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Recession, high interest rates and instability: simple macro-dynamics

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Abstract

We present a highly stylized closed economy macro-model that recreates some empirically verified aspects of financial and macroeconomic instability in emerging markets. Simple dynamics show how a recession may lead to a shortfall of liquidity of banks which in turn may be forced to acquire additional liabilities and increase deposit rates. We show that an unstable path may emerge as a result of high interest rates paid on deposits and low output levels.

Keywords: Recession; Instability; Interest rate; Financial crisis

JEL classification: E44; G21

1. Introduction

To the extent that the empirical literature on emerging market crises has proven successful, the results have started to highlight a number of macroeconomic and early warning indicators associated with the genesis and evolution of economic distress. Kaminsky (1998), for instance, referring to the literature on banking crisis, says that "most of the work has pointed that crises and panics are preceded by recessions" (p. 5). Evans et al. (2000), in their effort to take stock of current knowledge in the area of macroprudential indicators, similarly state: "Recessions have preceded many episodes of systemic financial distress" (p. 10). Indeed, the early work citing recessions as an antecedent of historical banking

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crisis is Kindelberger (1978). Demirguc-Kunt and Detragiache (1998), in their panel study for 65 countries, offer a broader picture. They find a low GDP growth and a high real interest rate (among other factors) is strongly associated with a high probability of banking crisis. They also find that the variable with the lowest type I error (failure to identify a crisis) is the real interest rate. The same factors have been identified by Kaminsky and Reinhart (1998, 1999) empirical study of early warnings signals.[1] More recently, Rojas-Suarez (2001) has provided evidence showing that in assessing banks performance in emerging markets, alternative financial system indicators such as interest rate paid on deposits and interest rate spreads may reveal better the true riskiness of banks than the traditional indicators (such as capitalization and proxies for the quality of loans), especially on the eve of a crises. Specifically, she points out that fragile banks fund their cash requirements by offering high deposit rates, but the resulting increases in funding costs are not translated into proportional increases in loan rates, as banks are aware that this could cause their risky borrowers to default. Consequently, spreads between deposit and lending rates decline during bad times.

The aim of this note is to present, in a highly stylized macro-model, an analytical and reliable connection between bad times of macroeconomic activity and a small set of early warning signals reported above. In particular, we want to highlight that as a recession starts, the fall in the income stream of banks leads to an earnings squeeze and illiquid conditions. To compensate for the fall in interest income and to meet the obligations as they fall, due (maturing deposits) liquidity is essential. If sophisticated asset–liability managements are not available, banks are forced to acquire additional liabilities and increase deposit rates. This dynamic leads the system towards an unstable and explosive path.[2] Furthermore, we also show that once the level of economic activity is endogenized, high interest rates paid on deposits when combined with low output levels can lead the economy towards an unstable path. In Section 2, we first present a very simple structure of real and financial sector in a closed economy framework and derive a linkage between a fall in economic activity and the explosive behavior of interest rates on deposits. Section 3 extends this simple analytical model to examine the dynamic interactions between the flow of output and the interest rate over time.

2. Rising deposit rates with an exogenous output shock

In order to make the presentation simple, we will assume that the price level is constant and normalized to unit. Hence, no distinction can be made between nominal and real variables. Consider then a Kalecki–Steindl investment function as reproduced by Dutt (1990)

$$I = \beta_0 + \beta_1 r \tag{1}$$

where private investment, I, is sensitive to autonomous changes guided by unexpected and unpredictable events, and by changes in the effective profit rate, r.

[1] Kaminsky and Reinhart (1999) also point out that "the financial vulnerability of the economy increases as the unbacked liabilities of the banking-system climb to lofty levels" (p. 474).

[2] Another similar line of inquire states that as the recession unfolds, depositors try to reassess the risk of the bank debt. Since they are uninformed about the quality and the value of bank assets, the bad shock may result in depositors withdrawing large amounts from all banks and banks increasing interest rates on deposits as a reaction (see, for instance, Calomiris and Gorton, 1991).

