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Financial Crisis in Developing Countries and Structural Weaknesses of the Financial System

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Abstract

This paper examines the generation of financial crises in developing economies and shows that the microeconomic structure of the financial sector is a crucial factor in creating the conditions for a crisis. Structural problems of the financial system in developing countries, including implicit insurance on bank liabilities, limitations of capital markets, and lack of appropriate regulations, are sources of financial fragility. The paper concludes that close supervision of bank loans is needed to eliminate these distortions, and the optimal intervention consists of imposing an adjustable bankruptcy penalty on banking activity or charging a fair insurance premium on bank liabilities.

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Contents

I. Introduction

This paper studies, mainly from a theoretical point of view, the generation of financial crises in developing economies. Financial crises consist of a series of events including the failure of banks, the substantial reduction of asset values, widespread over-indebtedness and international capital flight. Financial crises in developing countries can be considered a leading cause of recessions, and of disruptions in the intermediation of savings, with adverse consequences for long-run economic growth. It is generally accepted that these crises arise from macroeconomic instability created by exogenous shocks or policy inconsistencies. 1/

The purpose of this paper is to show that deficiencies of the microeconomic structure of the financial system create the conditions for excessive risk-taking by banks, thus increasing the probability of a financial crisis. The structural deficiencies are aggravated by the liberalization of the financial system, consisting of the simple elimination of interest rate ceilings and credit controls, because several other distortions become relevant as the market repression mechanisms are lifted. These other distortions, including explicit or implicit insurance on bank liabilities, encourage banks to adopt riskier loan portfolios.

The paper concludes that excessive risk-taking by banks is a likely consequence in a liberalized financial system, and that the structural reform to the financial sector should also consider the supervision of bank loans. In theory, bank supervision could be used to preserve the stability of the financial system by imposing effective bankruptcy penalties, or by implementing a system of actuarially-fair insurance premiums on bank liabilities in which the premium is tied to the risk of the loan portfolio.

The plan of the paper is as follows. The next section discusses the characteristics, effects, and origins of financial crises in developing countries, with specific references to some recent experiences. Section III analyzes structural deficiencies of the financial system. Section IV presents a simplified model of financial intermediation to illustrate the problem of bank excessive risk taking resulting from deficiencies in the structure of the financial system. Some concluding remarks are offered in Section V. Alternative solutions to the model of financial intermediation are presented in an Appendix.

1/ Consider, for instance, Friedman and Schwartz (1971) monetary explanation of the Great Depression and King and Plosser (1984) real business cycle hypothesis.

II. Characteristics, Effects and Origins of Financial Crises

This section describes what a financial crisis is, explains what are the consequences of a crisis, and discusses how the crises are generated. The approach taken is primarily theoretical and consists of a review of the literature, although some references are made to recent experiences of financial crises in developing countries. The financial crisis literature can be classified into two categories: first, descriptions of historical episodes, generally lacking theoretical interpretations, and second, theoretical interpretations of various aspects of financial crises. 1/ Experiences of financial crises in developing countries during the 1980's include those of the Southern Cone countries (SCCs) which, after undertaking the liberalization of their trade and financial systems in various degrees and intensities, suffered deep financial crises and serious foreign debt problems. 2/

1. Characteristics of financial crises

There is no concise or precise definition of financial crises, although there are numerous lengthy descriptions of the events that characterize them. Paraphrasing Kindleberger (1978), financial crises are macroeconomic phenomena difficult to define, but recognizable on sight. The main events that characterize them include the failure of banks and other important financial intermediaries, sharp reductions of asset values, including stocks and real assets, widespread over-indebtedness of domestic agents, speculation against the domestic currency, and international capital flight. 3/

Bank failures prompted by runs on deposits, or by deteriorations in the performance of loan portfolios, are characteristic of financial crises. Runs on deposits caused by a loss of confidence in the financial system can lead to bank failures as banks sell their assets at a loss.

1/ Historical descriptions of financial crises can be found in Kindleberger (1978), and Kindleberger and Laffargue (1982). Theoretical interpretations of some aspects of financial crises can be found in Bernanke (1983), Flood and Garber (1981), Diamond and Dybvig (1983) and Minsky (1982). A survey on the subject is presented in LeFort and Vial (1987).

2/ The Southern Cone countries included in this analysis are Argentina and Chile. For an analysis of the macroeconomic policies pursued and of the results obtained by these countries during the late 1970s and early 1980s, see Edwards (1986) and Corbo, de Melo and Tybout (1986).

3/ Financial crises in developing countries are analyzed in Diaz Alejandro (1985) and Massad and Zahler (1988).

Bank failures can also result from an increase in the proportion of non-performing loans and the reduction of real asset values. In practice, Central Bank intervention has prevented bank failures and runs on deposits by backing bank deposits and covering their losses. In the early 1980s in Argentina and Chile, several important commercial banks technically failed and had to be rescued by their respective central banks. A significant proportion of the banks' loan portfolios was non-performing and banks, without central bank assistance, would have been unable to fulfill their commitments with depositors. 1/ Significant reductions in the real value of bank deposit liabilities took place in the SCCs during the financial crisis: time and savings deposits in real terms fell by 17 percent in Argentina in 1982 and by 21 percent in Chile in 1983 (Table 1).

Sharp reductions in real asset values in response to changes in market fundamentals or to the bursting of price bubbles are also characteristic of financial crises. Market fundamentals--the expected future yields of the assets and the relevant discount rates--can be changed by shifts in macroeconomic policy or exogenous shocks. Price bubbles are defined as divergences of asset prices from their fundamental value and are the result of speculative behavior under limited information. During the early 1980s in Argentina and Chile, real stock prices fell sharply by more than 60 percent from their pre-crisis peak value before beginning a partial recovery (Table 1).

The widespread over-indebtedness of domestic agents and the tightening of the liquidity constraints are also characteristic of financial crises. Over-indebted agents cannot obtain regular financing and are unable to realize their savings and investment plans and service their debt on previously agreed terms. The tightening of liquidity constraints forces domestic agents to adjust their investment and consumption levels, to borrow in distress (waiting for an improvement of external conditions), and eventually to declare bankruptcy. In the SCCs, real private sector credit was moderately reduced in years of the crises, but recovered promptly. The ratios of investment to GDP, however, were severely reduced and remained well below their pre-crisis levels. The investment to GDP ratio fell from a peak of 27 percent in the late 1970s to 18 percent in Argentina and from 23 percent to 10 percent in Chile (Table 1).

International capital flight and the external debt problem also characterize financial crises in developing economies. International capital flight is triggered by expectations of falling asset prices and a

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1/ For details on the Argentinean financial crisis, see Balino (1987) and Fernandez (1983). For the Chilean case, see, for example, Arellano (1983), Barandiaran (1983), and Velasco (1988).

Table 1. Southern Cone Countries: Selected Economic Indicators

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
GDP Growth [1]						(Percentage Change)				
Argentina	0.0	-5.9	-2.8	6.7	1.8	-7.1	-3.8	2.0	2.9	-4.7
Chile	3.5	9.9	8.2	8.3	7.8	5.5	-14.1	-0.7	6.3	2.4
Fixed Investment [2]						(Percent of GDP)				
Argentina	27.1	27.2	24.5	23.5	22.7	18.2	18.1	17.9	...	...
Chile	17.8	14.4	17.8	17.8	21.0	22.7	11.3	9.8	13.6	14.2
Current Account [3]						(Percent of GDP)				
Argentina	1.2	2.2	2.8	-0.5	-3.1	-3.8	-4.1	-3.8	-3.2	-1.5
Chile	1.5	-4.1	-7.1	5.7	-7.1	-14.5	-9.5	-5.7	-10.7	-8.3
Real Quasi-Money [4]						(Index 1980 = 100)				
Argentina	60.6	77.7	80.2	93.2	100.0	112.4	93.2	106.9	140.9	61.3
Chile	34.3	44.6	67.7	85.4	100.0	131.8	158.2	124.2	145.4	...
Real Domestic Credit [5]						(Index 1980 = 100)				
Argentina	66.0	84.7	77.9	81.2	100.0	148.7	172.0	189.1	208.1	...
Chile	57.8	70.4	83.1	91.4	100.0	110.2	175.9	154.2	178.3	...
Capital Account [6]						(U.S. $ millions)				
Argentina	...	...	...	4,486	1,890	1,072	-2,335	-2,687	8	-183
Chile	...	...	...	2,141	3,216	4,799	947	-3,168	100	-1,281
Real Stock Prices [7]						(Index 1980 = 100)				
Argentina	...	58.7	65.8	125.4	100.0	48.3	46.3	58.9	57.9	50.5
Chile	...	23.6	46.7	54.0	100.0	80.1	61.0	39.1	39.0	38.2

Sources: For [1] to [6], IMF International Financial Statistics; for [7], Banco Central de Chile, Boletin Mensual, and Indicadores Bursatiles; [4], [5] and [7] were deflated using CPI. The capital account [6] excludes exceptional financing.

depreciating currency. The external debt problem develops as creditors attempt to reduce their exposure because of the perceived deterioration in the domestic agents' ability to pay. Capital flight and the external debt problem amplify the crisis. The reduced availability of foreign credit further depresses asset prices and economic activity, thereby impairing debt-servicing capacity. A large shift in the international capital flows took place in the SCCs during their financial crises. In Argentina, net foreign capital inflows shifted from a net inflow of $4.5 billion in 1979 to a net outflow of $2.7 billion in 1983; in Chile, from a net inflow of $4.8 billion in 1981 to a net outflow of $3.2 billion in 1983 (Table 1).

