ON THE INDEPENDENCE BETWEEN DEPOSIT AND CREDIT RATES

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N° 82/13

Director of Publication:

Edith Penrose
Associate Dean: Research and Development
INSEAD

Printed by INSEAD, Fontainebleau
France

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September 1982

An understanding of the causal relationship between deposit and credit rates is essential to study the effects of deposit rate regulation on the volume of loans and on the riskiness of bank income.

It is shown in this paper that the independence property of the well known Klein-Monti model is lost when bankruptcy risk is introduced in the model. The causal relationship between deposit and credit rates is recursive and the direction of the recursivity depends on the existence or absence of a deposit insurance mechanism.

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An analysis of the causal relationship between deposit and credit rates is motivated by at least two arguments.

First, there is the well known argument that excessive competition between banks could raise deposit rates and lead to higher yield, riskier investment policies (e.g., by a substitution of risky loans in place of risk-free securities), threatening the solvency of banks and the stability of the banking system.

Secondly, it is sometimes argued in Europe that regulations of deposit rates will lower these rates and the cost of funding loans, permitting to expand the credit volume and spending, a welcome effect in a depressed economy.

This set of arguments has been denied by economists on theoretical and empirical grounds. The well known models of Klein (7) and Monti (11), have been used to show the independence between deposit and credit rates, and empirical studies by Benston (2) and more recently Mingo (10) suggest that the riskiness of bank income is not related positively to the level of deposit rates.

The aim of this paper is to re-examine the relationship between deposit and credit rates and to present some elements that have been neglected in previous studies. The model that will be used is a generalization of three models: the ones developed by Klein - Monti, Jaffee-Modigliani (5) and Greenbaum-Taggart (3). Its essential and realistic characteristic is to incorporate the eventual failure of the borrower or the financial intermediary to honour their debt commitments.

It will be shown that the independence property of the Klein-Monti model is lost, that the causal relationship between deposit and credit rates is recursive and that the direction of the recursivity depends on the existence or the absence of a deposit insurance mechanism.

The paper is organized as follows. The Klein-Monti model is exposed briefly in section one. The realistic feature of bankruptcy risk is included in section two and in the third section, the causal relationship between deposit and credit rates is discussed under alternative regimes of deposit insurance. The fourth section concludes the analysis.

Section One: The Klein-Monti model

The asset side of the intermediary's balance sheet consists of securities (B) and loans (L) and the liability side of deposits (D) and equity (E). The supply of securities (carrying an interest g) is perfectly elastic. However, the loan and deposit markets are imperfect: the loan demand by borrowers (L(.)) is a decreasing function of the interest rate (p) and the deposit supply (D(.)) is an increasing function of the interest rate (d). All parameters are known with certainty. [1]

The opportunity cost of equity in a certain world is the exogenous security rate, g. The intermediary chooses deposit and credit rates to maximize its end-of-period net value (NV):

$$\max_{d,p} NV = (1 + p)L + (1 + g)B - (1 + d)D - (1 + g)E' \quad \text{s.t. } L + B = D + E \tag{1}$$

Substituting the balance sheet constraint into the objective function, one has:

$$\max_{p,d} NV = (p - g)L + (g - d)D \tag{2}$$

The net value is the sum of two terms: income on loans net of an opportunity cost (g) and net income on deposits invested in securities.

The first-order conditions for profit maximization are:

$$(p - g)L' + L = o \tag{3i}$$

$$(g - d)D' - D = o \tag{3ii}$$

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1 Klein introduces also a liquidity cost function to reflect the fact that deposits are withdrawable. As this does not affect the causal relationship (see Langhor (8)), we have chosen the simpler model of Monti.

