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IS-LM-BP in the Pampas

LUIS FELIPE CÉSPEDES, ROBERTO CHANG, and ANDRÉS VELASCO*

Emerging markets (sometimes endowed with fertile pampas) have limited access to world capital markets and suffer from original sin: they cannot borrow in their own currency. Does this mean that monetary and exchange rate policies have non-standard effects in such countries? We develop a simple IS-LM-BP model with balance sheet effects to study that question. Our answer: it all depends.

Most standard macro models of the open economy, such as the textbook IS-LM-BP model, treat financial markets and international capital mobility as perfect. In that world, only expectations of future returns, properly arbitraged, guide capital flows and investment; corporate balance sheets and current output levels are irrelevant.

There are many reasons to be doubtful about this approach. Much recent research provides reasons to believe that sovereign risk, limited and costly monitoring, and imperfect contract enforceability render international capital markets particularly prone to failure in the sense that agents cannot borrow all they want at the world rate of interest limited only by intertemporal solvency constraints. The problem is compounded by *original sin*, which prevents almost all emerging countries from borrowing in their own currencies. This leaves them exposed to currency and relative-price risk, making repayment even dicier.

*Luis Felipe Céspedes is an Economist in the European I Department of the International Monetary Fund. Roberto Chang is Associate Professor of Economics at Rutgers University. Andrés Velasco is Sumitomo Professor of International Finance and Development at the Kennedy School of Government, Harvard University. We are grateful to the Research Department of the IMF for their hospitality while working on this paper. We are also indebted to Michael Devereux, Michael Kumhof, and seminar participants at the Third Annual Research Conference of the IMF, Banco de Mexico, Harvard University, the Middle Eastern Technical Institute (Ankara), and Universidad Torcuato di Tella (Buenos Aires) for useful comments and suggestions. Chang and Velasco thank the National Science Foundation and the Harvard Center for International Development for financial support. The title is inspired by Taylor (1981).

Policymakers fret a great deal over the potentially harmful balance sheet effects of devaluation. They were the main reason Argentina delayed changes in its peg—despite massive overvaluation and a deepening recession—until the economy collapsed along with the currency board. Similar concerns have been voiced in Uruguay and in less-dollarized Brazil. Allegedly, IS-LM-BP works differently in the pampas of these three countries, and in others like them.

We have developed several models of the open economy that embed financial-market imperfections in otherwise standard optimizing dynamic models. Here we present a particularly simple one, a variant of the textbook IS-LM-BP model. Though it has a simple graphical representation, this model permits us to pose a richer array of questions, and obtain more nuanced answers, than does the traditional perfect-capital-mobility approach. In fact, the standard model is simply a special case of our more general framework.

Capital market imperfections and balance sheet effects matter in two senses. First, they magnify the domestic real effects of adverse external shocks, such as a fall in export volumes or an increase in the world real interest rate. Second, devaluation may be expansionary (as in the standard model) or contractionary. The second result requires particularly strong balance sheet effects, arising from both high sensitivity of risk premiums and large inherited dollar debts. Then, and only then, does IS-LM-BP turn out to operate differently in the pampas.

I. The Model

Monopolistically competitive firms in the home economy produce differentiated goods using labor and capital. These goods are exported or sold to domestic agents. There is also a foreign good, which can be imported. Capital is made up of domestic and foreign goods, with Cobb-Douglas shares γ and $1-\gamma$, and depreciates fully after one period. Prices and wages are preset for one period, but are free to adjust thereafter.

Labor and capital are supplied by distinct agents called workers and entrepreneurs. Workers work and consume an aggregate of the domestic and foreign good.[1] Entrepreneurs own capital and also own the firms. In order to finance investment in excess of their own net worth, entrepreneurs borrow from the world capital market. As in Bernanke and Gertler (1989), the cost of borrowing depends inversely on net worth relative to the amount borrowed.

In what follows, all variables are in percentage deviation from the no-shock steady state.[2] Start with the IS, which is standard:

$$y = \alpha_i i + \alpha_x x + \alpha_e e, \tag{1}$$

where y is output of the domestically produced good, i is investment, x is the dollar value of exports, and e is the real exchange rate (the value of the foreign goods in terms of the domestic good). The αs are positive coefficients, which in turn are

[1] With Cobb-Douglas shares γ and $1-\gamma$.

[2] Except for the world interest rate and the risk premium, which are just deviations (not percentage deviations) from the steady state.

combinations of the underlying preference and technology parameters of the model (see the Appendix for details). Under our assumptions, x is exogenously given, while e is endogenous (or at least influenced by monetary policy when prices are sticky). For a given e, the IS schedule slopes up in (i, y) space.