2. Effects of financial crises

Financial crises result in severe recessions and increase financial intermediation costs. Although some theories postulate the direction of causation running only from the real to the financial sector, the mainstream of macroeconomic schools recognizes a causal relationship from the financial sector to economic activity, at least in the short run. 1/ According to monetary models, a sudden and unanticipated monetary contraction prompts a transitory reduction in economic activity. This monetary contraction induces an unexpected reduction in the price level that is confused with changes in relative prices, causing output to fall. 2/ According to a second group of models, a reduction in the availability of credit also prompts a contraction in economic activity. These models assume that production takes time and that firms finance the purchase of inputs with bank loans. 3/ A financial crisis creates a reduction in credit for the financing of working capital, causing firms to restrict production.

Higher financial intermediation costs reduce the efficiency of the financial system to perform risk-sharing and inter-temporal transactions, resulting in welfare losses as otherwise feasible economic transactions cannot be performed. The higher costs of financial intermediation are the result of the loss of confidence in the financial system, and also of the increase in the cost of gathering information as the crisis distorts the

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1/ According to the real business cycle theory, King and Plosser (1984), recessions and financial crises jointly result from negative productivity shocks.

2/ The monetarist explanation of financial crisis popularized by Friedman and Schwartz (1971) is consistent with this paradigm.

3/ See Cavallo (1981), Van Wijnbergen (1983), Buffie (1984) and Blinder and Stiglitz (1983).

significance of past records. 1/ Severe recessions and sharp reductions in investment were experienced by the SCCs during the early 1980s. In Argentina, GDP fell by 7 percent in 1981 and 4 percent in 1982, and in Chile, by 14 percent in 1982 and 1 percent in 1983. Economic growth over the medium-term was also reduced due to the severe contraction in investment; the investment to GDP ratios fell substantially during the crisis and did not recover their previous levels for several years (Table 1).

3. Origins of financial crisis in developing economies

The principal causes of financial crises in developing countries are macroeconomic shocks and structural weaknesses of the financial system. Macroeconomic shocks deteriorate the financial position of domestic agents and the performance of loan portfolios, and structural weaknesses of the financial system impairs the financial system's resilience to these shocks. Macroeconomic shocks, including exogenous disturbances and policy inconsistencies, can generate wide swings in relative prices that increase the proportion of non-performing bank loans and lead to bank failures. In general, banks have to bear part of the costs suffered by agents that are adversely affected by the relative price change, and that cannot service their debts in previously agreed terms. Exogenous disturbances suffered by the SCCs in the early 1980s include reductions in productivity in key economic sectors; changes in international terms of trade and interest rates; and changes in the availability of foreign financing. 2/ Policy inconsistencies suffered by SCCs in the early 1980s include using the nominal exchange rate as an anti-inflationary instrument, while wages and other prices were indexed to past inflation rates; attempting to stabilize domestic prices while running significant fiscal deficits (only in Argentina); and opening the current and capital accounts of the balance of payments without implementing adequate supportive macroeconomic policies. 3/ Table 1 reveals the wide swings in the real exchange rate and in real domestic demand that took place in the SCCs during the early 1980s.

1/ For an interpretation of economic depressions based on intermediation costs, see Bernanke (1983). For a theoretical analysis of intermediation costs, see Bernanke and Getler (1985).

2/ The concentration of economic activity, and particularly of exports, in few productive sectors, the high levels of accumulated foreign debt, and the lack of financial diversification makes the financial system in developing countries very vulnerable to exogenous disturbances.

3/ For discussions on the macroeconomic policy inconsistencies in the SCCs, see Corbo de Melo and Tybout (1986), Edwards (1986), and Khan and Zahler (1983) and (1985).

There are different views about the structural weaknesses of the financial system. On the one hand, structural weaknesses are considered an inherent characteristic of the financial system in market economies. According to this view, identified as the intrinsic fragility hypothesis, financial institutions are always prone to crises. On the other hand, structural weaknesses of the financial system can be made consistent with rational behavior and linked to limited information, externalities and inadequate incentives and regulations. The intrinsic fragility hypothesis has been defended by Minsky (1982) and Kindleberger (1978). In their view, crises are the result of a mechanistic cycle that gears economic units to increasingly speculative forms of financing, leading to a generalized crisis. 1/ The main problem with this hypothesis is its apparent inconsistency with rational economic behavior. The weaknesses of the financial system can, however, be explained in a setting consistent with rational behavior of economic agents under limited information. The main elements of financial crises, including deviation of asset prices from market fundamentals--speculative bubbles--and runs on bank deposits, have received interpretation consistent with rational behavior. Price bubbles can be treated as the result of speculators attempting to obtain capital gains by anticipating changes in asset prices. 2/ Runs on bank deposits result from the loss of confidence in the soundness of a financial institution. It has been justified on theoretical grounds that even a run on deposits based on an unfounded loss of confidence in a financial institution can be consistent with rationality. 3/ In addition, structural weaknesses of the financial system also result from deposit insurance schemes imposed to ensure the confidence in the financial system. The moral hazard effect of deposit insurance schemes leads to excessively risky loan portfolios that increases the probability of bank failures. 4/ Finally, limited equity markets are also sources of financial fragility as the financing of domestic agents is concentrated in bank loans; thus, the flexibility of the system to respond to macro-economic shocks is reduced.

1/ Minsky (1982) presents the financing of units in a market economy evolving, over a cycle, from low risk and liquid financial position (hedge finance) to a risky and fragile position (speculative finance) and finally to an unsustainable financial position (Ponzi finance) that will ultimately collapse into a crisis.

2/ For a formal analysis of rational speculative bubbles, see Blanchard and Watson (1982) and Flood and Garber (1980).

3/ See Diamond and Dybvig (1983) and Flood and Garber (1981).

4/ See Solow (1982), Dooley and Mathieson (1987).

III. The Structure of the Financial System in Developing Countries

There are several structural problems that affect the financial systems of developing countries. Deposit insurance schemes, including those in which the insurance is not explicit but agents expect that the government will bail depositors out in case of a crisis, foster excessive risk-taking by insulating the cost of financing loans from the risks of the loan portfolio. Limitations of the capital markets, including their narrowness and thinness, reduce the possibilities of risk-sharing and affect the stability of the financial system. Finally, the lack of adequate rules and regulations to allocate losses that may arise under different contingencies leaves ample room for government discretion, that in turn leads to resource misallocation and wrong signals for the future operation of the system. The deregulation of the financial system in several developing countries during the 1970's did not eliminate these structural problems. Indeed, the experience of the Southern Cone countries suggests that financial liberalization produced unexpected results even though the level of financial intermediation significantly increased. The real interest rate jumped to extremely high levels as financial activity involving excessive risks increased sharply, resulting in the collapse of an important portion of the financial system. 1/

1. Externalities and insurance schemes

The externality derived from the public confidence in the financial system has led to the provision of deposit insurance to prevent runs on deposits. Even when an explicit deposit insurance scheme has not been established, economic agents have counted on an implicit central bank guarantee for the full amount of their deposits. The social costs associated with financial crises justify the government intervention in the event of failure of a financial institution, and provide rationality of expecting such intervention. In addition, after the crisis of the 1930s, the strong link between financial crisis and economic activity became evident and many governments began to fully insure deposits of failing financial institutions to prevent any further erosion in the public's confidence in the financial system. 2/ This intervention can

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1/ Financial deregulation in the Southern Cone, which followed the financial liberalization proposals of McKinnon (1973) and Shaw (1973), basically consisted of the elimination of interest rate ceilings and government controls in credit allocation, and the reduction of reserve requirements.

2/ Kindleberger (1978) and Solow (1982) provide examples of government intervention in such cases. Diaz Alejandro (1985) discusses government backing of financial institutions in developing countries.

be considered a compensatory distortion; the loss of confidence in the financial system is critical in both creating a crisis and in determining its intensity and duration. 1/

In developing countries foreign credit to private financial institutions has, in practice, exhibited a remarkable similarity with domestic deposits in this respect. Reductions in the ability of local borrowers to service their commitments increase the "country risk" perceived by foreign creditors, making foreign credit more scarce and more expensive. In the event of failure of an individual local borrower, the increase in "country risk" changes the perceived ability to pay of the country as a whole. This externality could be considered among the factors that has led some developing countries to implicitly insure foreign credit to private financial institutions, and to give ex-post explicit public sector guarantees to private foreign debt.

