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A DYNAMIC MODEL OF FINANCIAL INTERMEDIATION IN A SEMI-INDUSTRIALIZED ECONOMY

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A Dynamic Model of Financial Intermediation

in a Semi Industrialized Economy

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This paper analyzes how the monetary policies which are commonly used in the LDC's affect governments non fiscal revenues. This is done in a fully dynamic model where the demands for money and for loans are derived simultaneously. Monetary adjustment mechanisms can thus take place in a complete general equilibrium setting. Policies which are usually used as non inflationary ways to finance higher public deficits, for example increases in the reserve ratio or in the deposits rate, are found to have shifting and opposite effects through time. While they do meet their goals in the short run, they have adverse long run impacts as they eventually cause an even higher inflation than if the deficits had been simply financed through money creation. The reason is shown to be the loss over time by the state of the rent associated with the provision of liquidity services.

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I) Introduction

The impact of financial reforms on governments abilities to finance their deficits is a topic which has been recently analyzed in several contributions, in particular in Fry (1981 and 1982), Siegel (1981), McKinnon (1981) and Brock (1981). These studies examine how governments non fiscal revenues are affected by changes in the reserve ratio, the interest rate on bank deposits or the rate of monetary creation. Optimal policies are suggested or explicitely derived. The framework of analysis which has been used is however essentially static and no monetary adjustment mechanism is explicitely contemplated. On the other hand, the linkages between the demands for money and for loans are not explored and potentially important second round effects which are transmitted through the loan market are thus ignored.

This paper is an attempt to deal with these issues in the particularly simple setting of a pure consumption economy in which the demands for financial assets and liabilities are derived simultaneously in a fully dynamic context and on the basis of an explicit intertemporal maximization process. The basic framework is one of infinitely lived agents who derive their utility from consumption and from liquidity and have to allocate optimally their wealth between different types of financial instruments. It is therefore in the tradition of monetary adjustment models such as

Sidrauski's (1967) or Dornbusch and Mussa's (1975). Here a credit market is added where agents can borrow back part of the funds which they deposited in the banking system. Liquidity can therefore be either owned or borrowed and changes in monetary policies alter this composition in a dynamic way.

It is found in particular that policies which are usually thought of as non inflationary ways to finance higher public deficits, for instance increases in the reserve ratio or on the interest ceilings on bank deposits, although they do succeed in the short run, have long run impacts which go in the exact opposite direction of what was initially expected from them: inflation goes up even more than if the deficits had been simply financed by money creation. The reason behind this result is shown to be the loss by the state of the rent associated with the provision of liquidity services, as agents substitute the liquidity which they can borrow by their own.

The model to be used is presented in section two of the paper. Section three analyzes its dynamics and section four examines the impact of different monetary policies. Conclusions and possible extensions are presented in the last section.

II) The model

Consider an economy with identical and infinitely lived individuals who derive their utility from consumption and from liquidity. The later is provided by perfectly liquid checking accounts or by imperfectly liquid interest bearing time time deposits.[1/] A convenient form for the utility functional is the following.

$$U_t = \frac{1}{\gamma} \int_t^{\infty} \left[c_t^{\alpha_c} \; m_t^{\alpha_m} \; d_t^{\alpha_d} \right]^{\gamma} e^{-\delta t} dt \qquad (1)$$

$$\alpha_c + \alpha_m + \alpha_d = 1$$

where c, m and d correspond to consumption, checking and time deposits.[2/] The elasticity of substitution between m and d should however depend on their relative yields; one would expect the demand for time deposits to vanish as r^d, the nominal deposit rate, goes to zero; and vice versa, the demand for cash should vanish as r^d becomes infinitely large. A simple functional form meeting the requirements above could be the following:

1/ The inclusion of liquidity into the utility function is a convenient and traditional short cut, although it clearly is not the most desirable way to deal with the underpinnings of the demand for money.

2/ The last two concepts are expressed in real terms.

$$\alpha_m = \alpha_\ell / (1+r^d)$$
$$\alpha_d = \alpha_\ell r^d / (1+r^d) \qquad (2)$$

where, given (1), it is clear that $\alpha_c + \alpha_\ell = 1$.