If market imperfections and excess capacity prevail in the goods market, and the mark-up remains constant, following Taylor (1983), the profit rate will respond to changes in the level of economic activity according to the following equation

$$r = \frac{\tau}{(1+\tau)} \frac{Y}{K} \tag{2}$$

where τ represents the mark-up on unit costs, K is the given stock of capital, and Y stands for the output level of the economy. Indeed, Eq. (2) is no more than the result of substituting a price level equation such as, $p=(1+\tau)\phi$, into the profit rate equation, $r=(pY-\phi Y)/pK$, where ϕ, the average unit cost face by the firm, is exogenously fixed.

At the firm level, the demand for loans, L, equals the sum of corporate debt inherited from the past and the financing gap. We implicitly assume away the amount financed by internal funds.

$$L_t = L_{t-1} + I_t \tag{3}$$

From the balance sheet of the financial system, we know that

$$E = L + R - D \tag{4}$$

that is, net worth, E, is equal to assets (loans, L, and reserves, R) minus liabilities, D. Banks have only loans for assets and no income other than from bank loans. If for simplicity we assume that the required reserve ratio is zero, then the change in net worth over time, $\mathrm{d}E/\mathrm{d}t$, yields

$$\frac{\mathrm{d}E}{\mathrm{d}t} = i_{\mathrm{L}}L - i_{\mathrm{D}}D \tag{5}$$

where i_{L} and i_{R} are the average rate that banks charge for loans and the average deposit rate, respectively.

Since our economy is on the eve of a crisis, we will assume that the interest rate on loans, i_{L}, is fixed at an upper threshold beyond which banks are aware that their risky borrowers can default. That is

$$i_{\mathrm{L}} = \bar{i}_{\mathrm{L}} \tag{6}$$

This assumption may allow us to recreate Rojas-Suarez's idea that in periods where banks offer high deposit rates, the resulting increases are not translated into proportional increases in loan rates, and therefore, the interest rate spread will diminish. In fact, Stiglitz and Weiss (1981) have argued that lenders often impose optimal ceilings on the loan rate because only riskier borrowers would be willing to borrow at higher rates. This derives directly from the residual imperfect information which is present in loan markets after banks have evaluated loan applications.[3]

[3] Hence, any increase in profits from a higher spread between lending and deposit rates would be more than offset by the rising incidence of default.

Proposition 1. *If banks react to a fall in the return on assets by increasing the deposit rate, then the increase in the deposit rate will further increase the cash flow needs of the banks and the system will exhibit an unstable and explosive path.*

Proof of Proposition 1. Suppose that the demand for deposits depends positively on the deposit interest rate as shown in expression (7).

$$D = D(i_D); \frac{\mathrm{d}D}{\mathrm{d}i_D} > 0 \tag{7}$$

Substituting now Eq. (2) into Eq. (1) and the result into Eq. (3), we get

$$L = L_{t-1} + \beta_0 + \beta_1 \frac{\tau Y}{(1+\tau)K} \tag{8}$$

which indicates that the demand for loans will depend on the output level of the economy. That is, lending is output-driven. □

The behavioral equation for net worth will be given by

$$E = L(Y) - D(i_\mathrm{d}) \tag{9}$$

In that case, the time variation of net worth is given by

$$\frac{\mathrm{d}E}{\mathrm{d}t} = \frac{\mathrm{d}L}{\mathrm{d}Y}\frac{\mathrm{d}Y}{\mathrm{d}t} - \frac{\mathrm{d}D}{\mathrm{d}i_\mathrm{d}}\frac{\mathrm{d}i_\mathrm{d}}{\mathrm{d}t} \tag{10}$$

Now let us assume, for the moment that the level of output is exogenous to the system, so that $\frac{\mathrm{d}L}{\mathrm{d}Y}\frac{\mathrm{d}Y}{\mathrm{d}t} = 0$. Then, combining Eqs. (10) and (5) and rearranging, we may obtain the time path of the deposit interest rate as

$$\frac{\mathrm{d}i_\mathrm{d}}{\mathrm{d}t} = \frac{-i_\mathrm{L}L + i_\mathrm{d}D}{(\mathrm{d}D/\mathrm{d}i_\mathrm{d})} \tag{11}$$

