TECHNOLOGY, CAPITAL FLOWS AND THE BALANCE OF PAYMENTS CONSTRAINT IN A STRUCTURALIST NORTH-SOUTH MODEL

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ABSTRACT This paper presents a North-South model which combines a demand curve for foreign exchange, based on the Keynesian Balance-of-Payments-constrained-growth theory, and a supply curve, based on the principle of increasing risks, which is nonlinear on the interest rate. The dynamics of the model describes a situation of external fragility in economies facing problems of international competitiveness, in which external desequilibrium recurrently puts a downward pressure on the rate of growth and favors exchange rate devaluation in Southern economies.

Key words: structuralist macroeconomic models; balance-of-payments-constrained growth

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TECNOLOGIA, FLUXOS DE CAPITAL E RESTRIÇÕES NO BALANÇO DE PAGAMENTOS EM UM MODELO ESTRUTURALISTA NORTE-SUL

RESUMO O trabalho desenvolve um modelo Norte-Sul que combina, por um lado, uma curva de demanda de capital externo, baseada na teoria keynesiana de crescimento com restrições no Balanço de Pagamentos, e por outro, uma curva de oferta de capital externo não-linear na taxa de juros, como sugerido pelo princípio do risco crescente. A dinâmica do modelo descreve uma situação de elevada fragilidade externa em economias com problemas estruturais de competitividade internacional, que pressionam recorrentemente no sentido da redução das taxas de crescimento econômico ou da desvalorização do câmbio.

Palavras-chave: modelos macroeconômicos estruturalistas; crescimento com restrição no balanço de pagamentos

INTRODUCTION

After the "lost decade" of the eighties, when Latin America was left aside as a destination for international lending, the nineties witnessed the return of foreign capital to the region (Cepal, 1998, chapter III). This has been a mixed blessing, however. Mounting trade deficits, external debt and the increasing fragility of the capital account once again posed in the agenda of several Latin American countries the problem of both currency and debt crises in the late nineties (French-Davis, 2000). In this chapter we present a simple model which highlights the external fragility of Latin America and the region's tendency to suffer from recurrent currency crises. The basic argument is as follows.

First, it is argued — as in the writings of Raúl Prebisch and the Economic Commission for Latin America (ECLA) — that Latin America is prone to external disequilibria stemming from its relative technological backwardness, which hampers international competitiveness (Prebisch, 1949, 1986; Rodríguez, 1980, p. 69-71; Fajnzylber, 1990). This means that the rate of growth consistent with current account equilibrium tends to be significantly lower than the rate of growth required to absorb the population that is either unemployed or employed in low-productivity sectors. Secondly, the possibility of attracting more capital (with a view to financing current account deficits at higher rates of growth) by raising interest rates is limited, as international lenders believe that the risk of default increases with the interest rate when the latter goes above a certain critical value. Both factors produce curves of demand and supply for foreign exchange which define a situation of external vulnerability, meaning that small variations in the initial conditions or in the parameters of the system could unleash a currency crisis. The government enters the model in two ways: on the one hand, it uses fiscal policy to achieve the desired rate of growth; on the other, it uses the interest rate to balance the demand and supply of foreign currency.

This paper consists of three sections. Section 1 presents a demand curve for foreign exchange based on a North-South technology gap, and presents a supply curve of foreign exchange as a nonlinear function of the nominal exchange rate. Section 2 analyzes the dynamics of the interest rate and discusses the problem of external fragility in the South. Section 3 presents the main conclusions of the paper.