Besides having access to bank deposits, consumers may also borrow freely from banks at a nominal rate r^b; let b be their real stock of debt. Their budget and wealth constraints may thus be written:

$$y + \rho^d d_t = c_t + \pi m_t + \rho_t^b b_t + \dot{a}_t \qquad (3)$$

$$a_t = m_t + d_t - b_t \qquad (4)$$

where y is agents' income, assumed constant, ρ^d and ρ^b are the real deposit and loan rates and π is the inflation rate, also assumed to be constant.[3/] If e is the uniform reserve ratio applied on all banking deposits, the loan market equilibrium condition is:

$$b_t = (1-e)\ (m_t + d_t) \qquad (5)$$

Agents are thus maximizing (1) subject to the constraints (3) and (4). Assuming rational expectations, they also derive from (5)

3/ The government is thus assumed to adjust its spending at all times so as maintain π constant. The alternative assumption of a constant level of spending and a variable inflation rate would complicate the analysis unnecessarily.

their expectations of the path followed by the loan rate.

III) Differential system and dynamics

Necessary conditions for this maximization problem are as follows:

$$\frac{\alpha_c}{c}\frac{U}{\lambda} = 1 \tag{6}$$

$$\frac{\alpha_\ell}{m}\frac{U}{\lambda} = (1 + r^d)\ (\pi + \mu/\lambda) \tag{7}$$

$$\frac{\alpha_\ell}{d}\frac{U}{\lambda} = \frac{(1 + r^d)}{r^d}\ (-\rho^d + \mu/\lambda) \tag{8}$$

$$\mu / \lambda = \rho^b \tag{9}$$

$$\frac{d}{dt}\left[e^{-\delta t}\lambda\right] = -e^{-\delta t}\mu \tag{10}$$

$$\lim_{t \to +\infty}\left[a\ \lambda\ e^{-\delta t}\right] = o \tag{11}$$

where λ and μ are the shadow prices associated with the flow and stock constraints. Define a^F as financial asset holdings ($a^F = m + d$); summing up (7) and (8) and using (9) gives:

$$a^F = \frac{1}{R}\ \frac{U}{\lambda} \tag{12}$$

where $$\frac{1}{R} = \frac{\alpha_\ell}{1+r^d}\ \left(\frac{1}{r^b} + \frac{r^d}{r^b-r^d}\right) \tag{13}$$

Since r^b is the opportunity cost of checking deposits, r^b-r^d of time deposits, R can be interpreted as an average opportunity cost of liquidity and (12) indicates that financial asset holdings are inversely related to their cost. Now, substitute U/λ obtained from (12) into conditions (6) to (8) to obtain the following set of demand functions:

$$c = \alpha_c \, R a^F \tag{14}$$

$$m = \frac{\alpha_\ell}{r^b(1+r^d)} \, R \, a^F \tag{15}$$

$$d = \frac{\alpha_\ell \, r^d}{(r^b-r^d)(1+r^d)} \, R \, a^F \tag{16}$$

The differentiation of equations (12) to (16), together with the differentiation of the utility function and with equation (10) yields, after some algebraic manipulations which are detailed in the appendix, the following set of differential equations:

$$\dot{\rho}^b = \frac{R}{R_\rho b + \gamma/(1-\gamma)} \left[\frac{\rho^b-\delta}{1-\gamma} - \frac{\dot{a}^F}{a^F}\right] \tag{17}$$

$$\dot{a} = y + \rho^b a - Ra^F \tag{18}$$

On the other hand, using the wealth constraint (4), the loan market equilibrium condition may be expressed as:

$$a^F = a/e \tag{19}$$

Equations (17) to (19), together with the initial value of wealth and the transversality condition (11), completly define the dynamics of the system. Note in particular that according to (18), agents go on accumulating wealth as long as their imputed income ($y + \rho^b a$) is larger than the cost of their liquidity holdings (Ra^F). The steady state equilibrium is reached when wealth equals:

$$a^* = \frac{y}{R^*/e - \rho^{b*}} \tag{20}$$

A more in-depth analysis of the dynamics can be achieved by considering separately two sub-systems in (a, ρ^b) and (a, a^F). Using (19) and substituting into (17) and (18) gives the first following subsystem:

$$\dot{\rho}^b = \frac{y}{R_\rho b + \gamma(1-\gamma)} \left(\frac{\gamma\rho^b - \delta}{1-\gamma} + \frac{R}{e} - \frac{y}{a}\right) \tag{21}$$

$$\dot{a} = y + (\rho^b - \frac{R}{e})\ a \tag{22}$$

Since $R_\rho b > o$, the loan rate equilibrium schedule ($\dot{\rho}^b = o$) is downwards sloping while the wealth equilibrium schedule ($\dot{a} = o$) may slope either way, depending on the sign of $R_\rho b - 1$. Suppose it is upwards sloping; the directions of motion are those shown on figure one. They indicate that the steady state equilibrium is a saddle

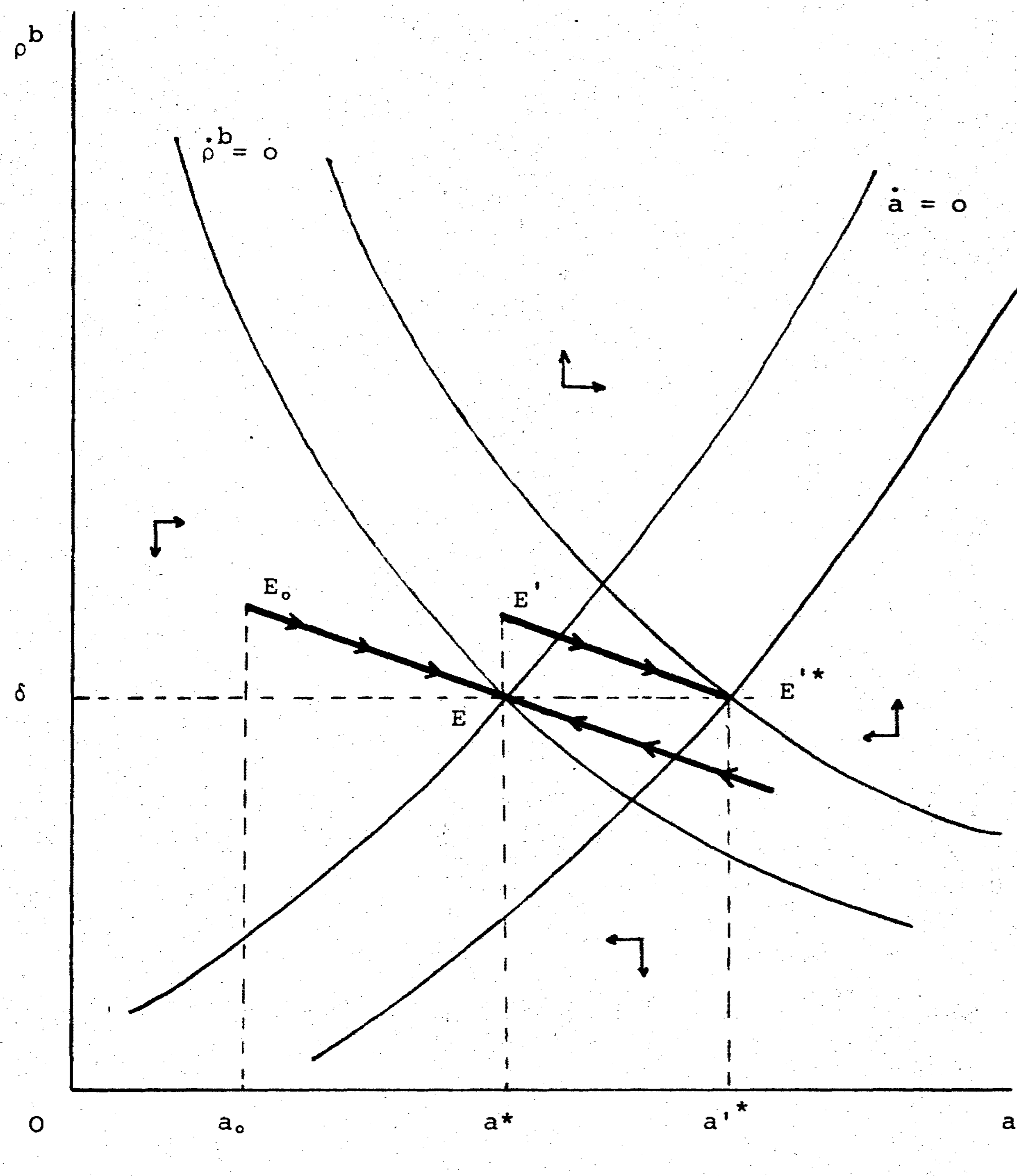

Figure one

point.[4/] Given an initial value of wealth $a_o < a^*$ and given rational expectations, equilibrium in the credit market sets the loan rate at $\rho_o^b > \delta$, on the stable arm of the manifold; ρ^b then falls as a rises towards a^*. These are usual characteristics of monetary growth models.[5/]