The provision by the public sector of implicit or explicit insurance for local deposits and foreign credit of domestic financial institutions results in a moral hazard problem. Insurance schemes isolate local depositors and foreign creditors from the risks taken by local banks in their loan portfolio, leading to excessive risk-taking by financial institutions, distortions in the allocation of credit, and to a higher probability of a financial crisis. 2/

2. Limitations of the equity markets

A second source of structural fragility of financial systems consist of the limitations of the equity markets. These limitations reduce the ability of the financial system to perform risk-sharing activities and increase the relative importance of banks' deposits and loans in financial intermediation. The equity markets in developing countries lack diversity of financial instruments, the amount of resources invested is relatively small, and nominal and real asset prices fluctuate widely. In Argentina and Chile, real stock prices showed wide fluctuations in the period 1975-85. In Argentina, the monthly average real stock price index

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1/ As an alternative to the provision of deposit insurance, Henry Simons (1948) proposed a financial system divided into investment units, where deposits receive a variable and uncertain yield, and deposit institutions subject to 100 percent reserve requirements. In the context of Islamic banking, a similar system of equity-based banking is proposed. See Mohsin Khan (1986).

2/ Solow (1982) discusses the moral hazard problem in financial systems where a lender of last resort stands ready to bail out banks in trouble. Zahler and Valdivia (1987) discusses the asymmetries of the risk of financial sector liabilities and assets in developing countries.

(represented as a percentage of the sample mean) fluctuated from a minimum of 31.4 to a maximum of 258.6. In Chile, the monthly average stock price index fluctuated from 7.5 to 235.1. (Table 1).

Among the hypotheses used to explain the limitations of the capital markets are the distortions imposed by the tax system, and the asymmetries of information between managers and external equity holders. The incentives for holding equity are largely reduced by a tax system that imposes a heavier levy on equity returns than on deposit returns. First, because equity returns are subject to double taxation--corporate taxes and personal income taxes--and second, because the degree of income tax evasion is larger for deposit returns than for equity returns. In most developing countries banks are not required to report to the tax authorities their interest payments to individuals, while the distribution of profits by corporations and the stock transactions must be reported.

The information asymmetry between managers and outside equity holders is aggravated in developing countries where government controls and restrictions are widespread. In these economies, illegal or quasi-illegal transactions--including tax evasion, dealings in parallel foreign exchange and credit markets, and smuggling--are common and profitable practices. Under those conditions the public accounting systems of firms do not convey accurate and relevant information. This widens the information asymmetry and reduces the incentives to hold equity. Moreover, when firms are involved in illegal activities, equity holders have an incentive for limiting the dissemination of information about their operations. This information asymmetry is also an incentive for the development of economic conglomerates which allow a group of investors to keep control over several firms while reducing risks by diversifying the activities within the group.

3. Financial system regulations

The regulations imposed on financial systems in developing countries leave ample room for government discretion in the event of a crisis. The use of government discretion to solve conflicts and allocate eventual losses leads to misallocation of resources, and sends wrong signals for the future operation of the system. The reliance on governmental discretion fosters rent-seeking behavior of private agents, which in turn, is a source of inefficiencies in the allocation of resources. The lack of rules to be applied in the event of a crisis can also jeopardize the future operation of the system by leaving unpunished the decisions and actions that were the cause of bank failures. 1/ In Chile, after the financial crisis private debtors received subsidies from the Central Bank

1/ See Barandiaran (1987) for a discussion on this subject.

through the conversion of dollar-denominated debt into peso-denominated debt at a preferential exchange rate. In addition, private sector debtors received credit from the Central Bank at below-market interest rates. In Argentina, the Central Bank subsidy to private debtors was given through the fixing of nominal interest rate while inflation accelerated.

The control of financial institutions by economic conglomerates creates distortions in the allocation of credit as financial institutions become agents of the debtors. A socially efficient financial system requires financial institutions to act as agents of depositors in the process of finding adequate borrowers and establishing a well-diversified loan portfolio. 1/ The control of financial institutions by the debtors, generally by economic conglomerates, results in excessive risk-taking by the financial institution and in a concentration of the loan portfolio in loans to the conglomerate. The failure to regulate such activity characterized the pre-crisis financial systems in the Southern Cone countries. In Argentina and Chile, several banks were controlled by conglomerates that used them as a source of financing for the group, resulting in a loan portfolio that was riskier than normal. 2/

IV. A Simple Model of Financial Intermediation

In this section we specify a simple model of financial intermediation in a developing economy to illustrate the problems arising from government insurance of bank liabilities (local deposits and foreign credit). The model considers two periods and rational optimizing agents including a representative consumer, a representative financial institution, a representative foreign bank, and M firms. An additional agent is the government whose behavior is not explicitly modelled. However, economic agents expect the government to intervene in the event of bankruptcy of the domestic financial institution, and to effect the transfer of resources needed to fulfill all commitments of the failing institution. The model shows that under those conditions the unrestricted banker's optimization leads to distortions in credit allocation and excessive risk-taking by the bank. The optimal credit allocation is obtained when the expected marginal productivity of capital in all the M sectors is equal to the expected rate of return of deposits. This optimal credit allocation can be reached using corrective policies based on the external supervision of the bank loan portfolio. Theoretically, an external supervisory agency can eliminate the distortions by imposing a bankruptcy penalty equal to the expected value of the bank losses, or by charging an actuarially fair insurance premium on bank liabilities.

1/ See Diamond (1984), and Baltensperger (1980).

2/ See Arellano (1983), Balino (1987), and Diaz-Alejandro (1985).

The main assumptions of the model are the following:

(a) The firms' managers are risk-neutral and maximize expected profits by investing in a single risky project that give yields in the second period.

(b) Information costs prevent firms from seeking direct financing and firms are completely financed by loans of local banks. The firms cannot obtain insurance against productivity shocks.

(c) The consumer is risk-averse and maximizes inter-temporal utility, selecting present consumption and holdings of local and foreign deposits.

(d) The elementary utility function is quadratic.

(e) The foreign banker is risk-neutral and the alternative cost of funds is given.

(f) The representative local banker is risk-neutral, and banking is a competitive activity. The banker maximizes expected profits by selecting a portfolio of loans to the M firms and a composition of financing between local deposits and foreign credit.

(g) The representative local bank has no equity and is completely financed by local deposits and foreign credit.

(h) The government imposes lump-sum taxes and effects transfers so as to insure local deposits and foreign loans.

1. Production, consumption and bank financing

Production activity takes time and has an uncertain outcome, it is performed by M different firms ($i=1,\ldots, M$) using a single input K_i (working capital). The production function (equation (1)) is twice differentiable, K_i represents firm's "i" purchase of inputs in the first period and Y_i represents firm's "i" output obtained in the second period. The production process is subject to random shocks that can wipe out the entire output of a firm. The supply shocks (Φ_i) in equation (2) can take a value of one or zero with probability Π_i and $1-\Pi_i$, respectively, and are independent across sectors.

$$Y_i = f_i [K_i] \Phi_i \quad (i=1,\ldots, M) \tag{1}$$

$$\Phi_i = \{1, 0; \Pi_i, 1-\Pi_i\} \tag{2}$$

Firms maximize expected profits subject to the restriction that working capital (K_i) is completely financed with bank loans (L_i). The demand for bank loans is obtained through equalizing the marginal productivity of working capital ($f'[K_i]$) with one plus the interest rate charged on loans (R_i). If the production process of firm "i" succeeds, profits of firm "i" would equal the excess of output over bank repayments. If the production process fails, profits would be equal to zero and the bank would lose the whole amount lent to firm "i". Providers of inputs would always receive their contractual payment because they are paid before the result of the production process is known using the proceeds of the loans.

$$FP_i = (f_i[K_i] - R_iL_i,\ 0;\ \Pi_i,\ 1-\Pi_i) \tag{3a}$$

$$R_i = f_i'[K_i]\ ; \tag{3b}$$

$$L_i = K_i \tag{3c}$$

The representative consumer maximizes expected utility by allocating initial wealth (W1) to present consumption (C1) and to holdings of local deposits (D) and foreign assets (F). The returns of deposits and foreign assets and non-interest income are used to finance future consumption (C2). Equations (4a) and (4b) below represent the budget constraint for each period where W1 is initial wealth, R_D represents the contractual payment of local deposits (one plus the interest rate), R_F is one plus the interest rate paid on foreign deposits, and I is non-interest income. 1/ Equations (4c) and (4d) represent the expected value and variance of future consumption. 2/

1/ Non-interest income is equal to payments to the providers of inputs plus profits of firms and banks. Formally, non-interest income is equal to:

$$I = \sum_{i=1}^{M} Y_i - (R_D - 1)*D - (R_{FC} - 1)FC$$

where FC represents foreign credit to local banks. National income includes, in addition, the proceeds from local and foreign deposits ($(R_D-1)D+(R_F-1)F$). It is assumed that payments to the providers of inputs are executed at the beginning of the second period.