1. THE TECHNOLOGY GAP AND THE DEMAND FOR FOREIGN CAPITAL

The literature on balance-of-payments (BOP) constraints on growth suggests that demand variables, especially those related to international trade, are the key to why growth rates differ (McCombie and Thirlwall, 1996, chapter 5; Patel and Pavitt, 1998; Cimoli, 1988). This kind of approach is very close to ECLA´s early concerns with the asymmetric diffusion of technology in the international economy and its effects upon the pattern of specialization, which in Ecla's view continuously reproduces external disequilibrium. In this chapter we take this literature as the basis for developing a North-South model with capital inflows.[1]

Following Amable (1994) and Verspagen (1993), we specify the demand for exports and imports in the South as follows:

$$(1)\ x = \alpha_1(p - w) + \beta_1\left[\log\ \left(\frac{Ts}{Tn}\right)\right] + \varepsilon z$$

$$(2)\ m = \alpha_2(w - p) + \beta_2\left[\log\ \left(\frac{Ts}{Tn}\right)\right] + \pi y$$

where small letters are proportionate rates of growth (*i.e.*, $x = [(dX/dt)\,(1/X)]$; X is the amount of exports). As in Verspagen (1993), the technology gap G is defined as the natural *log* of the ratio between the technological capabilities of the North (Tn) and the South (Ts) ($G = log\,(Tn/Ts)$). Equations (1) and (2) state that real exports growth and real imports growth are, respectively, a function of the difference between domestic inflation (p) and foreign inflation (w), the technology gap (G), real GDP growth in the North (z) and real GDP growth in the South (y). $S = 1/G$, the inverse of the technology gap, is the non-price competitiveness of the South. While in the literature non-price competitiveness is related to the quality of goods and to competitive devices such as financing, post-delivery services, and infrastructure (McCombie and Thirlwall, 1994, p. 284-289), we assume in this case that it is entirely determined by technological variables. α_1 and α_2 are negative price elasticities, ε and π are positive income elasticities, and β_1 and β_2 are positive technology-gap elasticities of the demand for exports and imports, respectively. The nominal exchange rate (E) is assumed to remain constant and equal to unity.

Balance-of-payments (BOP) equilibrium requires the value of imports (which is the volume of imports, *M*, multiplied by the price of imports denominated in domestic currency, *WE*) to equal the value of exports plus *F*, the net capital inflows in domestic currency, *i.e.*, $WEM = WM = PX + PF$ (Thirlwall and Hussain, 1982). Taking logarithms and differentiating with respect to time, we get:

$$(3)\ w + m = a(p + x) + (1 - a)(f - p)$$

where $a = PX/(PX + F)$ is the participation of nominal exports in total foreign exchange earnings (in domestic currency units) and $f = \frac{dF/dt}{F}$. Substituting from equations (1) and (2) into (3) we get the rate of growth of the South consistent with BOP equilibrium (ye):

$$(4)\ y_e = \frac{(1 + a)(\alpha_1 + \alpha_2)(p - w) + a(\beta_1 = \beta_2)\left[\ln\left(\frac{Ts}{Tn}\right)\right] + a\varepsilon z + (1 - a)f}{\pi}$$

If in the long run the real exchange rate adjusts to purchasing power parity ($p = w$), equation (4) turns into (5):

$$(5)\ y_e = \frac{a\beta S + a\varepsilon z + (1 - a)f}{\pi}$$

where $\beta = (\beta 1 + \beta 2)$ and $S = 1/G = ln\,(Ts/Tn)$.

Finally, we will assume that G is solely determined at a technological level, according to a linear North-South diffusion curve (as in Fagerberg, 1988a and 1998b), given by

$$(6)\ \frac{dS}{dt} = \mu - \mu\left[\left(\frac{Ts}{Tn}\right)\right] - p$$

where μ is a measure of the local effort at technological imitation in the South and ρ is the exogenous rate of technological innovation in the North. By assumption, $\mu > \rho$. Equation (6) gives a stable equilibrium solution for the capabilities ratio $(Ts/Tn)^* = (\mu - \rho)/\mu$ and therefore for G and S. In what follows we will assume that the technology gap is always in equilibrium. Substituting (Ts/Tn) for its equilibrium value in (5) we get:

$$(7)\ y_e = \left(\frac{1}{\pi}\right)\ [a\beta S_e + a\varepsilon\ z + (1-a)f]$$

where $S_e = \log\ [(\mu - \rho)\ /\mu] < 0$.

Equation (7) endogenously determines the rate of growth of the South given its non-price competitiveness, the rate of growth of the rest of the world, and real capital inflows.