Consider now the sub-system in (a, a^F). In this space (see figure 2), the 45 degree line defines the zero borrowing locus ($a=a^F$); the wealth equilibrium schedule AA, as obtained from (18) and defined at the steady state value of the loan rate, is an upwards sloping line, with a slope below unity.[6/] The financial equilibrium schedule BB, as given by (19), has a slope larger than unity and intersects the AA at the steady state equilibrium. Borrowing is given by the vertical distance between the BB and the 45 degree line, wealth by the vertical distance between the 45 degree line and the horizontal axis; asset holdings, by the sum of these two, reflecting the fact that liquidity is partly borrowed, partly owned. The

4/ The stability condition for this to be true is derived in the appendix. It is: $R > e\rho^b$. It means that the cost of liquidity cannot be too low compared to the cost of borrowing, since otherwise agents would keep accumulating and increasing their liquidity forever. Note that this condition can always be satisfied as $e \rightarrow o$ since in that case agents have all the liquidity they want ($a^F \rightarrow \infty$) without need for further accumulation.

5/ But note however that the lending rate here is a market determined variable and not only the ratio of the shadow prices associated with agents' income and wealth constraints, as in Sidrauski's model.

6/ This will be true if the stability condition $R > e\,\rho^b$ is verified for all values of the reserve ratio.