Substituting Eq. (8) into Eq. (11), the time path of the deposit rate yields

$$\frac{\mathrm{d}i_\mathrm{R}}{\mathrm{d}t} = \frac{-\left[L_{t-1} + \beta_0 + \beta_1 \frac{\tau Y}{(1+\tau)K}\right] i_\mathrm{L}}{(\mathrm{d}D/\mathrm{d}i_\mathrm{d})} + \frac{Di_\mathrm{d}}{(\mathrm{d}D/\mathrm{d}i_\mathrm{d})} \tag{12}$$

Eq. (12) is a first order linear differential equation. Notice that the time path of the deposit interest rate is inversely related to the output level of the economy. However, it is easily seen also that the positive sign of $\mathrm{d}D/\mathrm{d}i_\mathrm{d}$ makes for dynamic instability and the time path will diverge from equilibrium.[4]

[4] We can make the analysis even more realistic or general by assuming that reserve requirements are nonzero. Assuming that that deposits carry reserve requirements in a fraction r, Eq. (10) yields $\frac{\mathrm{d}E}{\mathrm{d}t} = \frac{\mathrm{d}L}{\mathrm{d}Y}\frac{\mathrm{d}y}{\mathrm{d}t} + (r-1)\frac{\mathrm{d}D}{\mathrm{d}i_\mathrm{d}}\frac{\mathrm{d}i_\mathrm{d}}{\mathrm{d}t}$. Now combining Eqs. (10) and (5) and rearranging, we may obtain $\frac{\mathrm{d}i_\mathrm{d}}{\mathrm{d}t} = \frac{i_\mathrm{L} - i_\mathrm{d}D}{(r-1)\frac{\mathrm{d}D}{\mathrm{d}i_\mathrm{d}}}$. Since $(r-1)$ is negative, again the time path of the deposit interest rate is inversely related to output.

3. The instability path with rising interest rates and endogenous output

Let us now consider the case when Y is endogenously determined. Most of the assumptions of Section 2 are retained. To understand the genesis of the loan market equilibrium, we keep the assumption that the amount of liabilities that banks can hold depends on the interest rate on deposits. The demand for loans responds to output variations as stated above. Consequently, the condition for clearing the loan market is

$$D = L \tag{13}$$

or

$$D(i_{\mathrm{d}}) = L(Y);$$

$$\mathrm{d}D/\mathrm{d}i_{\mathrm{d}} > 0; \quad \mathrm{d}L/\mathrm{d}Y > 0 \tag{14}$$

Notice that the model has only one asset which means that an equilibrium condition in the market for loans implies that deposits, credit and money are virtually the same thing. A change in output, that requires the banking system to inject liquidity necessary to finance investment, should generate an amount of deposits (which is ex-post equal to the volume of loans) by means of variations in the interest rate on deposits. Since now $\frac{\mathrm{d}L}{\mathrm{d}Y}\frac{\mathrm{d}Y}{\mathrm{d}t} \neq 0$ the total differentiation of Eq. (14) yields

$$\frac{\mathrm{d}D}{\mathrm{d}i_{\mathrm{d}}}\frac{\mathrm{d}i_{\mathrm{d}}}{\mathrm{d}t} = \frac{\mathrm{d}L}{\mathrm{d}Y}\frac{\mathrm{d}Y}{\mathrm{d}t} \tag{15}$$

In the goods market (following Blanchard and Fischer, 1989), we assume that adjustment of output to movements in demand takes time. Namely, we assume that

$$\frac{\mathrm{d}Y}{\mathrm{d}t} = \varphi(Y, i_{\mathrm{d}})$$

$$\varphi_Y < 0 \; y \; \varphi_{i_{\mathrm{d}}} < 0 \tag{16}$$

Note that $\varphi_Y < 0$ follows from the assumption that the marginal propensity to absorb is lower that one, and $\varphi_{i_{\mathrm{d}}} < 0$ represents the contractionary effect of a higher interest rate on deposits. Literally, higher deposits correspond to a decision not to spend.