2/ The expected value of variable X is represented by $[X]^e$, its variance by $S^2[X]$, and the covariance of variables X and Z by $S[X,Z]$. $[R_D]^e$ is the expected rate of return of local deposits and $S[R_D,R_F]$ the covariance of the returns of local and foreign deposits.

$$C1 = W_1 - (D + F) \tag{4a}$$

$$C2 = R_D D + R_F F + I \tag{4b}$$

$$[C2]^e = [R_D]^e D + [R_F]^e F + [I]^e \tag{4c}$$

$$S^2[C2] = D^2 S^2[R_D] + F^2 S^2[R_F] + S^2[I] + 2(DF\, S[R_D, R_F] + D\, S[R_D, I] + F\, S[R_F, I]) \tag{4d}$$

The optimal asset holding is reached when the expected return of each asset, corrected for risk, equals the subjective marginal rate of substitution of expected future consumption and present consumption. The correction for risk depends on the degree of absolute risk aversion (ARA) and on the marginal contribution of each asset to the variance of future consumption ($S[C2]_D$, $S[C2]_F$). 1/ The marginal rate of substitution between expected future consumption and present consumption depends on the rate of time preference (δ) and the ratio of marginal utilities (MRS). 2/ This result was obtained using a mean variance approach according to which expected utility is a function of present consumption, and the expected value and variance of future consumption. 3/

$$R^e_D - ARA\ \ S[C2]_D = (1+\delta)\ MRS \tag{5a}$$

$$R^e_F - ARA\ \ S[C2]_F = (1+\delta)\ MRS \tag{5b}$$

$$[U]^e = (1+\delta)\ v(C1) + v([C2]^e) + v''(C_2)\ S^2[C2]/\ 2 \tag{5c}$$

1/ The ARA, defined as $ARA = - v''([C2]^e) / v'([C2]^e)$, is the Pratt (1978) degree of absolute risk aversion evaluated at expected consumption level, $v([C2]^e)$ is the elementary utility function evaluated at expected consumption for the second period, $v'[C2]^e$ is the marginal utility, and $v''[C2]^e$ the second derivative.

2/ Given by $MRS = v'(C_1)/v'(C^e_2)$, where $v'(C1)$ and $v'([C2]^e)$ represent marginal utility evaluated at the levels of first period consumption and of expected second-period consumption.

3/ See the Appendix for details on the derivation.

In the absence of insurance to bank liabilities, the contractual compensation demanded by consumers to provide a given amount of local deposits (the supply function of deposits (6)) differs from the expected return of deposits due to the probability of bank failure. The supply of deposits is a function of the expected return of deposits, the probability of bank failure (1-P), and the expected rate of return of deposits in the event of bank failure ($[g_C]^e$). 1/

$$R_D = (1/P)*\{R^e_D - [g^C]^e*(1-P)\} \qquad (6)$$

In the absence of insurance on bank liabilities, the contractual compensation demanded by foreign banks to supply a given amount of foreign credit (7) exceeds the expected return of foreign credit (R_F). The compensation demanded is a function of the expected return of alternative foreign assets (R_F), the probability of bank failure (1-P), and the expected rate of return of foreign credit conditional on bank failure ($[g^C]^e$):

$$R_{FC} = (1/P)*\{R_F - [g^C]^e*(1-P)\} \qquad (7)$$

It is assumed that foreign bankers are risk-neutral and that the expected return of an alternative foreign asset is given. 2/

2. Bank intermediation, insurance and distortions

Government insurance of bank liabilities increases the confidence in the financial system at the cost of creating distortions in credit allocation and excessive risk-taking by financial institutions. Government insurance attempts to increase the stability of the financial system by insulating the holders of bank liabilities from the risks of the bank's loan portfolio. Thus, in the event of bank failure the government would cover the shortfall of loan returns in order to pay off bank liabilities. However, the insurance also creates new incentives for the banker that result in distortions in the allocation of credit and in excessive risk-

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1/ The expected rate of return of deposits conditional on bank failure is equal to the expected return of bank loans conditional on bank failure ($[G^c]^e$) divided by total bank liabilities in the first period (BL1), i.e., $[g^c]^e = [G^c]^e/BL1$.

2/ The supply of foreign credit is upward slopping and backward bending, as in Aizenman (1987), because the probability of bank failure is directly linked to the level of outstanding foreign credit.

taking: the expected marginal productivity of capital differs across sectors and the loan portfolio tends to be concentrated in a few sectors, thus becoming riskier though more profitable. A formal presentation of the model and derivation of the main results are included in the Appendix.

Banks maximize expected profits over a truncated profit density function, the excluded portion of which corresponds to the loan returns that result in bank failure. The bank lends to different sectors using funds collected through deposits and foreign credit. The banker decides the level and composition of bank financing and the composition of the bank portfolio so as to maximize truncated expected profits. In this model, the result of the intermediation process is uncertain, but it can be summarized by two different states: no-failure if loan repayments (G) are enough to cover bank liabilities ($G \geq BL2$), and failure if loan repayments fall short and the bank fails ($G < BL2$). 1/ If loan repayments cover bank liabilities the banker's profits are the excess of credit repayments over bank liabilities. However, if loan repayments fall short, the banker's profits are zero and depositors and foreign creditors accept the losses by sharing net loan repayments. Expected bank profits ($[BP]^e$) are presented in equation (8) where P is the probability of no-failure, and $[G^N]^e$ are expected loan returns in the no-failure state. 2/ The probability of no-failure (P) can be defined as the area below the density function of bank profits, f(BP), lying to the right of the critical value represented by the level of bank liabilities (BL2), (see equation (9) and Figure 1). 3/

1/ BL2 represent, bank liabilities in the second period:
$BL2 = D\ R_D + FC\ R_{FC}$

2/ Expected loan repayments over all possible events ($[G]^e$) can be presented as the weighted average of expected loan repayments conditional on the event of failure ($[G^C]^e$) and no-failure $[G^N]^e$). q_i is the joint probability of bank failure and success of sector "i" production process.

$$[G]^e = P[G^N]^e + (1-P)\ [G^C]^e$$

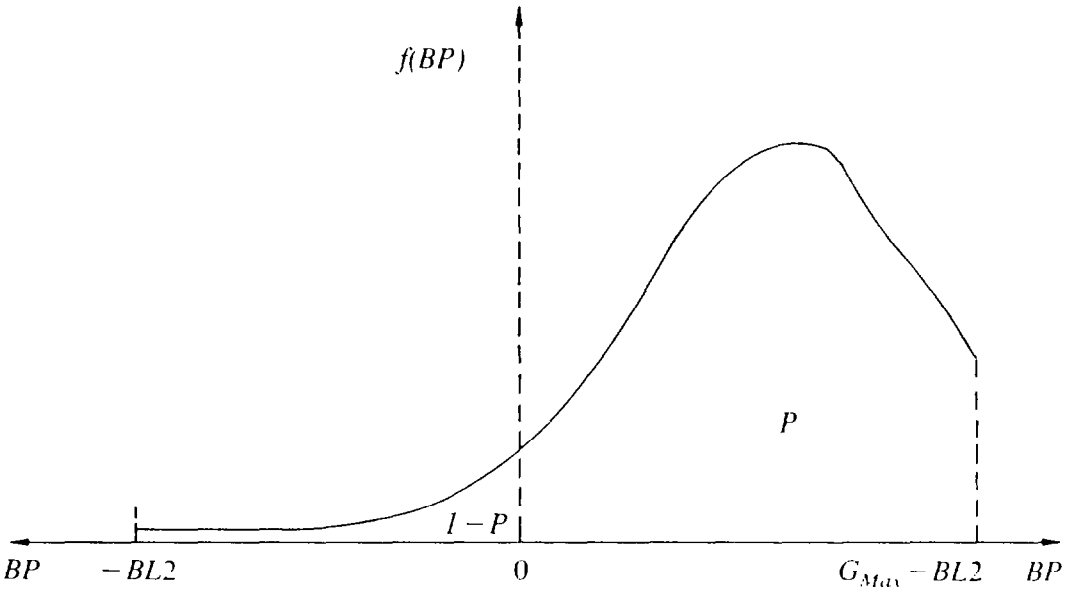
Where: $[G^N]^e = \sum_{i=1}^{M} R_i L_i (\Pi_i - q_i) P$; $[G^C]^e = \sum_{i=1}^{M} R_i L_i q_i / (1-P)$;

$$q_i = \text{Prob}\ \{\Phi_i = 1,\ G < BL2\}$$

3/ Here f(BP) represents the density function and F(BP) the probability distribution function of bank profits.