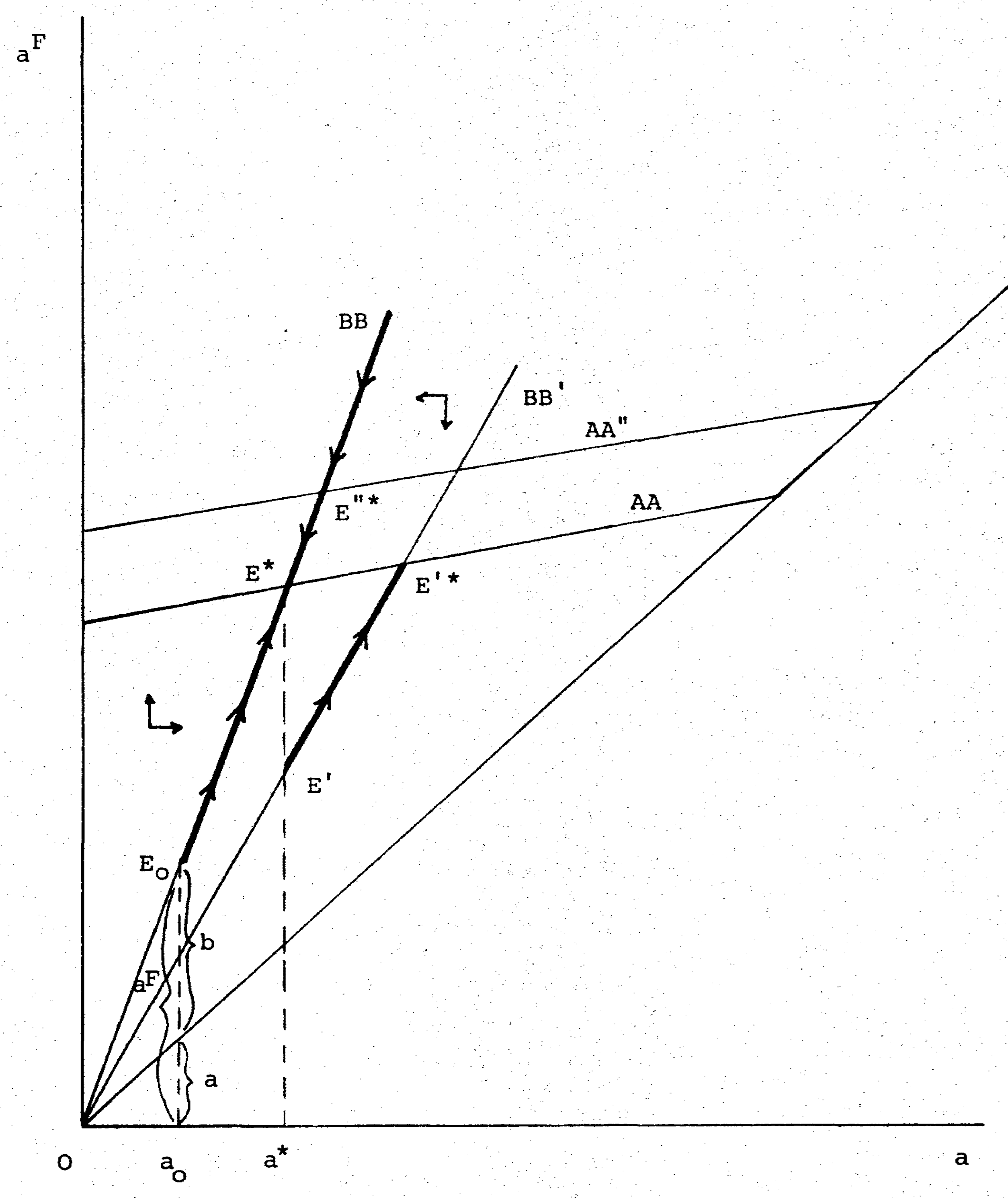

Figure two

directions of motion are those indicated on the diagram. From an initial equilibrium with $a_o < a^*$, wealth, liquidity and borrowing rise over time until they reach their steady state values. The economic underpinnings are easy to understand: at lower wealth levels, agents' desire for liquidity is unsatisfied; at a result, they try to borrow more liquidity, thus raising the loan rate beyond its long run opportunity cost (δ); they also increase their own liquidity over time through saving and accumulation, thus raising simultaneously the supply of loanable funds.

IV) The impact of monetary policies

Consider now the impact of the two most frequently used monetary policies in developing economies: changes in the reserve ratio or in the deposits rate; and consider also the impact of changes in inflation caused by alterations in the rate of money creation. Assume, for convenience, that public spending adjusts in all cases so as to avoid any jump of the price level on the impact. Assume also, for greater simplicity, that the central bank can adjust the interest rate it pays on reserves so as to maintain a constant level of banking revenues.7/ Any variation in private consumption must then be accomodated via public spending.

To begin with, suppose that e rises. Equations (21) and (22) indicate that the wealth and loan rate schedules move rightwards on figure one, intersecting at a new steady state E'^* with a

7/ Another plausible alternative would consist in indexing the rate paid on resserves on the deposits rate. Bank revenues would then fluctuate with changes in monetary policies. It does not however alter in any fundamental way the results obtained with constant revenues.

higher level of wealth. If the system was initially in a steady state, ρ^b must then rise on the impact so that it may later fall back over time to δ. In figure two, on the other hand, the financial equilibrium schedule (BB) rotates clockwise; the new short run equilibrium E' has a lower level of liquidity. From there, a and a^F rise over time until E'^* is reached. Finally, as shown in the appendix, consumption falls in the short run; government spending may then rise without altering the rate of inflation. The economic interpretation is as follows. The higher reserve ratio has reduced the supply of loanable funds, hence raising the cost of borrowed liquidity and incentivating agents to substitute it by their own. To do so, they must save more in order to increase their wealth. The government can then take advantage from these higher levels of savings and raise its own spending in a non-inflationary way.[8/] This is basically what central banks expect when they advocate higher reserve ratios as a way to avoid higher deficits and hence higher rates of inflation.