Consider next the LM, which can be written as

$$m = \beta_y y + \beta_e e - \beta_i i, \tag{2}$$

where m is the value of money in terms of the domestic good, β_y and β_i are positive coefficients (all functions of underlying structural parameters), and β_e may be positive or negative depending on whether the elasticity of money demand with respect to consumption expenditures is larger or smaller than one.[3] The real exchange rate enters money demand because it is the value of monetary balances in terms of consumption that matters to the agents who hold it, and they consume both the foreign and the domestic good. Hence, a change in relative prices (a move in e) alters the home-good value of consumption and changes money demand as well. The reason money demand falls with investment is as follows: Holding other factors constant, money demand today depends inversely on consumption tomorrow (recall the standard Euler relationship), and consumption tomorrow is increasing in investment today.

Turn next to the BP. It contains the nonstandard features of the model, so we derive it in more detail. Begin with the investment demand equation

$$i = -(\rho + \eta) + \gamma e, \tag{3}$$

where ρ is the world rate of interest and η the country risk premium (both in units of the foreign good). This relationship can easily be derived from the standard rate of return international arbitrage equation (see the Appendix for details). As it stands, it has a simple intuition: investment is decreasing in the relevant international cost of capital (recall entrepreneurs borrow abroad to finance investment) and increasing in the current real exchange rate—because, all things being equal, a higher e today means a lower expected real depreciation between today and tomorrow, and hence a lower cost of foreign capital, when measured in terms of the domestic good.

Crucially, the risk premium is endogenously determined and given by

$$\eta = \mu\left[(1-\gamma)e + i - n\right], \tag{4}$$

where n is entrepreneurs' net worth (in units of the domestic good) and μ is a positive coefficient. Intuitively, the risk premium increases when the value of current investment is high (we can think of $(1-\gamma)e$ as the price of the investment good in terms of the home good) and decreases with net worth. For a derivation of this relationship from an underlying contract environment with imperfect information and costly monitoring, see Céspedes, Chang, and Velasco (2000). Notice that capital markets are perfect if $\mu = 0$.

Finally, net worth is given by

$$n = \delta_y y - \delta_e e, \tag{5}$$

[3]If this elasticity is smaller than one, then β_e is positive, and vice versa. If it is exactly one, then $\beta_e = 0$.

where both δs are positive coefficients that increase with the initial stock of dollar liabilities relative to initial net worth. An increase in output raises the income of capitalists and therefore increases net worth. A depreciation of the (real) exchange rate increases the output value of debt repayments, because of dollarization of liabilities, and reduces net worth.

Substituting equation (5) into equation (4) we have

$$\eta = \mu\left[\left(1-\gamma+\delta_e\right)e + i - \delta_y y\right], \tag{6}$$

so that the risk premium unambiguously increases with e and i and decreases with y. Finally, substituting this into equation (3) we arrive at the BP curve:

$$i = -\left(\frac{1}{1+\mu}\right)\rho + \left(\frac{\mu\delta_y}{1+\mu}\right)y + \left[\frac{\gamma-\mu\left(1-\gamma+\delta_e\right)}{1+\mu}\right]e. \tag{7}$$

Quite naturally, investment is decreasing in the world rate of interest. The other two terms are more novel. Investment increases with output only if capital markets are imperfect ($\mu > 0$), since higher output increases net worth and reduces the risk premium. Hence the BP curve slopes up in (i, y) space for a given real exchange rate and shock to the world interest rate. If $\mu = 0$, the BP is horizontal.

Notice also that investment may be increasing or decreasing in the real exchange rate. Standard arbitrage forces described above push for an increasing relationship: a higher e makes borrowing abroad cheaper. But the balance sheet effect pushes in the opposite direction: a higher e means a higher value of debt payments and, hence, lower net worth and higher risk premiums. Notice that the balance sheet effect prevails when capital market imperfections are high (large μ) and when the initial stock of dollar debt is high (large δ_e). If the coefficient on e is positive, we have a *financially vulnerable economy*. If the coefficient is negative, we have a *financially robust economy*. The size of balance sheet effects also matters for the slope of the BP curve. The stronger the balance sheet effects (the larger are μ and δ_y), the larger the slope of the BP curve.

We solve the model diagrammatically under the regime of fixed (but adjustable) exchange rates. Because the home currency price is predetermined, a fixed nominal exchange rate makes the relative price e also predetermined. For a given e, the intersection of the IS and BP curves pins down investment and output.[4] In turn, the LM yields the level of money supply necessary for that particular equilibrium.[5]

[4]We consider only the case in which the slope of the IS is larger than the slope of the BP. The opposite case is empirically odd, since it implies that an increase in the world interest rate or a fall in exports leads the economy to a boom in production and investment.