Figure 1: Density Functions for Bank Profits

$$\textit{Bank Profits: } BP = \sum_{i=1}^{M} R_i L_i \Phi_i - \left(R_D D + R_{FC} FC\right) = G - BL2$$



$$[BP]^e = P([G^N]^e - R_D D - R_{FC} FC) \tag{8}$$

$$P = \text{Prob. } \{G \geq BL2\} = \int_0^{G_{Max}-BL2} f(BP)\, dBP = 1 - F(BL2) \tag{9}$$

A competitive financial system free of externalities and without government insurance to bank liabilities--referred here as a laissez-faire system--is a benchmark where the market mechanism attains the optimal credit allocation and the optimal bank risk-taking position. In this model it is assumed that in a competitive financial system market-wide conditions are given for the individual bank, while bank-specific conditions are adjustable variables in the optimization process. Market-wide conditions include the expected rate of return of deposits and foreign loans, the variance of deposit returns, and the interest rates charged on local loans. Bank-specific conditions include the probability of bank failure, and the expected rate of return of bank liabilities in the event of bank failure. The control variables used by the bank in the optimization process are the amounts of each type of loans, local deposits, and foreign credits. In a laissez-faire financial system, depositors and creditors react to actions of individual banks that modify the bank-specific conditions by requiring changes in their contractual payments (R_D and R_{FC}) as presented in equations (10) and (11). 1/

$$R_D = (1/P)\{ [R_D]^e + (1-P)[g^C]^e \} \tag{10}$$

$$R_{FC} = (1/P)\{ R_F + (1-P)[g^C]^e \} \tag{11}$$

In a laissez-faire financial system the banker's optimization leads to an allocation of bank credit, such that the expected return of each type of loans equals the expected return of deposits. This result implies

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1/ In this system an increase in the rate of return of deposits (R_D) can, up to a certain point, compensate for higher risk. Above a critical R_D level, the supply of deposits is backward bending and deposits fall as R_D increases. The supply is backward bending because an increase in (R_D) also leads to a reduction in P, the probability of no-failure, and this second effect becomes dominant for lower levels of P.

that the expected marginal productivity of capital is equal in all sectors, and thus that expected output is maximized. 1/ In addition, the composition of bank financing is such that the contractual return of deposits equals the contractual return of foreign credit.

$$R_i \Pi_i = [R_D]^e \; ; \tag{12a}$$

$$R_D = R_{FC} \tag{12b}$$

Assuming instead that the government fully insures bank liabilities at no charge, the bank optimization process leads to the concentration of the portfolio of bank loans, and hence to distortions in credit allocation and excessive risk-taking by the bank. When deposits and foreign credit are fully insured, their supply prices do not depend on the risk of the loan portfolio, because depositors and creditors would receive their contractual returns even in the event of bank failure. 2/ The optimization conditions for the bank under full insurance (equation (13) and (14)) imply that the portfolio of loans tend to be concentrated in sectors where the joint probability of loan success and bank failure (q_i) is low because loan repayments in the event of failure do not affect the cost of bank financing. Moreover, loans are also concentrated in sectors where additional lending results in reduction of the probability of no-failure (P_D+P_i) < 0 and, thus, in lower expected bank liabilities.

$$R_i \Pi_i = R_i q_i + (P_i+P_D)BL2 + PR_D \tag{13}$$

$$R_D = R_{FC} \tag{14}$$

Thus, under full insurance of bank liabilities, distortions in credit allocation and excessive risk-taking arise, the expected marginal productivity of capital differs across sectors, and a moral hazard problem leads to a higher probability of bank failure. More credit than the optimal amount will be allocated to some sectors resulting in a level of expected output that is lower than the maximum (see equation (15)). In addition, the concentration of loans in sectors with a smaller probability of yielding returns in the event of failure (small q_i) implies that the success of loans in individual sectors becomes critical to avoid bank failure, thus increasing the probability of bankruptcy. The moral hazard

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1/ These first order conditions imply: $f_i'[K_i]\ \Pi_i = [R_D]^e$.

2/ In this model, when foreign credit is fully insured the expected return is equal to the contractual return: $R_D = [R_D]^e$; $R_{FC} = [R_{FC}]^e$.

problem arises because the banker does not have to bear all the possible outcomes of the loan portfolio selected (bankruptcy and limited liability), and because the insurance insulates the cost of bank financing from the riskiness of the loan portfolio. In the event of failure the shortfall between total bank commitments and loan repayment is borne by the insurer (the government).

$$\Pi_i f'[K_i] - R_D = R_i q_i + (P_i+P_D)BL2 - (1-P)R_D \qquad (15)$$

The distortions created by the full insurance of bank liabilities also result in domestic over-intermediation and foreign over-borrowing by banks. The full insurance system eliminates the risk of bank liabilities, increasing the quantity supplied of deposits and foreign credit at the same interest rate. In addition, the moral hazard problem also implies that the banker can increase the size, risk, and return of the loan portfolio and offer higher interest rates to obtain additional financing. 1/

3. Corrective policies

Corrective policy instruments are needed to offset the distortions created by fully insuring bank liabilities. The elimination of the insurance on bank liabilities is ruled out because of externalities that induce economic agents to expect government intervention in case of a bank failure. The policy instruments considered are a bankruptcy penalty and an insurance premium on bank liabilities. The optimal credit allocation and bank risk-taking can be obtained by imposing an adjustable bankruptcy penalty, or a "fair" insurance premium that compels the banker to consider the entire range of consequences of their portfolio selection.

A pecuniary bankruptcy penalty can be represented in this model by capital restrictions to banking consisting of equity requirements and minimum holdings of a certain riskless asset. These capital restrictions are in effect in virtually all countries in the form of minimum equity requirements and legal reserve requirements. However, these requirements are not effective in correcting the distortions created by the insurance on bank liabilities because they are imposed independently from the characteristics of each institutions loan portfolio. In the event of bankruptcy, defined as loan repayments falling short of bank liabilities,

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1/ This type of reasoning has been used to explain the high interest rates in the Southern Cone countries during the late 1970's early 1980's. See Zahler and Valdivia (1987).

the government uses the riskless asset to cover bank liabilities. 1/ The optimization conditions for the bank when a bankruptcy penalty (Z) is imposed, presented in equation (16), depend critically on the response of the penalty to changes in the composition of the loan portfolio and to changes in the level of deposits $(\frac{dZ}{dL_i} + \frac{dZ}{dD})$.

$$Ri\ \Pi_i = Ri\ q_i + (P_i+P_D)\ (BL2-Z) + P\ R_D + (1-P)\ (\frac{dZ}{dL_i} + \frac{dZ}{dD}) \tag{16}$$

$$R_D = R_{FC} \tag{17}$$

The imposition of a fixed bankruptcy penalty does not eliminate all sources of distortions in credit allocation, and the expected marginal productivity of capital still differs across sectors. The imposition of a fixed bankruptcy penalty acts as an incentive to reduce bank risk-taking because expected bank liabilities also include the expected value of the bankruptcy penalty. However, unless the penalty changes with the level of deposits and with the loan composition, the expected rates of return of loans would differ across sectors, implying a sub-optimal credit allocation.

In principle, the supervision of the bank loan portfolio could be used to design an adjustable bankruptcy penalty Z that would respond to changes in the riskiness of that portfolio. This optimal bankruptcy penalty (Z^*) is equal to the expected value of the loss or the difference between bank liabilities in the second period and expected credit repayments conditional on bankruptcy (18). The imposition of Z^* leads to the optimal credit allocation and bank risk-taking; then the bank optimization conditions (19) consist of equating the expected returns of loans in each sector with the return of deposits and foreign credit. 2/

$$Z^* = (BL2 - [G^C]) \tag{18}$$

$$R_i\Pi_i = R_D = R_{FC} \tag{19}$$

1/ A bankruptcy penalty could also take the form of non-pecuniary costs to be born by the banker in the event of bank failure. These include the loss of reputation and legal actions against the banker.

2/ See Appendix.

To avoid the distortions created by fully insuring bank liabilities, a second corrective policy is to charge an insurance premium on bank liabilities, the value of which must be deducted from the amount of funds available for lending. Insurance premiums for local deposits are in effect in several countries; however, the way in which the premium is calculated is not appropriate to deal with this distortion because the premium is independent from the riskiness of each institution's loan portfolio. The first-order conditions for bank optimization when an insurance premium (w) is imposed are presented in equations (20) and (21). 1/ The effect of the premium on the system's risk depends critically on the premium response to changes in the level of deposits and in the composition of the loan portfolio. The imposition of a fixed insurance premium does not eliminate the distortions in credit allocation and bank risk-taking, and results in differences in the expected marginal productivity of working capital across sectors.

$$R_i \Pi_i = R_i q_i + P_i BL2 + (P_D BL2 + PR_D)\ \Omega \tag{20}$$

$$R_D = R_{FC} \tag{21}$$

$$\Omega = \frac{1 - BL1 \quad [d(1-w)/dL_i]}{(1-w) + BL1\ [d(1-w)/dD]} \tag{22}$$

In theory, the optimal credit allocation is obtained by imposing an insurance premium adjusted for the risk of the loan portfolio. A fair insurance premium on bank liabilities can eliminate the distortions in credit allocation and bank risk-taking. The fair insurance premium (w^*, in equation (23)) is equal to the expected value of the loss, which is equal to the optimal bankruptcy penalty, times its probability of occurrence. As a result, under fair insurance the expected marginal productivity of capital would be equal in all sectors, ensuring an *optimal credit allocation.* 2/

1/ The value of Ω in equation (22) depends on the marginal response of the premium to changes in the level of deposits and in the composition of the loan portfolio. If the premium is constant then: $\Omega = 1/(1-w)$.