Let us now look at equation (7) from a different perspective. If we assume that there exists a desired rate of growth (*yd*) for the South (see below), to which the government is committed and which it actively pursues (for instance, through an expansionary fiscal policy), we can write (7) as a demand equation for foreign currency *given* the rate of growth:

$$(8)\ f_d = \left[\frac{1}{(1-a)}\right][\pi y_d - a\beta S_e - a\varepsilon z]$$

where $f_d = \dfrac{dFd/dt}{Fd}$ is the proportionate rate of growth of capital inflows (*Fd*) the South will have to obtain in the international markets in order to sustain y_d, given non-price competitiveness (as mentioned, a function of the parameters of North-South technological diffusion), the rate of growth of the North, and the participation of capital inflows in the BOP $(1 - a)$.

We define the desired rate of growth of Southern economies as the rate of growth that produces full employment. This is the objective governments seek to achieve by using conventional fiscal instruments. In a dual economy with a large low-productivity sector, this objective means that the modern sector must grow at a rate capable of producing the employment required to absorb not only the vegetative growth of the work force, but also the people forced to abandon the low-productivity subsistence sector. *The desired rate of growth is taken as exogenous in the model*, but there is a vast literature illustrating how it is determined. It will be a function of the size of the subsistence sector, the elasticity of substitution between labor and capital, and the impact of international trade and technological change on the low-productivity sector (Rodríguez, 1980, p. 98-107; Ros, 2000, p. 71-76). For our purposes, it suffices to say that *yd* is such that $\pi y_d > a\beta S_e + a\varepsilon z$,[2] which makes the assistance of foreign lending necessary to keep the BOP in equilibrium.

We will initially assume that the desired rate of growth y_d is always achieved by means of an active fiscal policy. This assumption enables a

clearer demonstration of the barriers to full employment that emerge in a context of external fragility. This assumption, however, is highly unrealistic. Therefore, we subsequently assume that the effective rate of growth the economy can attain (and which the government is actually able to sustain) falls as the interest rate rises. In other words, y_d is no longer an exogenous constant but a function of the interest rate $y_d(i)$, where $[\delta(y_d)/\delta i]$ is negative. Higher interest rates depress investment and heighten the burden of public and private debt. As a result, y_d is no longer the full employment rate of growth, but a more modest rate of growth the economy succeeds in obtaining in an increasingly less favorable environment. In this case the gap between the full employment rate of growth and the effective rate of growth becomes larger as the interest rate increases.

It should be observed that the model gives inflation no role in shaping long-run growth. As it is assumed that (i) purchasing power parity holds, (ii) the exchange rate is fixed, (iii) foreign inflation is constant, and (iv) growth is only constrained by external disequilibrium, then domestic inflation is an exogenous constant which does not affect competitiveness and therefore could not affect growth. These assumptions are of course highly restrictive. The efforts by the government to achieve full employment through fiscal policy should probably lead to some crowding-out in the long run and to adjustments through prices as well as through output. Still, these assumptions are useful when the focus lies on structural constraints in the presence of technological backwardness. Moreover, these are standard assumptions in Balance-of-Payments-constrained-growth models, which we have preferred to maintain in order to make the model tractable.

We now direct our attention to the supply of foreign capital. The supply of capital from the North is modeled as a non-linear differential equation on the interest rate, where *fs* is the proportional rate of growth of the supply of foreign capital, *Fs*:

$$(9)\ f_s = \frac{[dFs/dt]}{Fs} = b_0 i - b_1 i^2$$

The basic idea (drawn from Curado, 2000, and Stiglitz and Weiss, 1981) is that up to a certain point North agents increase their investments in Southern bonds as the interest rate increases. However, once a critical value for the interest rate is surpassed ($i = b_0/2b_1$), agents regard further increases

in the interest rate as potentially destabilizing and as an indication of external vulnerability. In short, growing interest rates beyond the critical point are associated with an increasing risk of default. Northern investors will therefore reduce the rate of growth of investment in Southern bonds. In Stiglitz and Weiss (1981), higher interest rates lead to adverse selection (as more prudent and reliable borrowers exit the credit market) and to a moral hazard (as agents investing in highly risky projects, with very low probability of success, are stimulated to take credits). This implies that there exists an interest rate that maximizes the expected returns from lending. Such an idea, defined at a micro level, could be extended to a macro level with a view to analyzing the evolution of international lending to Southern countries.