The goods market and credit market equilibrium allow the following proposition:

Proposition 2. *The dynamic behavior (over time) of the system that represents equilibrium in both markets yields a saddle point.*

Proof of Proposition 2. Rearranging Eq. (15), we have

$$\frac{\mathrm{d}i_{\mathrm{d}}}{\mathrm{d}t} = \frac{(\mathrm{d}L/\mathrm{d}Y)/(\mathrm{d}Y/\mathrm{d}t)}{\mathrm{d}D/\mathrm{d}i_{\mathrm{d}}} \tag{17}$$

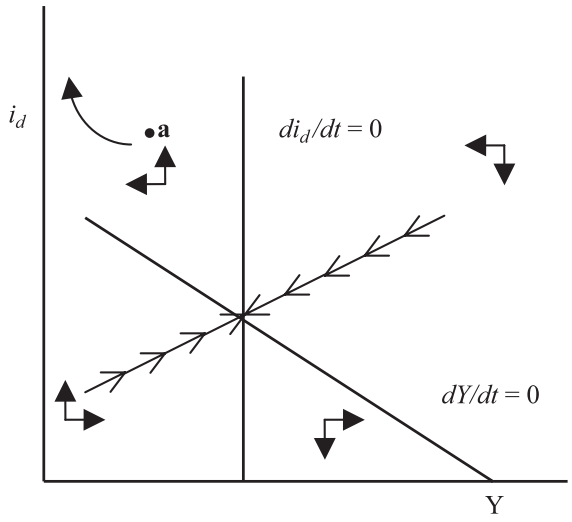

Fig. 1. The goods and loans market dynamic equilibrium.

Eqs. (16) and (17) represent a first order differential equation system in the variables interest rate, i_d, and income, Y. In steady state conditions, we know that $dY/dt = 0$ and $di/dt = 0$. Then, from the $di_d/dt = 0$ locus in Eq. (17) it is relatively easy to determine an equilibrium function in the credit market (in the $i_d - Y$ space). The constant interest rate locus is vertical as shown in Fig. 1. Moreover, the rule of the implicit function gives us a modified Eq. (16)

$$\frac{di_d}{dY_{\frac{dY}{dt}=0}} = -\frac{\varphi_Y}{\varphi_{i_d}} < 0$$

which indicates that the equilibrium in the goods market will exhibit a downward sloping schedule in the $i - Y$ space. Fig. 1 shows then the two loci on which i_d and Y, respectively, are not changing. The intersection of the two loci depicts the steady state but this steady state is, not surprisingly, a saddlepoint with a unique convergent path. The system is stable in some directions and unstable in others. It is quite interesting to note that initial positions that show very high interest rates (above equilibrium) combined with very low output levels (below the equilibrium level) will exhibit instability. Along the path starting at 'a', for example, instability will prevail.

4. Conclusions

Despite the simplistic and starkly schematized nature of the model presented here, it suggests how economic dynamics may be akin to some empirically verified aspects of financial and macroeconomic instability in emerging markets. We have shown that absence of sophisticated asset–liability management, a fall in the demand for loans induced by a recession, may lead to a shortfall of liquidity and banks are forced then to acquire additional liabilities and increase deposit rates. This process may lead to an explosive path of debt dynamics. Moreover, we have argued that macroeconomic instability is in large

part due to the interplay between the forces that push the economy into a recession and the phenomenon of increasing interest rates on deposits.

We do not claim here that the above model is a fair representation of the complex interplay of factors that generate macroeconomic or banking crises in emerging markets. To say the least, our model exhibits a very primitive financial system, ignores open economy issues and does not have much to say about oscillations. Yet we believe that a view on the economic dynamics that takes into account recent styled facts has to be taken more seriously.

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