2/ See equation (19); details of the derivation are presented in the Appendix.

$$w^* = \frac{(1-P)\ [R_D\ BL1\ -\ \sum q_i\ R_i\ L_i/(1-P)]}{R_D\ *\ BL1} = \frac{(1-P)\ Z^*}{R_D\ *\ BL1} \qquad (23)$$

V. Concluding Remarks

After the crisis in the 1930s, in most countries, including developing countries, an implicit safety net has in practice been offered by the governments to the holders of bank liabilities. Even in the absence of explicit deposit insurance schemes, economic agents take this safety net into account. However, this safety net and the inadequacy of corrective policies have contributed to the distortions and inefficiencies of the financial system. Under these conditions, structural reforms of the financial system can significantly increase the efficiency of the system in performing inter-temporal transactions and risk-sharing. However, any structural reform of the financial system consisting only of the simple elimination of market repression mechanisms would not eliminate all sources of distortions and may well increase the fragility of the financial system. The structural reforms of the financial system should emphasize the institution of a regulatory system that could compensate for these externalities.

In this paper only the excessive risk-taking derived from deposit insurance schemes has been formalized and analyzed using a simple model of financial intermediation. In order to correct the distortions and avoid the excessive risk-taking created by explicit or implicit deposit insurance schemes, a system of bank supervision needs to be implemented and used to penalize the banks in direct relation to the risk of their loan portfolio. According to the model presented the optimal credit allocation under full insurance of bank liabilities can be obtained if a supervisory agency imposes an adjustable bankruptcy penalty in banking activity or charges a fair insurance premium on bank liabilities.

APPENDIX

A Two-Period Model of Financial Intermediation

1. The demand for credit

The production function of firm "i" (A1) is assumed concave and twice differentiable: f' and f" represent its first and second derivative. Y_i is output, K_i is resource input, and Φ_i is a firm-specific supply shock.

$$Y_i = f_i [K_i] \Phi_i \qquad (i=1,\ldots, M) \qquad (A1)$$

$$f'_i [K_i] > 0 \qquad (A2)$$

$$f"_i [K_i] < 0 \ ; \qquad (A3)$$

The firm specific supply shock (A4) takes values 0 or 1 with probability Π_i and $1-\Pi_i$, respectively, and is independent across sectors. The expected value of Φ_i is represented by $[\Phi_i]e$, and the covariance of Φ_i and Φ_j by $S[\Phi_i,\Phi_j]]$.

$$\Phi_i = \{1, 0; \Pi_i, 1-\Pi_i\} \qquad (i=1,\ldots, M) \qquad (A4)$$

$$[\Phi_i]^e = \Pi_i \qquad (i=1,\ldots, M) \qquad (A5)$$

$$S[\Phi_i,\Phi_j] = 0 \qquad (i \neq j) \qquad (A6)$$

Profits of the individual firm (A7) are either equal to the excess of output ($f_i[K_i]$) over loan repayments (R_iL_i) or equal to zero depending on the success or failure of the production process. The production process takes time and input payments of each firm (K_i) are financed with bank loans (L_i); R_i is one plus the interest rate charged on loans to firm "i". The maximization of profits (A7) subject to the restriction (A8) yields the producer's first order condition in (A9).

$$FP_i = \{f_i[K_i] - R_iL_i, 0; \Pi_i, 1-\Pi_i\} \qquad (A7)$$

$$K_i = L_i \ ; \qquad (A8)$$

$$R_i = f'[K_i] \qquad (A9)$$

2. The supply of deposits

Expected utility of the representative consumer (A10) is a function of present (C1) and future consumption (C2), δ is the rate of time preference. The utility function (v(C)) is assumed to be quadratic.

$$[U]^e = (1+\delta)v(C1) + [v\ (C2)]^e \qquad (A10)$$

$$v'(Ct) > 0 \qquad (A11)$$

$$v''(Ct) < 0 \qquad (A12)$$

$$v'''(Ct) = 0 \qquad (t=1,2) \qquad (A13)$$

The expected utility of future consumption (A14) is obtained by applying a Taylor's series expansion around $[C2]^e$, the expected value of C2, to $[v(C2)]^e$. Higher order terms were disregarded, given that the utility function is assumed quadratic. The variance of C2 is represented by $S^2\ [C2]$.

$$[v\ (C2)]^e = v([C2]^e) + v''([C2]^e)\ S^2\ [C2]\ /\ 2 \qquad (A14)$$

First-period consumption (A15) must be equal to initial wealth (W1) less the holdings of deposits (D) and foreign assets (F). Second-period consumption (A16) must be equal to the return of deposits ($R_D D$), plus the return of foreign assets ($R_F F$), and plus non-interest income (I). R_D and R_F are equal to one plus the interest rate paid by deposits and foreign assets, respectively. Non-interest income (I) consists of profits of firms and banks and the income received by owners of real resources ($\sum K_i$).

$$C1 = W_1 - D - F\ ; \qquad (A15)$$

$$C2 = R_D D + R_F F + I \qquad (A16)$$

$$I = \sum Y_i - (R_D - 1)\ D - (R_F - 1)F \qquad (A17)$$

The variance (A18) and expected value (A19) of C2 were derived from equation (A16); $S[R_h, R_j]$ is the covariance of the returns of assets h and j.

$$S^2[C2] = D^2S^2[R_D] + F^2S^2[R_F] + S^2[I] \quad (A18)$$

$$2(DFS[R_D,R_F] + DS[R_D,I] + FS[R_F,I])$$

$$[C2]^e = [R_D]^e D + [R_F]^e F + [I]^e \quad (A19)$$

The expected utility function (A20) was obtained by replacing (A14) in (A10). The maximization of (A20) subject to the conditions (A15) and (A16) yields the consumer's first order conditions in (A21) and (A22). 1/

$$[U]^e = (1+\delta)\, v(C1) + v([C2]^e) + v''(C_2)\, S^2[C2]/\, 2 \quad (A20)$$

$$[R_D]^e = (1+\delta)\, MRS + ARA\, S[C2]_D/2 \quad (A21)$$

$$[R_F]^e = (1+\delta)\, MRS + ARA\, S[C2]_F/2 \quad (A22)$$

MRS is the ratio of the marginal utilities of present and expected future consumption, ARA is the degree of absolute risk aversion evaluated at the value of expected future consumption, and $S[C2]_D$ and $S[C2]_F$ are the marginal contributions of D and F to the variance of C2.

$$MRS = v'(C1) / v'([C2]^e) \quad (A23)$$

$$ARA = - v''([C2]^e) / v'([C2]^e) \quad (A24)$$

$$S[C2]_D = 2\,(DS_{DD} + FS_{DF} + S_{DI}); \quad (A25)$$

$$S[C2]_F = 2\,(DS_{DF} + FS_{FF} + S_{FI}); \quad (A26)$$

Given the possibility of bank failure the expected return of deposits (A27) is lower than the contractual return of deposits(R_D). The expected rate of return of deposits conditional on bank failure is $[g^C]^e$, and the probability of bank failure is (1-P). The contractual return of deposits needed to satisfy the consumer's expected return (A28) is obtained by rearranging (A27).

1/ The expected return on deposits demanded by the consumer ($[R_D]^e$ in (A21) is an increasing function of the level of deposits. As D increases MRS (A23) rises because present consumption becomes more scarce relative to future consumption; in addition, as D rises the correction for risk increases as ARA (A24) and $S[C2]_D$ (A25) rise.

$$[R_D]^e = PR_D + (1-P)[g^C]^e \quad (A27)$$

$$R_D = (1/P)\ [R_D]^e - (1-P)/P\ [g^C]^e \quad (A28)$$

3. The supply of foreign credit

It is assumed that only local banks can obtain foreign credit and that foreign creditors are risk-neutral. The expected return of FC is equal to that of some alternative foreign asset (R^F) (A29). However, given the probability of bank failure the expected return of FC (A30) is lower than its contractual return R_{FC}. The contractual return required by the foreign creditor (A31) is obtained by replacing (A29) in (A30) and rearranging terms. 1/

$$[R_{FC}]^e = R_F \quad (A29)$$

$$[R_{FC}]^e = P\ R_{FC} + (1-P)\ [g^C]^e \quad (A30)$$

$$R_{FC} = (1/P)\ (R_F - (1-P)\ [g^C]^e) \quad (A31)$$

4. Bank intermediation

Bank liabilities in period 1 and 2 (BL1 and BL2) are presented in (A32) and (A33). Bank's assets in period 2 equal the sum of loan returns (G in (A34)).

$$BL1 = D + FC \quad (A32)$$

$$BL2 = R_D D + R_{FC} FC \quad (A33)$$

$$G = \sum_{i=1}^{M} R_i L_i \Phi_i \quad (A34)$$

1/ The contractual return of foreign credit (A31) is an increasing function of FC; as FC increases the expected return in the event of failure ($[g^C]^e$) decreases and the probability of bank failure (1-P) increases.