In the next section both curves are placed together. It will be argued that they define a situation of high external fragility in the South stemming from the technological asymmetry that hampers Southern exports, and the ineffectiveness of the interest rate policy to equilibrate the market for foreign exchange.

2. INTEREST RATE DYNAMICS AND EXTERNAL FRAGILITY

(a) The case of the horizontal desired growth rate

Equilibrium between supply and demand of Southern bonds is achieved through variations in the interest rate. We will assume static expectations about the exchange rate as long as the interest rate can work as an effective policy instrument (*i.e.*, it succeeds in balancing the supply and demand of foreign exchange). In other words, the foreign exchange market is in equilibrium with a constant real and nominal exchange rate and when there is no expectation of devaluation. But when the interest rate can no longer play this role a currency crisis may occur. It should be noted that the model is not intended to endogenously produce a currency crisis. It just describes why Southern economies with BOP constraints on growth are more likely to suffer this kind of crises or, at the very least, to recurrently experience serious pressure for devaluating or for reducing their rate of growth.

As mentioned, we will firstly assume that the desired rate of growth (full employment growth) does equal the effective rate of growth. Under this assumption, equation (10) describes the motion of the interest rate as a function of the excess of demand for foreign currency ($f_d - f_s$):

$$(10)\ \frac{di}{dt} = \nu \left[\left(\frac{1}{1-a} \right) (\pi y_d - a\beta S_e - a\varepsilon z) - b_0 i + b_1 i_2 \right]$$

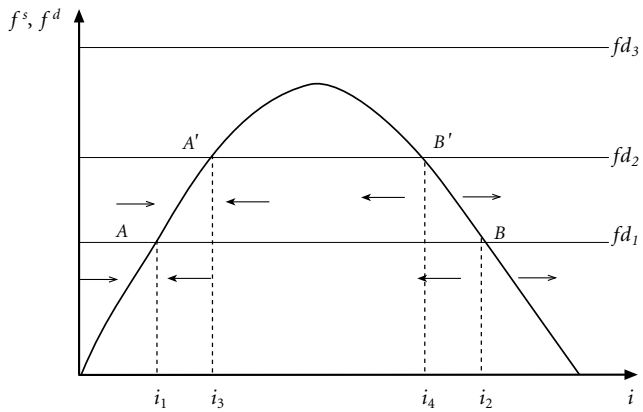
where ν is positive.

The graphic in figure 1 describes the dynamic behavior of the variables in equation (10). When the horizontal line representing the rate of growth of the demand for capital inflows is above the curve that gives the rate of growth at which foreign capital is offered by Northern investors, the interest rate must be increasing. Inversely, when capital is supplied at a higher rate of growth than demanded by Southern investors, the interest rate falls. The interest rate thus adjusts the rate of growth of the demand and supply of foreign capital. In equilibrium, both rates of growth are equal and the central bank reserves remain stable.

The system thus shows two equilibrium solutions, points *A* and *B* in figure 1, where $f^s = f^d$ and the interest rate is steady. Are these points stable? In order to answer this question we must look at di/dt in the vicinity of the equilibrium values of the interest rate. Let us first look at i_1. For points to the left of i_1 di/dt is positive, hence the interest rate increases. For points to the right of i_1 di/dt is negative and the interest rate falls; i_1 is therefore an attractor (stable). Inversely, to the left (right) of i_2 di/dt is negative (positive), hence i_2 is a repeller (unstable).

The model asserts that when the interest rate is higher than i_2 it will be unable to provide a stable solution to a continuous fall in central bank re-

Figure 1: Changes in the *fd* curve



serves (stemming from the asymmetry in the growth of the demand and supply of foreign capital). An increase in the demand of foreign capital increases the interest rate, but this fails to attract new capital because of the perception that the risk of default is growing. A higher interest rate is in this case destabilizing and moves the system away from equilibrium.