But consider now what happens in the long run. Consumption in the new steady state rises, since from (14), (19) and (20):

$$c^* = \alpha_c \frac{y}{1-e\rho^b/R^*} \tag{23}$$

8/ Note that the government could also, as an alternative policy, maintain the same level of spending and reduce the rate of money creation, and hence inflation.

Government spending must then fall in relation to its initial, pre-impact, level; or else, the rate of money creation and inflation must rise enough to increase the steady state cost of liquidity (R^*) up to the point where the reduction in private consumption is sufficient to accomodate the initial level of public spending. A quick glance to equation (23) in fact indicates that for a given level of public spending (and hence a given c^*) higher reserve ratios imply higher inflation rates. The original motivation for raising the reserve ratio may thus backfire as the end result goes exactly opposite to what was initially intended and obtained. Vice versa, it can also be checked from (23) that, for a given rate of inflation, public spending is maximized (private consumption minimized) when the reserve ratio is equal to zero.

The story behind this result is as follows: liquidity is a needed good which each agent can acquire individually through savings but at the cost of some sacrifice in his consumption; this sacrifice can in turn be exploited by the government to substitute the fall in private consumption by public spending. But liquidity can also be provided collectively in a relatively costless way through the multiplier effects of the banking system. In the extreme case of a null reserve ratio (the case of full intermediation), no private accumulation at all is needed and everybody can enjoy as much liquidity as he wants. The difference between the utility provided in this way and its cost is a pure rent which the state can appropriate for itself; and the more liquidity services offered to the public, the higher the rent. In this stationary economy without taxes, this rent is in fact the only non-inflationary source of public revenue. As the reserve ratio goes up, a temporary windfall in revenues is provided to the state as agents reduce their consumption in order to accumulate more liquidity on their own. But once they have done so, they end up paying less on their debt, their disposable income goes up, and with it their consumption. The state has lost part of the rent it was extracting and has to reduce its spending correspondingly.

Consider now the case of a rise in the deposits rate. Equations (13) and (20) indicate again that the new steady state E''^* has a higher level of wealth. The trajectory followed by the loan rate on figure one is thus similar to the previous case. In figure two, the AA shifts upwards while the BB is unaltered; over time then wealth, liquidity and borrowing rise until they reach their new steady state values at E''^*. Consumption falls on the impact (see the appendix) and then rises gradually up to a new steady state value above the pre-impact level (check equation (23)). Finally, the ratio of checking to time deposits falls (see equations (15) and (16)).

The economics of the experiment are as follows. A higher deposits rate lowers the cost of owned liquidity and induces agents to accumulate more wealth. The desire for greater accumulation puts an upwards pressure on the lending rate and a downwards pressure on consumption. Public spending may thus rise temporarily without affecting adversely the rate of inflation. In the long run, however, the lower cost of liquidity raises agents' disposable income, hence their consumption and their demand for liquidity; public spending must then be reduced below its initial pre-impact level. If a rise in the deposits rate was initially designed as a policy to attract more funds into the banking system and thus finance a larger public deficit in a non-inflationary way, the end result goes in the opposite direction, again because it lowers in the long run the rent perceived by the state on the provision of liquidity services.[9/]

Consider finally the case of a fall in inflation caused by a reduction in the rate of money creation. The impact is similar to the one we have just analyzed. But the portfolio substitution goes now the other way, from time into checking deposits.