[5]Remember that these are percentage deviations from the no-shock steady state, holding prices and wages constant. Without nominal stickiness, output is exogenous (pinned down by the inherited capital stock and by equilibrium labor supply $l = 0$), the IS and BP pin down the equilibrium real exchange rate for a given output level, and the LM only determines the price level.

II. The Effects of External and Policy Shocks

Consider first the effects of a fall in current exports, depicted in Figure 1. The shock shifts the IS up and to the left, so that for each level of investment there is now a smaller corresponding output level. The new intersection is at point A, with lower investment and output than in the steady state. The output fall is as in the standard model with perfect capital markets and no balance sheet effects, but the fall in investment is not. In that model, a fall in exports today does not affect the profitability of capital tomorrow, and hence it leaves investment unchanged. That is what happens in our model in the special case $\mu = 0$, so that the BP curve is horizontal. Notice that with stronger balance sheet effects (larger μ and δ_y) the BP becomes steeper, magnifying the adverse effects on both investment and output.

Consider next the effects of a one-period increase in the world rate of interest. In Figure 2, the shock shifts the BP down and to the right, so that investment is lower for each output level. The result is lower investment and output, as in point A. This is qualitatively as it would be in the standard model with perfect capital markets and a horizontal BP curve, but quantitatively there is a difference: for the same downward shift, the steeper the BP the larger the reduction in investment and output. The capital market imperfections and resulting balance sheet effects magnify the real effects of adverse interest rate shocks.[6]

Can monetary policy play a countercyclical role? To answer that question we look at the impact of a real depreciation, accommodated by monetary policy. Start with a financially robust economy. This is the case in which initial dollar debt is low with respect to net worth and the elasticity of the risk premium with respect to the ratio of investment spending to net worth is also low. A depreciation of the real exchange rate shifts the IS down and the BP up. This situation appears in Figure 3. Both output and investment unambiguously go up. This is just as in the standard model: real depreciation is expansionary, and it can be used to offset the real effects of adverse shocks.[7]

Turn next to the financially vulnerable economy. This is the case in which balance sheet effects are strong, that is, the initial level of debt is high and the elasticity μ is also high. Figure 4 illustrates the three possible situations. The IS still shifts down, but now the BP shifts down as well. The economy may settle in a point like A with higher output and investment (this is an economy that is vulnerable but not too much so); a point like B where there is a trade-off between investment and output; or a case like C where both output and investment decline. The last one is the case of unambiguously contractionary devaluation, and trying to use exchange rate and monetary policy for countercyclical purposes can only make matters worse.

The intuition of why devaluation can be contractionary is simple: with imperfect capital markets, balance sheets matter; if there are enough inherited dollar liabilities, the real depreciation worsens the balance sheet and increases the risk premium; in turn, this pulls down investment and aggregate demand; and if the

[6]The same is true of export shocks.

[7]Notice that the presence of financial imperfections has ambiguous effects on the size of the expansion. On the one hand, having $\mu > 0$ and large δ_e reduces the size of the vertical shift in the BP; on the other hand, a large μ increases the slope of the BP, which magnifies the equilibrium impact of any depreciation.