In sum, there is a stable equilibrium (at i_1 in point A) and an unstable equilibrium (at iB in point B) for the interest rate. Beginning from any point within a certain interval of i (between i_2 and iB), the economy will move towards the stable equilibrium. This defines the stability region in which the South will be able to get the foreign exchange it needs to achieve the desired growth rate.[3]

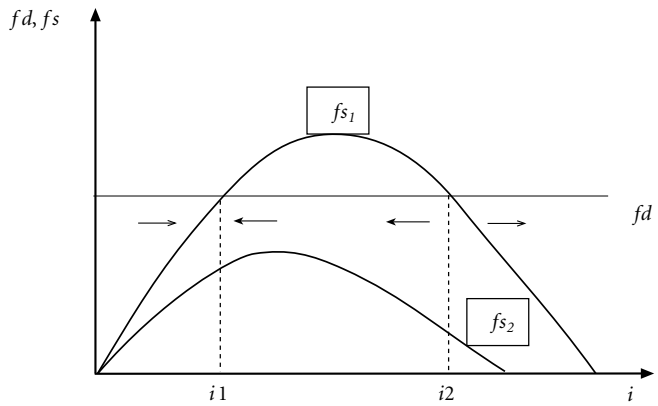
There are two potential sources of instability.

First, there exists a value of y_d for which a stable equilibrium ceases to be possible. This critical value of y_d represents a bifurcation point, as the qualitative behavior of the system changes when this value is surpassed. If y_d is high enough, the straight line f_d will never cut the f_s curve, the interest rate will increase boundlessly and foreign exchange reserves will evaporate. The line f_{d2} illustrates such a case in figure 1. In addition, any negative exogenous shocks in the other variables shaping f_d (for instance, a positive technological shock in the North increasing the technology gap or a negative demand shock reducing the rate of growth of the North) may move f_d upwards and take it irreversibly away from the stability path.

Secondly, as already mentioned, even when f_d cuts f_s, for $i > i_2$, the interest rate ceases to work as an effective instrument for achieving external equilibrium. When the f_d curve is far from its origin (as in f_{d2}), the instability region is already very large. Any minor aleatory shock either in the interest rate or in the position of the f_d line will place i in the instability region.

Changes in the demand curve are not the only factor affecting the stability of the debt path. Changes in the position of the f_s curve can also play a similar role. f_s will move as a result of alterations in the parameters b_0 and b_1, which reflect the lenders' perceptions of the risk of increasing their investments in Southern bonds. As in the case of the desired rate of growth, there exists a certain combination of b_0 and b_1 that represents a bifurcation point — no equilibrium is possible for the system when b_0 / db_1 is below this critical value. Figure 2 illustrates that case, assuming that b_0 falls and b_1 increases

Figure 2: Changes in the *fs* curve



(for instance, because of a contagion effect from other countries). In this particular example, the alteration in the parameters of the supply curve makes stability impossible at the previous rate of growth. Either the government alters its fiscal policy, bringing about a fall in the rate of growth (in our model, this implies a downward revision of y_d), or it gives way to devaluation.

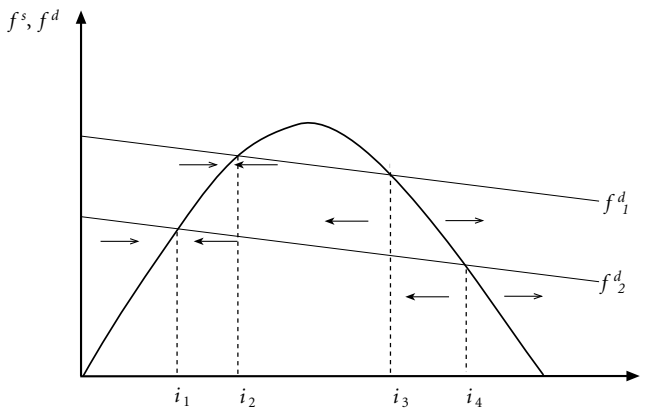
b) The case of a downward-sloping curve of effective growth, $y_d(i)$