Denoting by η_L and η_D the interest rate elasticity of loans and deposits, one obtains:

$$p\ (1 + \eta_L^{-1}) = g \tag{4i}$$

$$d\ (1 + \eta_D^{-1}) = g \tag{4ii}$$

Conditions (4) express the classical equality between the marginal cost of deposits, the marginal revenue on loans and the exogenous opportunity cost g. The security rate g is the peg of the system and brings independence between the deposit and credit rates decisions. [2]

One observes from relation (2) that the equity level is indeterminate because the opportunity cost of equity equals the exogenous market rate g. Additional equity invested in market securities does not yield any net value.

The last result shows the limits of the Klein-Monti model. Given the current debate on capital adequacy, it seems that this model is missing the important and realistic feature of bankruptcy risk. Additional equity invested in some assets reduces the probability of the intermediary's bankruptcy. This will increase the expected return on deposits and their volume when there is no insurance mechanism and, if there is one, the insurance premium will be eventually lowered. If one ignores bankruptcy risk, it is not surprising that the equity level becomes indeterminate.

One would like to model the fact that the borrower and the intermediary might not honour their debt commitments. This is the object of section two.

Section Two: Interest rate setting and bankruptcy risk.

We adapt the Jaffee-Modigliani's presentation (5) and assume that the eventual failure of the borrower or the intermediary to honour their debt commitments depends on the borrower's asset value (a) at the end of the period. Is it larger or smaller than the borrower's promised debt repayment? If it is smaller, will it force the intermediary into bankruptcy or not?

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2 As has been discussed by Baltensberger (1), the presence of monopoly power is essential to ensure the finite size of the intermediary. A real cost function for loans and deposits could easily be added to the model and the imperfect markets assumption would then be unnecessary as the net marginal revenue (the exogenous competitive interest rate net of a marginally increasing real cost) would be decreasing. We have kept the imperfect market hypothesis for simplicity of exposition.

Let us denote by f(a) the borrower's asset value marginal density function over the interval (k,K) and by F(a) the cumulative density function.

The first step is to calculate the break-even asset value a* just sufficient to cover the intermediary's deposit obligation (an asset value smaller than a* implies the intermediary's bankruptcy):

$$a^* \mid a^* + (1 + g)B = (1 + d)D \qquad (5)$$

Secondly, as announced earlier, we introduce a deposit insurance mechanism and assume that the premium (C) to be paid at the beginning of the period to the insurance corporation, is a fraction α of the present value of the expected deposit insurance liabilities (i.e. the intermediary's expected end-of-period losses):

$$C = - \alpha \; \frac{1}{1+g} \int_k^{a^*} (a + (1 + g)B - (1 + d)D) \; f(a) \; d\, a^3 \qquad (6)$$

The integral represents the intermediary's expected liabilities that will not be covered by its assets. The integral is bounded upward, since above a* the intermediary is solvent. The deposit insurance premium is fairly priced when the parameter α is equal to unity. [3]

Under this setting, the intermediary's financing constraint becomes:

$$L + B + C = D + E \qquad (7)$$

Substituting the financing constraint (7) into relation (5), one has:

$$a^* = (1 + g)L + (d - g)D - (1 + g)E + (1 + g)C \qquad (8)$$

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3 In most countries, parameter α takes a zero value and the insurance premium is proportional to deposits: C = cD. Results under this setting will be reported in footnotes.

Thirdly, we assume that the intermediary maximizes its expected end-of-period value net of an equity opportunity cost. The cost of equity is, in an assumed risk neutral world, the exogenous security rate g.

The expected net value is given by relation (9). The first integral represents the end-of-period value of the intermediary if the borrower can repay his debt; the second integral represents the value in case of borrower's bankruptcy. In this last case, the intermediary does not recover the loan (plus interest) but only the borrower's asset, a:

$$E\ (NV) = \int_{(1+p)L}^{K} ((1+p)L + (1+g)B - (1+d)D)\ f\ (a)\ d\ a$$

$$+ \int_{a^*}^{(1+p)L} (a + (1+g)B - (1+d)D)\ f\ (a)\ d\ a - (1+g)E \quad (9)$$

$$\text{s.t.} \quad B + L + C = D + E$$

The last integral is evaluated from a lower bound a* since the shareholders' liabilities are limited.