Figure 1. Fall in Exports

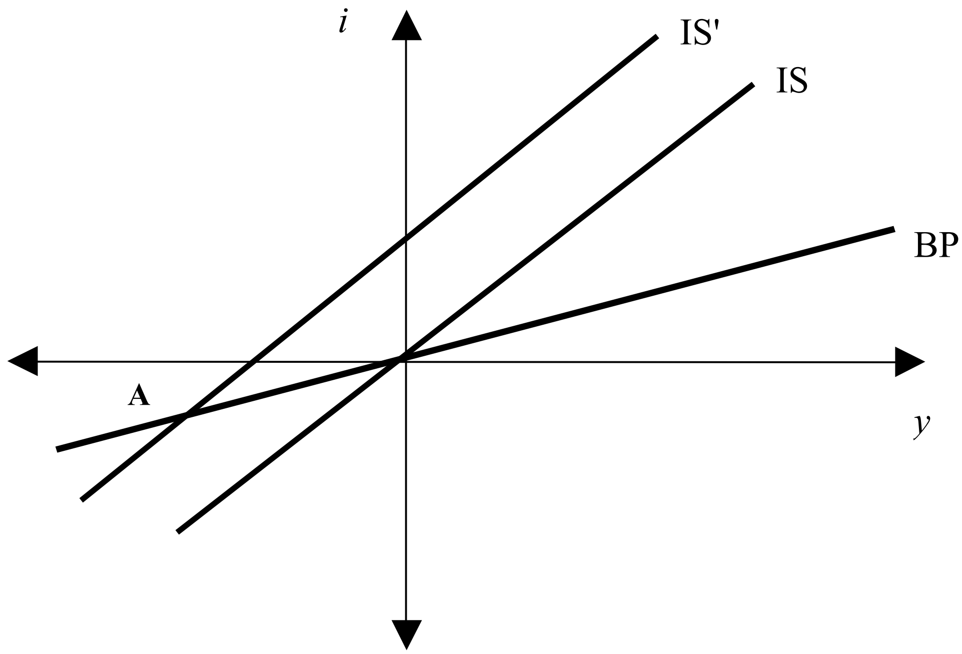


Figure 2. Increase in the World Interest Rate

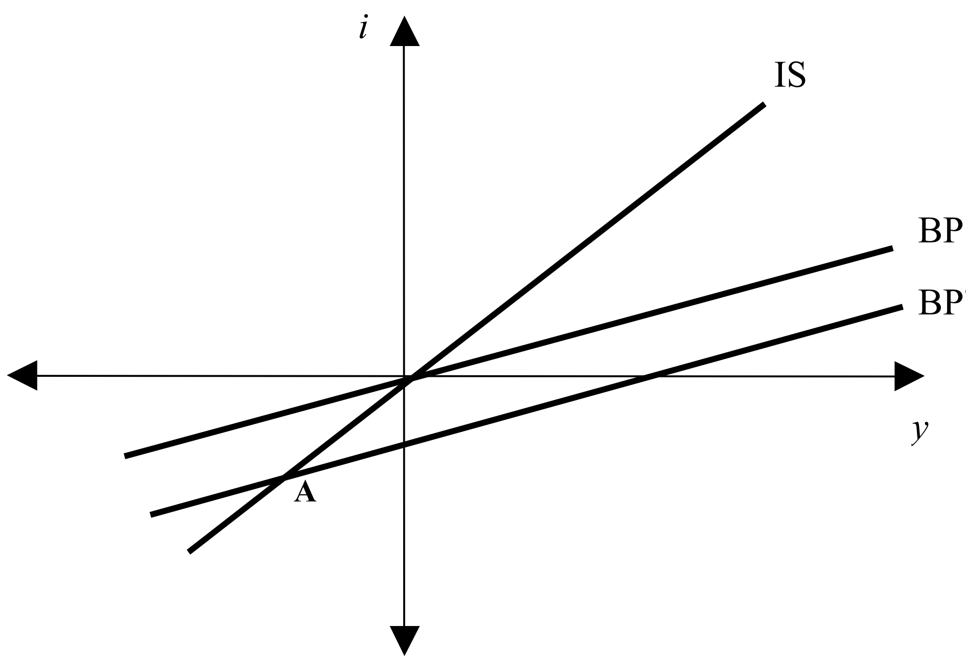


Figure 3. Devaluation in a Financially Robust Economy

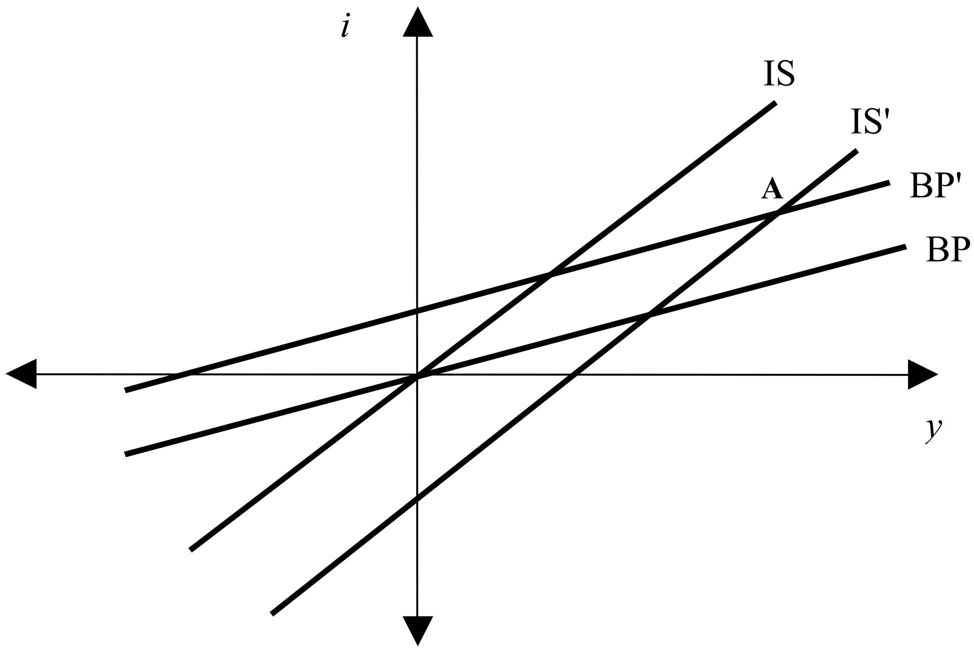
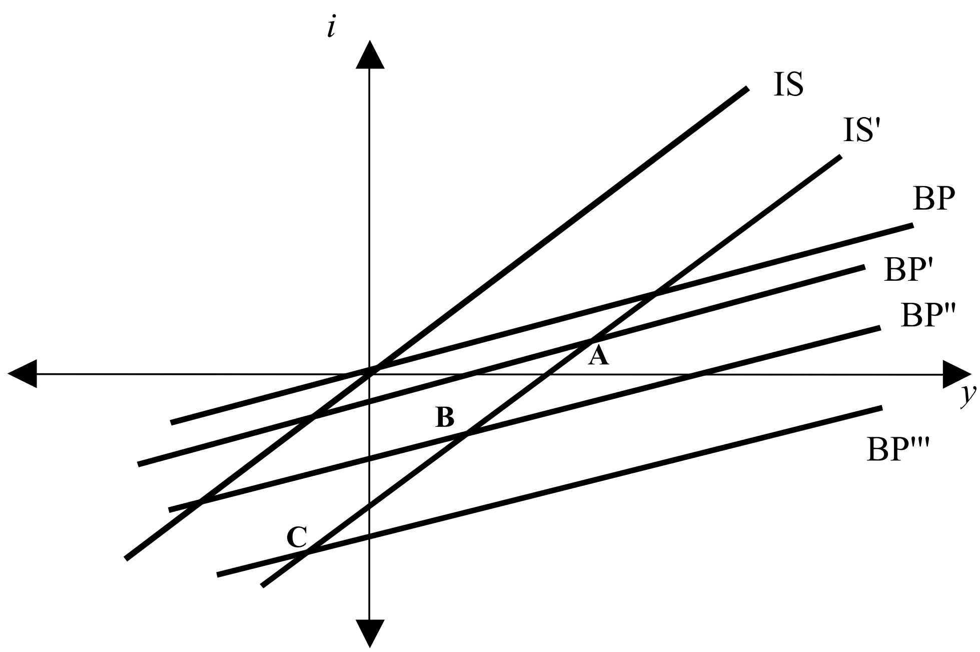