The assumption that the government *always* attains the full-employment growth rate is implausible, as higher interest rates will be associated with crowding-out in capital markets, higher uncertainty, and less stimulus for private and public investment. It is more reasonable to suppose that the government will accept a higher level of unemployment as the interest rate increases, or that it will simply admit it has neither the power nor the instruments required to implement its preferred policy. As a result, the effective rate of growth will decline as the interest rate escalates. The motion of the interest rate will be described, in this case, by equation (11):

$$(11)\ \frac{di}{dt} = \nu \left[\left(\frac{1}{1-a} \right) (\pi g - \pi h i - \alpha\beta S_e - a\varepsilon z) - b_0 i + b_1 i^2 \right]$$

where we assume the effective rate of growth to fall linearly according to $y_d = g - hi$.

Figure 3: The case of a downward-sloping curfe of effective growth, $y_d(i)$



Such a situation does not qualitatively alter the analysis presented in the previous section. This can be seen in figure 3.

There are still a stable and an unstable equilibrium value for the interest rate. The regions of potential instability still depend on the parameters of the capital supply curve (b_0 and b_1), on technological competitiveness, and on the effective rate of economic growth. However, the revised demand function does lead to a difference in terms of the magnitude of the region of instability. In view of its downward slope, the new demand curve allows for a broader range of values of the parameters and of the interest rate that produce a stable equilibrium. Figure 3 shows the broadening of the instability region when f_d shifts outwards (the new stable equilibrium is obtained at iB rather than at iA), now assuming a declining effective rate of growth. It can be seen that potential instability increases when f_d shifts, but to a lesser extent than in the previous model.

As already mentioned, however, the basic conclusion about the existence of a significant potential for external fragility and instability in Southern economies will remain in place in both cases. Moreover, the increase in the degrees of stability of this variant of the model results from the admission that full employment ceases to be a plausible policy option. The basic message — the difficulty to keep full employment in a context of weak structural competitiveness — thus remains unaffected.

3. CONCLUDING REMARKS

We have taken as a point of departure a BOP-constrained growth model with capital inflows which we modified in two ways. First, we assumed that governments are committed to attain a desired rate of growth. As a result, we obtained a demand function for foreign exchange which gives the rate of capital inflows that equilibrate the BOP at the desired growth rate. Secondly, we set forth a supply function of capital inflows which is non-linear on the interest rate. For the sake of simplicity we have ignored foreign direct investment and other forms of capital inflows which do not depend on the interest rate. Combining both the supply and demand functions of foreign exchange we produced a framework in which the external fragility of the South is highlighted: the South faces a recurrent external disequilibrium (which the interest rate cannot correct) when it tries to attain the desired rate of growth.

Both North and South may seek to achieve a rate of growth compatible with full employment. But in the South this objective becomes particularly difficult to attain. The existence of a labor surplus puts more pressure on the labor market in the South. And the fact that S^* is negative imposes a stronger dependence on foreign lending. The result is an f_d curve far from the origin and closer to the point of structural instability, which in turn is associated to external vulnerability. If we admit that the effective rate of growth is systematically lower than the desired rate of growth when the interest rate rises, the scope for instability is reduced, but the qualitative properties of the system remain unaltered.

NOTES

1. Moreno-Brid (1998-1999) offers a very interesting model in which capital flows and BOP - constrained growth are combined. Still, as our primary interest concerns external fragility and the possibility of currency crises, we focus on the role of the interest rate in attracting foreign capital.
2. This condition implies that capital inflows are necessary to equilibrate the balance of payments, as the effective rate of growth surpasses the rate of growth compatible with equilibrium in current account. Such a condition is not difficult to hold, since S_e is negative.
3. The slope of the *fs* must be high enough to ensure that at i^* the desired growth rate will be higher than (or equal to) the rate of real capital inflows, allowing for a decreasing (constant) debt/GDP ratio (a key point raised by Moreno-Brid, 1998-1999). This will send a further positive signal to foreign investors as regards the stability of the debt path.

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