Substituting the financing constraint, one gets:

$$E\ (NV) = \int_{(1+p)L}^{K} ((p-g)L + (g-d)D + (1+g)E - (1+g)C) f\ (a)\ d\ a$$

$$+ \int_{a^*}^{(1+p)L} (a - (1+g)L + (g-d)D + (1+g)E - (1+g)C)\ f\ (a)\ d\ a - (1+g)E \quad (10)$$

This relation can be simplified to obtain relation (12). Add and substract from (10)

$$\int_{a^*}^{(1+p)L} ((p-g)L + (g-d)D + (1+g)E - (1+g)C)\ f\ (a)\ d\ a$$

This leads to (10 a):

$$E\ (NV) = \int_{a^*}^{K} ((p-g)L + (g-d)D + (1+g)E - (1-g)C)\ f\ (a)\ d\ a$$

$$+ \int_{a^*}^{(1+p)L} a\ f\ (a)\ d\ a + (-(1+g)L + (g-p)L) \left(\int_{a^*}^{(1+p)L} f(a)\ d\ a \right) - (1+g)E \quad (10a)$$

Integrate by parts the second integral of (10 a) to obtain:

$$E\ (NV) = \int_{a^*}^{K} ((p-g)L + (g-d)D + (1+g)E - (1+g)C)\ f\ (a)\ d\ a - a^* F\ (a^*)$$
$$- \int_{a^*}^{(1+p)L} F\ (a)\ d\ a + (1+p)L\ F(a^*) - (1+g)E \qquad (10b)$$

Relation (10 b) can be simplified further by taking account of the definition of a* in relation (8) to yield (11):

$$E\ (NV) = (p - g)L + (g - d)D - (1 + g)C - \int_{a^*}^{(1 + p)L} F\ (a)\ d\ a \qquad (11)$$

And a similar procedure can be used to solve the value of the insurance premium, so that we obtain finally:

$$E\ (NV) = (p-g)L + (g-d)D - \alpha \int_{k}^{a^*} F\ (a)\ d\ a - \int_{a^*}^{(1 + p)L} F\ (a)\ d\ a \qquad (12)$$

The expected net value (12) is similar to the maximand of the Klein-Monti model (2), except that two terms have been added:a term to measure the premium of the deposit insurance (a fraction α of the intermediary's expected losses [4]) and a term to measure the loss of income due to the borrower's bankruptcy.

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4 It can be shown that the intermediary's losses $- \int_{k}^{a^*} (a + (1+g)B - (1+d)D)$ $f\ (a)\ d\ a$ - are equal to $- \int_{k}^{a^*} F\ (a)\ d\ a$.

In Merton's interpretation (9), the deposit insurer has issued a put option on the asset of the bank at an exercice price of (1 + d)D.

The model can be interpreted as a generalization of the Klein-Monti model ($F((1 + p)L) = F(a^*) = 0$) and of the Jaffee-Modigliani model as these authors ignore the risk of the intermediary's bankruptcy ($F(a^*) = 0$). Greenbaum- Taggart (3) consider the risk of intermediary's default but do not model explicitly the financial state of the borrower: they assume that gross income on loans is stochastic; also, in their model, the deposit insurance premium is a function of the stock of deposits.[5]

The next section will be concerned with the optimal choice of deposit and credit rates and with their causal relationship.

Section Three: The causal relationship

A preliminary question concerns the determinants of the supply of deposits. In the certainty case, deposits were an increasing function of the deposit rate. If the failure of the intermediary is possible, it becomes necessary to consider two institutional settings. In the first one (the case of many countries), government intervention or insurance mechanisms protect deposit holders and the relevant rate is the posted deposit rate. In the second setting, there is no insurance mechanism and we assume that the supply of deposits depends on the expected return ($\bar{d}$).