Before concluding the analysis of this model, let us briefly examine what the government should optimally do in this economy if it wanted to maximize steady state welfare while financing a given level of spending. If public spending is given, private consumption is given too and it is then easy to check from (14), (19) and (20) that this is equivalent to having a^* and e/R^* given; so that welfare is maximized when e, π and r^d are chosen so as to maximize:

$$V = \left(\frac{1}{1+r^d}\right)\left(\frac{1}{\pi+\delta}\right)^{\frac{1}{1+r^d}}\left(\frac{1}{\pi+\delta-r^d}\right)^{\frac{r^d}{1+r^d}}$$

with $\frac{e}{1+r^d}\left(\frac{1}{\pi+\delta}+\frac{r^d}{\pi+\delta-r^d}\right)$ given.

It is clear, by inspection, that the optimum is reached when $e \rightarrow o$, $\pi \rightarrow -\delta$, $r^d \rightarrow o$. This set of conditions, which correspond to the full liquidity rule of usual monetary growth models, provide

9/ Note that the removal of ceilings on the deposits rate are often proposed as an important component of a financial reform package. Taken in isolation (and in particular if not introduced together with reductions in the reserve ratio) this policy is bound in the context of this model, to have adverse long run effects.

a clear support for liberalization policies which intend to reduce simultaneously the reserve ratio and the rate of inflation while maintaining a positive real deposits rate ($\rho^d = \delta$).

V) Conclusions

It was found in this paper that policies which are usually used as non inflationary ways to finance higher public deficits have a long run impact which goes in the exact opposite direction: inflation goes up even higher than if the deficits had been simply monetized. The reason behind this result has to do with the rent associated with the provision of liquidity services. To the extent that the welfare provided by liquidity is larger than the cost of providing it,[10/] there exists a rent which can be tapped by the state and used to finance its deficit in a truly non inflationary way. If the state, through the use of mistaken monetary policies, forces agents to accumulate their own liquidity instead of using the one provided by the multiplier effects of the banking system, everybody stands to loose in the long run: the public because it had to lower its consumption for a while in order to accumulate more wealth; and the state because it drove out of the market part of his customers and had therefore to accept a lower income on the sale of its liquidity services.

10/ This seems to be intuitively true although the confirmation of the hypothesis is of course an empirical matter.

For this scenario to be true, the state should also be able to take away from the banking system the rent associated with liquidity. Wether this is true or not is a matter of empirical investigation. If one judges by the proliferation of banking branches and the general well being of banks in most LDC's, it may be thought that the banking system has generally been able to retain for itself a large part of this rent. If that is so, banks would have generally been made better off by a period of rising reserve ratios such as many LDC's have experienced in the last decades. And expenditures (particularly in the opening of new branches and the multiplication of banks) may also have risen in paralel.[11/] However, as the rising trends in the reserve ratios tend to stabilize, banks may experience a long run squeeze in their revenues. In the context of an overextended banking structure and of a generally non competitive interest rate determination, this may lead to a rise in the monopoly power of banks as they struggle to defend their incomes.

11/ That seems to be true in the case of Mexico. See for example Ize (1982).

Appendix

A. Derivation of the differential system.

Differentiate equations (12) to (16):

$$\frac{R}{R} + \frac{\mathring{a}^F}{a^F} = \frac{\mathring{U}}{U} - \frac{\mathring{\lambda}}{\lambda} \qquad \text{(A-1)}$$

$$\frac{\mathring{R}}{R} = \frac{R_{\rho^b}}{R}\,\mathring{\rho}^b \qquad \text{(A-2)}$$

$$\frac{\mathring{c}}{c} = \frac{\mathring{R}}{R} + \frac{\mathring{a}^F}{a^F} \qquad \text{(A-3)}$$

$$\frac{\mathring{m}}{m} = \frac{\mathring{R}}{R} + \frac{\mathring{a}^F}{a^F} - \frac{\mathring{\rho}^b}{r^b} \qquad \text{(A-4)}$$

$$\frac{\mathring{d}}{d} = \frac{\mathring{R}}{R} + \frac{\mathring{a}^F}{a^F} - \frac{\mathring{\rho}^b}{r^b - r^d} \qquad \text{(A-5)}$$

