of money.

3 Latter we will be using $(1/\delta)$ rather than δ as the relevant stochastic variable.

4 This is true because of the specific form assumed for the bankruptcy costs. A different specification for this costs (e.g. a nominal component) would imply some (i.e., negative) relationship between the level of inflation and the spread. The same conclusion may apply when considering reserve requirements.

5 We use $(1/\delta)$ rather than δ as the relevant stochastic variable because we need to satisfy $E(1/\delta) = 1/\Sigma K$. This will be satisfied when we consider a m.p.s in the p.d.f of $(1/\delta)$. On the other hand if we were to use δ, then a m.p.s in $g(\delta)$ would increase $E(1/\delta)$ because $(1/\delta)$ is a convex function of δ. This would imply that Σ would have to decrease and could not be considered as a constant.

6 Let $g'(1/\delta)$ and $G'(1/\delta)$ denote the p.d.f and the c.d.f of $(1/\delta)$ respectively.

7 The precise condition is that $f'(x) > -L(1+c)M^{-1}f(x)$, which is more likely to hold for a large L (and c) and a small M.

8 We are assuming that $L > M f(x)$ for $x = 0$. Also, it is assumed that expected-profits for the bank is a concave function of R. This is equivalent to say the following:
$E[f'(R\Sigma K/\delta)(1/\delta)^2] > -L(1+c)M^{-1}E[f(R\Sigma K/\delta)(1/\delta)^2]$.
Notice that this always hold for the case $M = 0$.

9 Notice that the first order condition in equation (7) can be written as a negative function of the expected value of $H(\delta) = F[R\Sigma K/\delta](1/\delta)$, which is either a concave or a convex function of $1/\delta$. This depends on $f'(x)$ being smaller or larger than $-2f(x)x^{-1}$.

10 The recent experiences in Latin America prove that indexation enlarges the transition period from a high to a low inflation (and sometimes it even forces the abandonment of the whole stabilization program). (See *World Development*, Vol. 13, N°8, 1985, and references therein).

11 Several pieces of evidence have been provided in the literature showing that the volatility of relative prices increases with inflation and inflation volatility. (See the references in Hernández, 1990).

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ECONOMIC GROWTH AND INCOME DISTRIBUTION IN CHILE: MACROECONOMIC TRADE-OFFS REVISITED*

ANDRES SOLIMANO**
The World Bank

Abstract:

Long run sustainable development requires both sustained growth and an equitable distribution of the fruits of growth and modernization. This paper analyzes the issue of maintaining the dynamic growth momentum of the Chilean economy while at the same time reducing poverty and improving income distribution patterns. The paper identifies the major constraints on growth for the Chilean economy and develops a macro model to explore and quantify potential trade offs between growth, poverty reduction and distribution.

The model is calibrated with parameters for the Chilean economy and used to examine the effects of various macro policies with distributive content. For example the model shows that an unbalanced increase in government spending (in social sectors) of 3 percent of potential GDP, will slow down the rate of growth of GDP by 1 percent, the real exchange rate appreciates (5.4 percent) and real wages rise (4.4 percent) in a capacity constrained-growth regime. The cut in government savings is the driving force behind the deceleration in growth, given a certain current account deficit. The adverse side effect on growth of the social program can be avoided with an increase in taxation or a reduction in other public spending items in order to prevent a decline in public savings.

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