Figure 4. Devaluation in a Financially Vulnerable Economy



standard demand-switching effects of devaluation are not sufficiently strong, the overall impact can be contractionary.

Again, notice that none of this could happen with perfect capital markets. In that case the BP is horizontal and shifts up after a real devaluation. The only possible outcome is an increase in both investment and output.

III. Conclusions

The analysis suggests that the currently fashionable conclusion that liability dollarization renders monetary policy useless, and fully justifies "fear of floating," is much too simple. When balance sheet effects are not too strong, the model behaves qualitatively just like the standard one, though quantitatively the capital market imperfections magnify the effects of adverse external shocks. In that case, monetary and exchange rate policies have the same effects as in the textbook example.

With very imperfect international financial markets and large inherited dollar debts, matters are different. An unexpected real devaluation can depress both investment and output, justifying policymakers' fears. The task ahead is to sort out when and how these circumstances arise. In previous work we have found that it takes unrealistically high steady-state debt ratios and risk premiums to generate the contractionary case, but researchers using more disaggregated models and alternative distributions for shocks may come to different conclusions.[8] Putting imperfect credibility into the picture is also important: it is in short supply in the pampas, and it crucially affects the beneficial results of devaluation. Again, in a previous paper we found that imperfect credibility, even in the presence of balance sheet effects, does not overturn received wisdom on the desirability of flexible exchange rates and countercyclical monetary policy.[9] But the issue surely remains open.

APPENDIX

For simplicity we assume only two periods, $t = 0, 1$, and focus on the effect of shocks only at the start of period 0.

Domestic Production

Production of each variety of domestic good is carried out by a continuum of firms acting as monopolistic competitors. These firms have access to a Cobb-Douglas technology given by

$$Y_{jt} = AK_{jt}^{\alpha}L_{jt}^{1-\alpha},\ 0 < \alpha < 1, \tag{A.1}$$

where Y_{jt} denotes output of variety j in period t, K_{jt} denotes capital input, and L_{jt} denotes labor input. Assume that workers' labor services are heterogeneous. Input L_{jt} is a constant elasticity of substitution (CES) aggregate of the services of the different workers in the economy:

$$L_{jt} = \left[\int_0^1 L_{ijt}^{\frac{\sigma}{\sigma-1}} di\right]^{\frac{\sigma}{\sigma-1}}, \tag{A.2}$$

[8] See Céspedes, Chang, and Velasco (2000).
[9] See Céspedes, Chang, and Velasco (2002).