Differentiate also the utility function:

$$\frac{\mathring{U}}{U} = \gamma \left[\alpha_c \frac{\mathring{c}}{c} + \frac{\alpha_\ell}{1+r^d} \frac{\mathring{m}}{m} + \frac{\alpha_\ell\, r^d}{1+r^d} \frac{\mathring{d}}{d} \right] \qquad \text{(A-6)}$$

Finally, express equation (10) as:

$$\frac{\mathring{\lambda}}{\lambda} = \delta - \rho^b \qquad \text{(A-7)}$$

Using (A-3), (A-4) and (A-5), (A-6) may be rewritten:

$$\frac{\mathring{U}}{U} = \gamma \left(\frac{R}{R} + \frac{\mathring{a}^F}{a^F}\right) - \gamma \frac{\mathring{\rho}^b}{R} \qquad \text{(A-8)}$$

On the other hand, (A-1) and (A-7) give:

$$\frac{\mathring{U}}{U} = \frac{\mathring{R}}{R} + \frac{\mathring{a}^F}{a^F} + \rho^b - \delta \qquad \text{(A-9)}$$

And, with (A-2), (A-8) and (A-9):

$$\mathring{\rho}^b = \frac{R}{R_{\rho}b + \gamma/(1-\gamma)} \left[\frac{\rho^b-\delta}{1-\gamma} - \frac{\mathring{a}^F}{a^F}\right] \qquad \text{(A-10)}$$

On the other hand, with (14) to (16), the budget constraint can be expressed as:

$$\mathring{a} = y - \rho^b b - \left[\alpha_c + \frac{\alpha_\ell \pi}{r^b(1+r^d)} - \frac{\alpha_\ell r^d \rho^d}{(r^b-r^r)(1+r^d)}\right] Ra^F \qquad \text{(A-11)}$$

Rearranging terms and expressing α_c as $1 - \alpha_\ell$, the last term on the right hand side of this equation can be shown to be equal to $-\left[R + \rho^b\right] a^F$. Substituting then b obtained from (4) into (A-11):

$$\mathring{a} = y + \rho^b a - Ra^F \qquad \text{(A-12)}$$

b. Stability condition

For the steady state equilibrium to be a saddle point, the determinant of the Jacobian of the system must be negative around it. Differentiation of equations (21) and (22) gives:

$$J = \begin{vmatrix} \rho^b - R/e & (1 - R_\rho b/e)a \\ \dfrac{R}{R_\rho b + \gamma/(1-\gamma)} \; \dfrac{y}{a^2} & \dfrac{R}{R_\rho b + \gamma/(1-\gamma)} \left(\dfrac{\gamma}{1-\gamma} + R_\rho b/e\right) \end{vmatrix}$$

So that det J < o if:

$$(\rho^b - R/e)\left(\frac{\gamma}{1-\gamma} + R_\rho b/e\right) - \frac{y}{a}\,(1-R_\rho b/e) < o$$

Replace y/a by its steady state value obtained from (20), and the condition above becomes:

$$(\rho^b - R/e) \;/\; (1-\gamma) < o \quad \text{and hence} \quad R > e\,\rho^b.$$

C. Short run impacts on consumption.

Consider the short run impact on consumption of a rise in e. We know that $\dot{\rho}^b < o$ after the impact. Hence, from (21):

$$\frac{\gamma\rho^b - \delta}{1-\gamma} + \frac{R}{e} - \frac{y}{a} < o$$

If the system was initially at the steady state, then from (20):

$\dfrac{y}{a} = \dfrac{R^*}{e^*} - \delta$, where e^* is the pre-impact value of e.

Replacing y/a obtained from this equation into the condition above:

$$\frac{R}{e} - \frac{R^*}{e^*} + \frac{\gamma(\rho^b - \delta)}{1-\gamma} < 0$$

Since $\rho^b > \delta$ after the impact; this implies $R/e < R^*/e^*$. It is then clear from (23) that consumption should rise on the impact.

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