The bank operation is successful if bank assets in period 2 exceed BL2, and the probability of this event is P (A35). f(G) and F[BL2] represent the density function and the distribution function of loan returns.

$$P = \text{Prob. } \{G \geq BL2\} = \int_{BL2}^{G_{Max}} f(G)\, dG = 1 - F[BL2] \qquad \text{(A35)}$$

Total expected loan returns ($[G]^e$ in (A36)) is equal to the sum of expected returns of individual loans or to the weighted average of expected returns conditional on the events of bank success $[G^N]e$ and bank failure $[G^C]e$.

$$[G]^e = \sum_{i=1}^{M} R_i L_i \Pi_i = P[G^N]e + (1-P)[G^C]e \qquad \text{(A36)}$$

The joint probability of the success of loan "i" and the failure of the bank is q_i (A37). From Bayes' law, q_i is equal to the conditional probability $[\Pi_i \backslash\ G < BL2]$ times the probability of bank failure (1-P). The joint probability of the success of loan "i" and successful bank operation is $\Pi_i - q_i$ in (A38).

$$q_i = \text{Prob } \{\Phi_i=1, G < BL2\} = (1-P)\ [\Pi_i \backslash\ G < BL2] \qquad \text{(A37)}$$

$$\Pi_i - q_i = \text{Prob } \{\Phi_i=1, G \geq BL2\} = P\ [\Pi_i \backslash\ G > BL2] \qquad \text{(A38)}$$

Expected loan returns conditional on the events of bank failure (A39) and bank success (A40) are obtained using (A37) and (A38).

$$[G^C]e = \sum_{i=1}^{M} R_i\ L_i\ [\Pi_i \backslash\ G < BL2] = \sum_{i=1}^{M} R_i\ L_i\ q_i/(1-P) \qquad (A39)$$

$$= [g^C]^e\ BL1$$

$$[G^N]e = \sum_{i=1}^{M} R_i\ L_i\ [\Pi_i \backslash\ G \geq BL2] = \sum_{i=1}^{M} R_i\ L_i\ (\Pi_i - q_i)/P \qquad (A40)$$

Bank profits (A41) are the excess of loan returns over bank liabilities if the bank succeeds, or zero if the bank fails. The banker is assumed risk-neutral and to maximize expected bank profits (A42), obtained by replacing (A40) into (A41).

$$BP = \{G^N - BL2,\ 0;\ P,\ 1-P\} \qquad (A41)$$

$$[BP]^e = \sum_{i=1}^{M} R_i\ L_i\ (\Pi_i - q_i) - [BL2]^e \qquad (A42)$$

$$[BL2]^e = P\ BL2 \qquad (A43)$$

The maximization of (A42), assuming that the representative bank is competitive and subject to (A46), yields the first order conditions (A44) and (A45) for the general case.

$$R_i\ (\Pi_i - q_i) = \frac{d[BL2]^e}{d\ L_i} + \frac{d[BL2]^e}{d\ D} \qquad (A44)$$

$$\frac{d[BL2]^e}{d\ D} = \frac{d[BL2]^e}{d\ FC} \qquad (A45)$$

$$\sum_{i=1}^{M} L_i = BL1 = (D+FC) \tag{A46}$$

The partial derivatives of expected bank liabilities ($[BL2]^e$) with respect to loans of type "i", deposits and foreign credit are presented in equations (A47) through (A49), where P_i, P_D, and P_{FC} are the marginal effects of type "i" loans, deposits, and foreign credit.

$$\frac{d[BL2]^e}{d\ L_i} = P_i\ BL2 + P\ D\ \frac{dR_D}{d\ L_i} + P\ FC\ \frac{dR_{FC}}{d\ L_i} \tag{A47}$$

$$\frac{d[BL2]^e}{d\ D} = P_D\ BL2 + P\ D\ \frac{dR_D}{d\ D} + P\ FC\ \frac{dR_{FC}}{d\ D} + P\ R_D \tag{A48}$$

$$\frac{d[BL2]^e}{d\ FC} = P_{FC}\ BL2 + P\ D\ \frac{dR_d}{d\ FC} + P\ FC\ \frac{dR_{FC}}{d\ FC} + P\ R_{FC} \tag{A49}$$

5. Solution under laissez-faire

Under laissez-faire conditions there are no externalities and there is no explicit or implicit system of insurance to bank liabilities. The partial derivatives of the contractual return of deposits with respect to type "i" loans (A50), deposits (A51), and foreign credit (A52) are obtained, using equation (A28). Because of competition it is assumed that actions of a particular bank do not affect the expected return of deposits $[R_D]^e$.

$$\frac{d\ R_D}{d\ L_i} = (1/P^2)\ \{\ P_i\ ([g^C]^e - [R_D]^e) - P\ (1-P)\ \frac{d\ [g^C]^e}{d\ L_i}\ \} \tag{A50}$$

$$\frac{d\ R_D}{d\ D} = (1/P^2)\ \{\ P_D\ ([g^C]^e - [R_D]^e)\ -\ P\ (1-P)\ \frac{d\ [g^C]^e}{d\ D}\ \} \tag{A51}$$

$$\frac{d\ R_D}{d\ FC} = (1/P^2)\ \{P_{FC}\ ([g^C]^e - [R_D]^e)\ -\ P\ (1-P)\ \frac{d\ [g^C]^e}{d\ FC}\ \} \tag{A52}$$

The partial derivatives of R_{FC} with respect to type "i" loans (A53), deposits (A54), and foreign credit (A55) are obtained, using equation (A31). It is assumed that bank decisions do not affect the expected return of foreign credit.

$$\frac{d\ R_{FC}}{d\ L_i} = (1/P^2)\ \{\ P_i\ ([g^C]^e - [R_{FC}]^e)\ -\ P\ (1-P)\ \frac{d\ [g^C]^e}{d\ L_i}\ \} \tag{A53}$$

$$\frac{d\ R_{FC}}{d\ D} = (1/P^2)\ \{\ P_D\ ([g^C]^e - [R_{FC}]^e)\ -\ P\ (1-P)\ \frac{d\ [g^C]^e}{d\ D}\ \} \tag{A54}$$

$$\frac{d\ R_{FC}}{d\ FC} = (1/P^2)\ \{P_{FC}\ ([g^C]^e - [R_{FC}]^e)\ -\ P\ (1-P)\ \frac{d\ [g^C]^e}{d\ FC}\ \} \tag{A55}$$

The partial derivatives of the expected rate of return of bank loans conditional on bank failure with respect to type "i" loans (A56), deposits (A57), and foreign credit (A58) are obtained, using equation (A39).

$$\frac{d\ [g^C]^e}{d\ L_i} = \frac{R_i\ q_i + [g^C]^e\ P_i\ BL1}{(1-P)\quad BL1} \tag{A56}$$

$$\frac{d\ [g^C]^e}{d\ D} = \frac{[g^C]^e\quad [P_D\ BL1\ -\ (1-P)]}{(1-P)\quad BL1} \tag{A57}$$

$$\frac{d\,[g^C]^e}{d\,FC} = \frac{[g^C]^e \quad [P_{FC}\ BL1 - (1-P)]}{(1-P) \quad BL1} \tag{A58}$$

Equations (A59) through (A64) are obtained by substituting equations (A56), (A57) and (A58) into the derivatives of the contractual returns of deposits (equations (A50), (A51) and (A52)) and foreign credit (equations (A53), (A54) and (A55)).

$$\frac{d\,R_D}{d\,L_i} = (1/P^2)\ \{P\ P\ \ ([g^C]^e - R_D) - (P/BL1)\ (R_i\ qi + P_i\ [g^C]^e\ BL1)\} \tag{A59}$$

$$\frac{d\,R_D}{d\,D} = (1/P^2)\ \{(1-P)\ [P_D + P/BL1]\ [g^C]^e - P_D\ [R_D]^e\} \tag{A60}$$

$$\frac{d\,R_D}{d\,FC} = (1/P^2)\ \{(1-P)\ [P_{FC} + P/BL1]\ [g^C]^e - P_{FC}\ [R_D]^e\} \tag{A61}$$

$$\frac{d\,R_{FC}}{d\,L_i} = (1/P^2)\ \{P\ P_i\ ([g^C]^e - R_{FC} - (P/BL1)\ (R_i\ q_i + P_i\ [g^C]^e\ BL1)\} \tag{A62}$$

$$\frac{d\,R_{FC}}{d\,D} = (1/P^2)\ \{(1-P)\ [P_D + P/BL1]\ [g^C]^e - P_D 8 [R_{FC}]^e\} \tag{A63}$$

$$\frac{d\,R_{FC}}{d\,FC} = (1-P^2)\ \{(1-P)\ [P_{FC} + P/BL1]\ [g^C]^e - P_{FC}\ [R_{FC}]^e\} \tag{A64}$$

The marginal effects on $[BL2]^e$ of changes in loans to each sector, level of deposits, and foreign credit are presented in equations (A65), (A66) and (A67). They were obtained by substituting equations (A59) through (A64) into equations (A47) through (A49).

$$\frac{d[BL2]^e}{d\ L_i} = -\ R_i\ q_i \qquad \text{(A65)}$$

$$\frac{d[BL2]^e}{d\ D} = P\ R_D + (1-P) \quad [g^C]^e \qquad \text{(A66)}$$

$$\frac{d[BL2]^e}{d\ FC} = P\ R_{FC} + (1-P) \quad [g^C]^e \qquad \text{(A67)}$$

The first order conditions for the maximization of bank's expected profit under laissez-faire are presented in equations (A68) and (A69). They were obtained by substituting equations (A65), (A66) and (A67) into the first order conditions of bank maximization for the general case, equations (A44) and (A45).