The two institutional settings are successively examined.

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5 When the premium is proportional to deposits, the expected net value becomes:

$$E\ (NV) = (p-g)L + (\bar{g}-d)D - \int_{a^*}^{(1+p)L} F\ (a)\ d\ a\ ,$$ where $\bar{g}$ is the return on deposits net of an insurance cost ($\bar{g} = g - c(1 + g)$); this case is similar to our own model with $\alpha = 0$.

3.1 The "deposit insurance" case.

In this case the deposit supply is an increasing function of the posted deposit rate, d. The first-order conditions to maximize the expected net value (12) are (assuming $\alpha F(a^*)<1$)[6]:

$$\frac{\partial E(NV)}{\partial d} = \left((g-d)D' - D\right)\left(\frac{1 - F(a^*)}{1 - \alpha F(a^*)}\right)^7 = 0 \qquad (13i)$$

$$\frac{\partial E(NV)}{\partial p} = \left((p-g)L' + L\right) - F\left((1+p)L\right)\left((1+p)L' + L\right)+(1-\alpha)(1+g)L' \frac{F(a^*)}{1-\alpha F(a^*)} = 0 \qquad (13ii)$$

$$= \left((p-g)L' + L\right) \left(1 - F\left((1+p)L\right) \right) - (1+g)L' \left(F\left((1+p)L\right) - F(a^*) \right)$$

$$- \frac{\alpha F(a^*)\,(1+g)L'}{1 - \alpha F(a^*)} \left(1 - F(a^*) \right) = 0 \qquad (13ii')$$

$$\frac{\partial E(NV)}{\partial E} = -(1 - \alpha)(1 + g) \frac{F(a^*)}{1 - \alpha F(a^*)} \lesseqgtr 0 \quad \text{as} \quad \alpha \lesseqgtr 1 \qquad (13iii)$$

$$= \left(-(1+g) + (1+g) \left(1 - F(a^*) \right) + \frac{\alpha F(a^*)(1+g)}{1-\alpha F(a^*)} (1-F(a^*) \right) \qquad (13iii')$$

The first first-order condition is identical to the one obtained in the certainty case (3). One observes that the deposit rate is independent of the credit rate.

The second first-order condition (13 ii') has a natural interpretation. The expected net profit due to a change in the loan rate is the sum of three terms: the expected net income when the borrower meets his obligations, an expected cost when the borrower goes bankrupt and an expected income due to the investment of the premium reduction $\left(\frac{\partial C}{\partial p} = \frac{\alpha F(a^*) L'}{1 - \alpha F(a^*)}\right)$

One will also note that the optimal loan rate depends on the break-even asset value a*. Two cases must be distinguished:

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6 This plausible condition is necessary to ensure that an exogenous shock to the break-even asset value carries a finite global effect on a*, as one can observe an infinite sequence of effects caused by the insurance premium (see relation (6) and (8)).

7 One obtains in the fixed premium case (C = cD): $(1-F(a^*))((\bar{g}-d)D'-D) = 0$.

i) $\alpha < 1$

Differentiating implicitly relation (13 ii) w.r.t. p and a*, one observes a negative relationship between the optimal credit rate p and the break-even asset value a*. A decrease in a* caused by additional equity or net deposit profit ((g-d)D) implies a higher credit rate (smaller loan and reduced probability of intermediary's bankruptcy).

The result has a natural interpretation when $\alpha = o$. A decrease in a* increases the expected cost when the borrower goes bankrupt (see (13 ii')) and, therefore, induces a reduction in loan volume and a higher loan rate.

ii) $\alpha > 1$

The last term in (13 ii) is positive and converse conclusions apply.

HORVITZ (1980) reports a tendency for banks in financial difficulty to take excessive risks. "The bank managers involved were neither stupid nor dishonest in acquiring these high risk assets. The practice is more accurately seen as an attempt to recoup once the bank was already insolvent." Such practices of increasing the volume of risky assets when equity is small confirm, in terms of our model, that parameter α is less than unity in the real world.