where workers are indexed by i in the unit interval, L_{ijt} denotes the services purchased from worker i by firm j, and $\sigma > 1$ is the elasticity of substitution among different labor types. The minimum cost of a unit of L_t is given by

$$W_t = \left[\int_0^1 W_{it}^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}, \tag{A.3}$$

which can be taken to be the aggregate nominal wage. The j^{th} firm maximizes expected profits in every period. Profits are given by

$$\Pi_{jt} = P_{jt}Y_{jt} - \int_0^1 W_{it}L_{ijt}di - R_tK_{jt}, \tag{A.4}$$

where R_t is the return to capital, and profits are expressed in terms of the domestic currency (henceforth called *peso*), subject to the production function in equation (A.1) and the demand for its good

$$Y_{jt}^d = \left[\frac{P_{jt}}{P_t}\right]^{-\theta} Y_t^d, \tag{A.5}$$

where Y_{jt}^d must be understood to include demand from domestic consumers and investors and foreign consumers. Cost minimization yields the demand for worker i's labor:

$$L_{ijt} = \left[\frac{W_{it}}{W_t}\right]^{-\sigma} L_{jt}, \tag{A.6}$$

where

$$L_{jt} = \frac{\int_0^1 W_{ijt}L_{ijt}di}{W_t}. \tag{A.7}$$

Cost minimization also requires

$$\frac{R_tK_t}{W_tL_t} = \frac{\alpha}{1-\alpha}. \tag{A.8}$$

Finally, firms will set prices for their differentiated products as a constant markup over marginal cost. In the symmetric monopolistic competitive equilibrium, prices are set such that

$$\varepsilon_{t-1}\left\{\frac{W_tL_t}{P_tY_t}\right\} = (1-\alpha)\left(\frac{\theta-1}{\theta}\right) \tag{A.9}$$

where $\varepsilon_t\{z\}$ denotes the expectation of z conditional on information available at period t.

Workers

There is a continuum of workers, whose total "number" is normalized to one. The representative worker has preferences over consumption, labor supply, and real money balances in each period t given by

$$\log C_t - \left(\frac{\sigma-1}{\sigma}\right)\frac{1}{\nu}L_t^{\nu} + \frac{1}{1-\varepsilon}\left(\frac{M_t}{Q_t}\right)^{1-\varepsilon} \tag{A.10}$$

where $\nu > 1$ and $\varepsilon > 1$. The consumption quantity C_t is an aggregate of home and imported goods:

$$C_t = \kappa\left(C_t^H\right)^{\gamma}\left(C_t^F\right)^{1-\gamma}, \tag{A.11}$$

where C_t^H denotes purchases of a basket of the different varieties of goods produced domestically, C_t^F purchases of the imported good, and $\kappa = [\gamma^{\gamma}(1-\gamma)^{1-\gamma}]^{-1}$ is an irrelevant constant. Assume that domestically produced goods are aggregated through a CES function represented by

$$C_t^H = \left[\int_0^1 C_{jt}^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}, \ \theta > 1. \tag{A.12}$$

Assume also that the imported good has a fixed price, normalized to one, in terms of a foreign currency, which we shall refer to as the *dollar*. Also, we assume that imports are freely traded and that the Law of One Price holds, so that the *peso* price of imports is equal to the *nominal exchange rate* of pesos per dollar.

Assume also that the only asset that workers can hold is money. Then, in every period t, the i^{th} worker's choices are constrained by

$$Q_t C_{it} = P_t C_{it}^H + S_t C_{it}^F = W_{it} L_{it} + T_t - M_{it} + M_{it-1}, \tag{A.13}$$

where P_t is the *peso* price of one unit of the basket of domestically produced goods, given by

$$P_t = \left[\int_0^1 P_{jt}^{1-\theta} dj\right]^{\frac{1}{1-\theta}} \tag{A.14}$$

and Q_t is the minimum cost of one unit of aggregate consumption, or CPI index:

$$Q_t = P_t^{\gamma} S_t^{1-\gamma}. \tag{A.15}$$

Fiscal policy is as simple as can be: inflation tax revenues are rebated to workers through lump-sum transfers. Then,

$$M_t - M_{t-1} = T_t, \tag{A.16}$$

where $M_t = \int_0^1 M_{it} di$. This assumption ensures that, in the symmetric equilibrium, workers consume their nominal income:

$$Q_t C_t = W_t L_t. \tag{A.17}$$

Now, purchasing consumption at minimum cost requires

$$\left(\frac{1-\gamma}{\gamma}\right)\frac{C_t^H}{C_t^F} = \frac{S_t}{P_t} \equiv E_t, \tag{A.18}$$

where absence of the subscript i indicates that we have imposed symmetry in equilibrium. Additionally, we have defined E_t as the price of foreign goods in terms of domestic goods, or the *real exchange rate*.

Each worker will optimally supply labor to equate his marginal disutility of labor to its marginal return. Our assumptions on preferences then ensure that

$$\varepsilon_{t-1}\left\{L_t^{\nu}\right\} = 1 \tag{A.19}$$

in equilibrium.