$$R_i\ \Pi_i = P\ \ R_D + (1-P)\ [g_F]e = [R_D]^e \qquad \text{(A68)}$$

$$R_D = R_{FC} \qquad \text{(A69)}$$

Consequently, the allocation of bank loans implies that the expected marginal productivity of capital in every sector is equal to the expected return of deposits. Using equations (A68) and (A9) this implies that the expected marginal productivity of capital is equal across sectors:

$$f'[K_i]\ \Pi_i = [R_D]^e \qquad (i=1,2,\ldots,M) \qquad \text{(A70)}$$

6. Solution under full insurance of bank liabilities

Under full insurance of bank liabilities, if the bank fails a government transfer would cover bank liabilities. The expected and contractual returns of bank liabilities are equal.

$$R_D = [R_D]^e \qquad \text{(A71)}$$

$$R_{FC} = [R_{FC}]^e \qquad \text{(A72)}$$

Using equations (A71) and (A72) in equations (A47), (A48) and (A49).

$$\frac{d[BL2]^e}{d\ L_i} = P_i\ BL2 \tag{A73}$$

$$\frac{d[BL2]^e}{d\ D} = P_D\ BL2 + P\ R_D \tag{A74}$$

$$\frac{d[BL2]^e}{d\ FC} = P_{FC}\ BL2 + P\ R_{FC} \tag{A75}$$

The banker's profit maximization conditions under full insurance of liabilities (equations (A76) and (A77)) are obtained by substituting equations (A73), (A74) and (A75) into the maximization conditions for the general case (equations (A44) and (A45)).

$$R_i{*}\Pi_i = R_i\ q_i + (P_i + P_D)\ BL2 + PR_D \tag{A76}$$

$$P_D\ BL2 + PR_D = P_{FC}\ BL2 + PR_{FC} \tag{A77}$$

Using (A35) to obtain the marginal effects of D and FC on P the probability of bank success:

$$P_D = -f[BL2]\ R_D \quad < \quad 0 \tag{A78}$$

$$P_{FC} = -f[BL2]\ R_{FC} \quad < \quad 0 \tag{A79}$$

Substituting (A78) and (A79) into (A77) it can be shown that these conditions imply that the contractual rate of return of deposit and foreign credit should be equal.

$$R_D = R_{FC} \tag{A80}$$

The insurance of bank liabilities creates distortions in credit allocation that can be represented by the differences between the expected marginal productivity of capital in each sector and the expected return of deposits. Using equations (A9) and (A76):

$$\Pi_i f_i'[K_i] - R_D = R_i q_i + (P_i+P_D)BL2 - (1-P)R_D \tag{A81}$$

7. Solution with bankruptcy penalty

Under a bankruptcy penalty, the banker is forced to pay a penalty Z if the bank fails; thus expected bank liabilities (A82) would include Z. The marginal effects of type "i" loans, deposits and foreign credit on $[BL2]^e$ are presented in equations (A83) to (A85).

$$[BL2]^e = P\ BL2 + (1-P)\ Z \tag{A82}$$

$$\frac{d[BL2]^e}{dL_i} = P_i\ (BL2-Z) + (1-P)\ \frac{dZ}{dL_i} \tag{A83}$$

$$\frac{d[BL2]^e}{dD} = P_D\ (BL2-Z) + (1-P)\ \frac{dZ}{dD} + P\ R_D \tag{A84}$$

$$\frac{d[BL2]^e}{dFC} = P_{FC}\ (BL2-Z) + (1-P)\ \frac{dZ}{dFC} + P\ R_{FC} \tag{A85}$$

The banker's profit maximization conditions under a bankruptcy penalty (equations (A86) and (A87)) are obtained by substituting equations (A83) to (A85) into the general profit maximization conditions (equations (A44) and (A45)).

$$R_i\ \Pi_i = R_i q_i + (P_i+P_D)\ (BL2-Z) + P\ R_D + (1-P)\ \left(\frac{dZ}{dL_i} + \frac{dZ}{dD}\right) \tag{A86}$$

$$P_D\ (BL2-Z) + P\ R_D + (1-P)\ \frac{dZ}{dD} = \tag{A87}$$

$$P_{FC}\ (BL2-Z) + P\ R_{FC} + (1-P)\ \frac{dZ}{dFC}$$

The optimal bankruptcy penalty (Z^*) is equal to the expected shortfall of loan returns over bank liabilities conditional on bankruptcy (A88), and responds to changes in the composition of the loan portfolio and in the level of bank liabilities ((A89) to (A91)).

$$Z^* = BL2 - \sum q_i R_i L_i/(1-P) \tag{A88}$$

$$\frac{dZ^*}{dL_i} = - q_i R_i/(1-P) - P_i \sum_{i=1}^{M} q_i R_i L_i/(1-P)^2 \tag{A89}$$

$$\frac{dZ^*}{dD} = R_D - P_D \sum q_i R_i L_i/(1-P)^2 \tag{A90}$$

$$\frac{dZ^*}{dFC} = R_{FC} - P_{FC} \sum q_i R_i L_i/(1-P)^2 \tag{A91}$$

The banker's profit maximization conditions under an optimal bankruptcy penalty (equations (A92) and (A93)) are obtained by substituting equations (A89), (A90) and (A91) into the maximization conditions under a general bankruptcy penalty Z (equations (A86) and (A87)).

$$R_i \Pi_i = R_D \tag{A92}$$

$$R_D = R_{FC} \tag{A93}$$

8. Solution with insurance premium

The banker must pay during the first period an insurance premium (w) for each unit of bank liabilities (BL1). Thus, the banker's maximization is constrained by equation (A96). The first order conditions are presented in (A94) to (A96).

$$R_i (\Pi_i - q_i) - P_i BL2 = (P_D BL2 + P R_D) \Omega \tag{A94}$$

$$P_D BL2 + P R_D = (P_{FC} BL2 + P R_{FC}) \Delta \tag{A95}$$

$$\sum L_i = (1-w) BL1 \tag{A96}$$

The variables Ω and Δ result from the imposition of the premium w.

$$\Omega = \frac{1 - BL1 * [d(1-w)/dL_i}{(1-w) + D\ [d(1-w)/dD] + [d(1-w)/dFC]} \tag{A97}$$

$$\Delta = \frac{(1-w) + BL1 \quad [d(1-w)/d\ D]}{(1-w) + BL1 \quad [d(1-w)/dFC]} \tag{A98}$$

Assuming that the contractual interest rates of deposits and foreign credit are equal (R_D=R_{FC}), as was derived in (A80) for the general case under deposit insurance, and substituting into (A97), (A98) and (A33):

$$\Omega = \frac{1 - BL1 \quad [d(1-w)/dL_i]}{(1-w) + BL1\ [d(1-w)/dD]} \tag{A99}$$

$$\Delta = 1 \tag{A100}$$

$$BL1 = BL2 * R_D \tag{A101}$$

Thus the first order conditions under insurance premium can be written:

$$R_i\ (\Pi_i - q_i) - P_i\ BL2 = (P_D\ BL2 + R_D)\ \Omega \tag{A102}$$

$$R_D = R_{FC} \tag{A103}$$

$$\sum L_i = (1-w)\ BL1 \tag{A104}$$

The optimal insurance premium (w^*) is an actuarially "fair" insurance premium on bank liabilities (A105). This premium is equal to the expected shortfall of loan returns times its probability of occurrence.

$$w^* = \frac{(1-P)\ [R_D\ BL1 - \sum q_i\ R_i\ L_i/(1-P)]}{R_D \quad BL1} \tag{A105}$$

$$(1-w^*) = \frac{P\ R_D\ BL1 + \sum q_i\ R_i L_i}{R_D\ \ BL1} \tag{A106}$$

The optimal premium changes with the composition of the loan portfolio and the level of deposits. Differentiating (A106) with respect to loans and deposits:

$$\frac{d(1-w^*)}{dL_i} = \frac{R_D\ BL1\ (P_i\ R_D\ BL1 + q_i\ R_i)}{(R_D\ BL1)^2} \tag{A107}$$

$$\frac{d(1-w^*)}{dD} = \frac{R_D\ BL1\ (P_D\ R_D\ BL1+P\ R_D)}{(R_D\ BL1)^2} - \frac{(P\ R_D\ BL1 + q_i\ R_i\ L_i}{(R_D\ BL1)^2} \tag{A108}$$

Substituting (A105), (A107) and (A108) into (A99):

$$\Omega = \Omega^* = \frac{R_D - R_i\ q_i - P_i\ BL2}{P_D\ BL2 + P\ R_D} \tag{A109}$$

The banker's profit maximization conditions under an optimal insurance premium (equation (A110)), are obtained by substituting equation (A109) into the maximization condition under a general premium w (A102)).

$$R_i\ \Pi_i = R_D \tag{A110}$$

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