The loan rate depends in this model on the net deposit profit and thus on the deposit rate. The causal relationship is recursive: the deposit rate is independent of the loan rate, but the loan rate is function of the deposit rate.

However, if the effect of the net profit on deposits ((g-d)D) on the loan rate is positive, the effect of the deposit rate remains ambiguous. One can easily construct cases where shifts in the deposit supply imply a higher deposit rate with higher or lower net deposit profit.

The third first-order condition (13 iii') relates to the optimal equity level. The expected net profit due to an increase in equity is the sum of three terms: the opportunity cost, the expected income of investing equity in case of nonbankruptcy and the revenue due to a change in the premium

$$\left(\frac{\partial C}{\partial E} = \frac{- \alpha \ F \ (a^*)}{1 - \alpha \ F \ (a^*)} \right)$$

When the insurance premium is underpriced ($\alpha<1$) , the optimal equity level will be close to zero. When the premium is fairly priced, the equity level is indeterminate [8] and for $\alpha>1$, the equity level will be such that $F(a^*) = 0$. In this case, the managers avoid completely the risk of bankruptcy.

Recursivity in the deposit and credit rate decisions follows when the deposit supply is assumed to be an increasing function of the posted rate. The optimal deposit rate is chosen before the loan rate.

It is amazing, as shown below, that a reverse recursivity occurs when the deposit supply is function of the expected return: the loan rate is chosen first.

3.2 The "risk bearing" case.

When the deposit holders assume themselves the risk of bankruptcy, the deposit supply will be, in a risk neutral world, function of the expected return on deposits and the parameter α will be equal to zero.

We will first define the expected return on deposits:

$$\bar{d} \mid (1+\bar{d})D = \int_{a^*}^{K} (1+d)D\, f(a)\, d\, a + \int_{k}^{a^*} (a + (1 + g)B\ )\, f\, (a)\, d\, a \tag{14}$$

The first integral represents depositors' income when the intermediary can cope with its obligations; the second integral, income in case of bankruptcy.

Substituting the balance sheet constraint into (14), we get:

$$(1+\bar{d})D = \int_{a^*}^{K} (1+d)D\, f(a)\, d\, a + \int_{k}^{a^*} (a+(1+g)D + (1+g)E -(1+g)L)f(a)\, d\, a \tag{15}$$

Relation (15) can be simplified to yield relation (16). Indeed, add and subtract from (15) $\int_{k}^{a^*} (1 + d)D\, f\, (a)\, d\, a$

$$(1 + \bar{d})D = (1 + d)D + \int_{k}^{a^*} (a + (g-d)D + (1+g)E -(1+g)L)\, f\, (a)\, d\, a \tag{15a}$$

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8 When bankruptcy costs are included in the model (Kareken-Wallace (6)), the equity level is determinate and such that the probability of bankruptcy is zero ($F(a^*) = 0$).

The second term can be integrated by parts to yield (16):

$$(1 + \bar{d})D = (1 + d)D - \int_{k}^{a^*} F (a) \, d a \tag{16}$$

The intermediary is assumed to maximize the expected end-of-period net value:

$$\max_{d,p} E (NV) = (p - g)L + (g - d)D - \int_{a^*}^{(1 + p)L} F (a) \, d a \tag{17}$$

This relation can be transformed by adding and subtracting $\int_k^{a^*} F (a) \, d a$:

$$\max_{d,p} E (NV) = (p-g)L + (g-d)D + \int_{k}^{a^*} F (a) \, d a - \int_{k}^{(1+p)L} F (a) \, d a \tag{18}$$

Given (16), one obtains:

$$\max_{d,p} E (NV) = (p-g)L + (g-\bar{d})D - \int_{k}^{(1 + p)L} F (a) \, d a \tag{19}$$