Now adopt the convention that no subscript indicates an initial period variable, while a subscript 1 indicates a final period variable. Money demands in periods 0 and 1 are given by

$$\left(\frac{M}{Q}\right)^{-\varepsilon} + \beta\frac{1}{C_1}\frac{Q}{Q_1} = \frac{1}{C} \ \text{and} \tag{A.20}$$

$$\left(\frac{M_1}{Q_1}\right)^{-\varepsilon} = \frac{1}{C_1}. \tag{A.21}$$

Entrepreneurs

Entrepreneurs borrow from abroad in order to finance investment. They do it using dollar-denominated debt contracts which, due to imperfections in the financial markets, require paying a risk premium over the risk-free interest rate. Assume that entrepreneurs start with some inherited debt repayments, due at the end of the period, equal to D in dollars. They also own a quantity K of capital, which is used to produce the home good in period 0. After debt repayments, these entrepreneurs borrow from the world capital market in order to finance investment in excess of their own *net worth*.

Investment becomes capital in the next period and is produced by combining home goods and imports. For simplicity, we assume that capital is produced in the same fashion as in equation (A.11). Therefore, the cost of producing one unit of capital available in period 1 is Q. The entrepreneurs' budget constraint in period 0 is

$$PN + SD_1 = QI, \tag{A.22}$$

where N represents net worth, D_1 denotes the amount borrowed abroad in period 0, and $I = K_1$ investment in period 1 capital.

Net worth plays a crucial role because the interest cost of borrowing abroad is not simply the world safe rate ρ. Entrepreneurs borrow abroad paying a premium, η, above this risk-free interest rate. We assume that the risk premium is an increasing function in the ratio of the value of investment to net worth as in Bernanke and Gertler (1989). In particular, we assume the following functional form for this relation:

$$1 + \eta = \left(\frac{QI}{PN}\right)^{\mu}. \tag{A.23}$$

We assume that capital depreciates completely in production. In equilibrium, the expected yield on capital in dollars must equal the cost of foreign borrowing:

$$\frac{R_1}{Q} = (1+\rho)(1+\eta)\left(\frac{S_1}{S}\right). \tag{A.24}$$

Given that entrepreneurs own local firms, the income that they receive is not only the payment to capital. They also receive the profits associated with the monopolistic power that each firm has. Entrepreneurs' net worth is

$$PN = RK + \Pi - SD = PY - WL - SD, \tag{A.25}$$

where Π reflects profits from the firms in pesos.

Equilibrium

Market clearing for the home goods require that domestic output be equal to demand. In period 0, the market for home goods will clear when

$$Y = \gamma\left(\frac{Q}{P}\right)(I + C) + EX. \tag{A.26}$$

Notice that the term EX stands for the home good value of exports to the rest of the world, where X is exogenous.[10]

[10] This is similar to Krugman (1999) and can be justified by positing that the foreign elasticity of substitution across goods in consumption is one, and that the share of domestic goods in foreigners' expenditure is negligible. This last fact allows us to treat X as exogenous.

Given that period 1 is the final period, there is no investment on it. Assuming that entrepreneurs consume only foreign goods, the market clearing condition for the second period is

$$P_1Y_1 = \gamma Q_1C_1 + E_1P_1X_1. \tag{A.27}$$

This last equation can be simplified further, since workers consume all their income each period:

$$Y_1 = \tau E_1X_1, \tag{A.28}$$

where $\tau = [1-\gamma(1-\alpha)(1-\theta^{-1})]^{-1} > 1$.

Linearization

The next step consists in obtaining log-linear approximations around the equilibrium with no shocks. Start by noticing that equation (A.15) implies

$$q_t - p_t = (1-\gamma)(s_t - p_t) = (1-\gamma)e_t \tag{A.29}$$

in both periods. Next derive equilibrium relations in period 1. The first relation is the log-linear version of equation (A.17),

$$q_1 + c_1 = w_1 + l_1. \tag{A.30}$$

Equation (A.9) shows that wage income in period 1 is a fraction of the total revenue. Therefore,

$$p_1 + y_1 = w_1 + l_1. \tag{A.31}$$

Combining these last three equations we obtain that

$$c_1 = y_1 - (q_1 - p_1) = y_1 - (1-\gamma)e_1. \tag{A.32}$$

Assuming no export shocks in period 1, the log-linear version of the market clearing condition for period 1 is

$$y_1 = e_1. \tag{A.33}$$

Using these two equations together we obtain $c_1 = \gamma e_1$. Now, since under no shocks labor supply is fixed at one (recall the first-order condition for labor supply), we have $\gamma_1 = \alpha i$. Combining this with (A.33) we have