The problem can be interpreted as the optimal choice of the loan rate p and the expected return on deposits $\bar{d}$. [9]

The first-order conditions are:

$$\frac{\partial E(NV)}{\partial \bar{d}} = (g - \bar{d}) \frac{\partial D}{\partial \bar{d}} - D = 0 \tag{20i}$$

$$\frac{\partial E(NV)}{\partial p} = (p - g)L' + L - F ((1+p)L) ((1+p)L' + L) = 0 \tag{20ii}$$

$$\frac{\partial E(NV)}{\partial E} \equiv 0 \tag{20iii}$$

Once the optimal loan rate p and expected return $\bar{d}$ have been calculated, one can use relation (16) to obtain the posted deposit rate d.

One will observe the indetermination of the equity level and the independence between the loan rate and the expected return on deposits decisions. This result is similar to the one obtained in the simple Klein-Monti model exposed in section one, except that now, independence concerns the <u>expected return on deposits</u>.

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9 Relation (19) is formally equivalent to the deposit insurance case with $\alpha = 1$ (see relation (12)), except that $\bar{d}$ replaces d.

The indetermination of the equity level is discussed first. More equity reduces the probability of bankruptcy and increases the expected return $\bar{d}$, so that the posted deposit rate d can be lowered. It appears from relations (16) and (17), that, ceteris paribus, the loss to the bank due to a decrease of the break-even asset value a* (caused by additional equity) is identical to the gain occurring to the depositors, so that the intermediary can reduce the posted deposit rate and recover exactly the initial loss.[10]

Secondly, one must emphasize that independence concerns the loan rate and the expected return on deposits. If the loan rate is independent of the posted deposit rate (20 ii), the reverse is not true. Indeed, one sees from relation (16) that the posted deposit rate is an increasing function of the break-even value a*, and via its definition in relation (8), a decreasing function of the loan rate. In this case, the effect of the loan rate on the posted deposit rate is clearly negative.

The direction of the recursivity is thus inversed in the "risk bearing" case. The loan rate is independent of the deposit rate but the deposit rate is negatively related to the loan rate.[11]

The volumes of loans in the "free insurance" case (α = o) and in the "risk bearing" case (or "fairly priced" case (α = 1)) can also be compared.

Looking at first-order conditions (20 ii) and (13 ii) in the case α = 0, one observes that the loan rate will be higher (and the loan volume and probability of bankruptcy smaller) in the "risk bearing" case. Deposit insurance with premium unrelated to risk or Central bank "de facto" protection provides unintended incentives to finance a larger volume of risky assets. This result is caused by the fact that a larger volume of loans increases the probability of bankruptcy (F(a*)) and reduces the expected return on deposits and the stock of deposits in the "risk bearing" case. This "penalizing" effect does not occur in the "free insurance" case.

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10 When bankruptcy costs are included in the model, the equity level is positive and such that F(a*) =0.

11 One will also note that the indetermination of the equity level causes the indetermination of the posted deposit rate (relation (16)). This may explain why different banks may post different rates d, while offering the same expected return $\bar{d}$.

Section Four: Conclusions

Independence between the rate decisions has been lost by the introduction of bankruptcy risk in the Klein-Monti neoclassical model, but recursivity permits to study the determinants of one rate, independently of the other one. The direction of the recursivity depends on institutional aspects of reality.

Deposit holders are, in most countries, very well protected by an explicit insurance mechanism (such as the FDIC in the United States) or, de facto, by the "lender of last resort" function of the Central Bank. This would suggest that the "deposit insurance" case developed in section 3.1 is relevant for empirical analysis.

Finally and related to the introduction, it appears that (1) empirical studies of the determinants of loan volume and income riskiness should use the net profit on deposits $((g - d) D)$ and not the deposit rate as an explanatory variable; and (2) that regulations designed to increase deposit profits may well have a negative effect on the loans volume, an unwelcome effect in a depressed economy.

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