$$\alpha i = e_1. \tag{A.34}$$

Pulling together these results we arrive at

$$c_1 = \gamma\alpha i. \tag{A.35}$$

We can now solve the model in the initial period. The log-linear version of the resource constraint in period 0 is

$$\tau y + (1-\tau)(q+c) = \lambda(q+i) + (1-\lambda)(e+x), \tag{A.36}$$

where

$$\lambda = \frac{\alpha\bar{Q}\bar{I}}{\alpha\bar{Q}\bar{I} + \bar{E}\bar{X}} < 1,$$

overbars denote no-shock values, and where, without loss of generality, we have set $p = 0$.
Given that capital is a predetermined variable in period 0, deviations of output from its no-shock equilibrium will be matched by changes in labor only:

$$y = (1-\alpha)l. \tag{A.37}$$

Log-linearizing equation (A.17) we have

$$q + c = l \tag{A.38}$$

since the nominal wage is preset. Combining these last two equations we have

$$q + c = \frac{y}{1-\alpha}. \tag{A.39}$$

Replacing this last relation and equation (A.29) into (A.36) and reordering, we obtain the IS curve

$$y = \tau\left[1 - \gamma\left(1 - \theta^{-1}\right)\right]^{-1}\left[\lambda i + (1 - \gamma\lambda)e + (1 - \lambda)x\right], \tag{A.40}$$

which is equation (1) in the text. Now focus on the money market. Log-linearize money demand in each period, given by equations (A.20) and (A.21), which yields

$$\varepsilon\left(m_1 - q_1\right) = c_1 \text{ and} \tag{A.41}$$

$$\varepsilon\omega(m - q) + (1 - \omega)\left(c_1 + q_1 - q\right) = c, \tag{A.42}$$

where

$$\omega = 1 - \beta\frac{\overline{Q}\,\overline{C}}{\overline{Q}_1\overline{C}_1}.$$

Note that ω is between 0 and 1 as long as the growth of nominal consumption is not too negative, which we assume from now on. Notice that ε^{-1} can be interpreted as the elasticity of money demand with respect to consumption expenditures. Using equations (A.35) and (A.39) to substitute out the consumptions, and rearranging, we have the LM schedule:

$$m = \frac{y}{\varepsilon\omega(1-\alpha)} - \left(\varepsilon^{-1} - 1\right)(1 - \gamma)e - \left(\omega^{-1} - 1\right)\varepsilon^{-1}\alpha i, \tag{A.43}$$

which is equation 2 in the text. The final block of equations to be solved is the one associated with the entrepreneurs. The log-linear version of the arbitrage relation (equation (A.24)) is

$$\left(r_1 - p_1\right) - q = \rho + \eta + e_1 - s, \tag{A.44}$$

while the log-linear version of A.8 is $r_1 - p_1 = -i(1-\alpha)$. Using this, (A.29) and (A.34) we have

$$i = -(\rho + \eta) + \gamma e, \tag{A.45}$$

which is equation (3) in the text. The log-linear version of the equation for the risk premium (A.23) is

$$\eta = \mu(q + i - n), \tag{A.46}$$

which, using (A.29), is equation (4) in the text. The log-linear version of the net worth equation (A.25) is

$$n = \theta^{-1}\left[1 - (1 - \alpha)\left(1 - \theta^{-1}\right)\right]^{-1}(1 + \psi)y - \psi e, \tag{A.47}$$

where

$$\psi = \frac{\overline{E}\,\overline{D}}{\overline{N}} > 0.$$

This is equation (5) in the text. Note that when ψ is large, initial debt is also large relative to net worth.

REFERENCES

Bernanke, B., and M. Gertler, 1989, “Agency Costs, Net Worth, and Business Fluctuations,” *American Economic Review,* Vol. 79, pp. 14–31.

Céspedes, L., R. Chang, and A. Velasco, 2000, “Balance Sheets and Exchange Rate Policy,” NBER Working Paper No. 7840 (Cambridge, Massachusetts: National Bureau of Economic Research).

———, 2002, “Dollarization of Liabilities, Net Worth Effects and Optimal Monetary Policy,” in *Preventing Crises in Emerging Markets*, ed. by J. Frankel and S. Edwards (Chicago: University of Chicago Press), pp. 559–91.

Krugman, P., 1999, “Balance Sheets, the Transfer Problem and Financial Crises,” in *International Finance and Financial Crises*, ed. by P. Isard, A. Razin, and A. Rose (Boston: Kluwer Academic Publishers), pp. 31–44.

Taylor, L., 1981, “IS/LM in the Tropics: Diagrammatics of the New Structuralist Macro Critique,” in *Economic Stabilization in Developing Countries*, ed. by W. Cline and S. Weintraub (Washington: The Brookings Institution).