Exchange-Rate-Based Stabilization, Durables Consumption, and the Stylized Facts*

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ABSTRACT

In this paper we show that a model featuring durables consumption, weak credibility, and sticky prices can explain many of the stylized facts associated with exchange-rate-based stabilization, including the *quantitative* variation exhibited by key macroeconomic variables. In standard models, the boom phase of ERBS is nothing more than a tepid expansion — changes in spending, real output, and the real exchange rate are unexceptional. But when durables are part of the choice set, the boom is truly a boom: following a temporary reduction in the crawl, total consumption spending rises 12-20%, the real exchange rate appreciates 40-55%, and the current account deficit swells to 5-7% of GDP. None of these results requires easy intertemporal substitution in consumption.

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In the past twenty years development macroeconomists have written a great deal about stabilization programs that fix the path of the nominal exchange rate. The literature divides along two lines. One branch has concentrated on documenting the empirical regularities associated with exchange-rate-based stabilization (ERBS) episodes. Case studies in the eighties and early nineties concluded that ERBS is characterized by continuous strong appreciation of the real exchange rate, rapid consumption growth, large current account deficits, and a pronounced boom-bust cycle in real output.[1] This view no longer commands widespread agreement. Later studies, based on larger, more diverse datasets, suggest that the stylized facts are not as robust as once thought (Santaella and Vela, 1996; Easterly, 1996; Hamann, 2001; Hamaan et al., 2005).[2] Booming output in the early stages is often followed by recession, but not always; sometimes the end of ERBS brings only a slowdown in growth or even persistent, modest expansion. The phase of high consumption spending and large current account deficits also varies greatly in depth and duration. In some cases, the current account deficit increases continuously and the consumption boom lasts until the end of the program; in others, the initial surge in spending is followed by a sharp contraction while the current account deficit disappears or turns into a surplus.[3] Out of the original set of stylized facts, only one has survived fully intact: cumulative appreciation of the real exchange rate is sizeable during ERBS regardless of the program's vintage (recent vs. old) and type (heterodox vs. orthodox).

The other major branch of the literature comprises diverse theoretical models that seek causal explanations for the ERBS syndrome. In a seminal paper, Calvo and Vegh (1993) demonstrated the potential relevance of models featuring weak credibility and sticky prices. To elaborate, suppose money demand is governed by a cash-in-advance constraint and that the country operates in a perfect world capital market. In this setup, a temporary (i.e., non-credible) reduction in the rate of crawl lowers the price of consumption today relative to the price of consumption in the future. Intertemporal substitution then leads to a consumption boom and a current account deficit financed by private capital inflows. Under the assumption of sticky prices, the consumption boom is accompanied by higher output in the nontradables sector and persistent appreciation of the real exchange rate. In the aftermath of the policy reversal, consumption drops below its pre-ERBS level and the nontradables sector suffers

through a recession.[4] The boom-bust cycle in real output is the source of the claim that the choice between money-based and exchange-rate-based stabilization boils down to a choice between "recession now or recession later."

Calvo and Vegh's results exercise a strong intuitive appeal and are consistent with important qualitative aspects of the data. Neither the original model nor its successors, however, provide a satisfactory explanation of the stylized facts. The single most vexing problem is that the predicted effects on consumption, the current account, and the real exchange rate in the boom phase are way too small. Employing a simplified one-good model, Reinhart and Vegh (1995) show that the weak credibility hypothesis predicts increases in consumption of 1.6-3% for the Southern Cone tablitas of the late seventies.[5] In a more exotic model that allows for time-varying credibility and positive wealth effects from unrebated seigniorage and lower transactions costs, Mendoza and Uribe (1996) find that consumption increases by roughly the same amount and that the real exchange rate appreciates 5-15%. These numbers have the right sign but are only 10-20% as large as the effects observed in the Southern Cone tablitas and other ERBS episodes.

Since the Calvo-Vegh papers first appeared, theoretical research has moved on to investigate the properties of flex-price models with assorted wealth and supply-side effects in the hope of achieving a better fit with the stylized facts. This hope has not been borne out. After surveying the literature and conducting additional independent analysis, Rebelo and Vegh (1995) conclude that, even when combined for maximum impact, the proposed effects cannot account for the quantitative magnitude of the consumption boom and real exchange rate appreciation seen in ERBS programs. The bottom line in Uribe (2002, p.563), the most recent attempt to secure strong wealth/supply effects, is equally discouraging: " . . . existing models produce consumption booms and real exchange rate appreciations that are too small compared to the actual data. The quantitative analysis conducted in Section 6 . . . does not help resolve this problem."

This paper is another attempt to explain the stylized facts surrounding ERBS by appeal to weak credibility and sticky prices. We depart from existing models by incorporating durable consumer goods and by relaxing the assumption that domestic residents have access to a perfect world capital market. Neither of these departures from the prototype ERBS

model is controversial. While it is analytically convenient to assume interest parity, the consensus among informed observers is that domestic and foreign currency assets are distinctly imperfect substitutes.[6] The importance of durables in the boom-bust cycle for consumption spending is also widely recognized. Data presented in Rebelo and Vegh (1995), De Gregorio, Guidotti, and Vegh (1998), and Calvo and Vegh (1999) show that the boom-bust cycle is driven by the tremendous expansion and subsequent collapse in durables purchases. Despite the evidence, durables have not figured in most formal models of ERBS. The sole exception is De Gregorio, Guidotti, and Vegh's elegant analysis of the "bunching" pattern in durables spending when purchases follow a S-s rule. Their model, however, abstracts from nondurables consumption and assumes ERBS is permanent and fully credible. It is too stylized therefore to confront with the data. The question of whether weak credibility can account for the quantitative variation exhibited by key macroeconomic aggregates via its impact on durables spending remains unanswered.[7]

In the model we develop, the private sector consumes both durable and nondurable goods, domestic and foreign currency assets are imperfect substitutes, and fiscal adjustment is delayed until after ERBS collapses. These features greatly improve the explanatory power of the weak credibility cum sticky prices hypothesis. Numerical simulations of the model produce paths that fit the stylized facts well along five dimensions:

- *Large increases in consumption spending even when the intertemporal elasticity of substitution is low.* In simulations where the intertemporal elasticity of substitution is a modest .25, the peak increase in real consumption spending ranges from 12-20%. The peak occurs in the first year; after the early surge, spending declines but is still 8-11% higher 2-4 years into the program. Thus the criticism that the weak credibility hypothesis cannot explain the consumption boom without appeal to unrealistically high values for the intertemporal elasticity (Agenor and Montiel, 1999) is not generally correct. Certainly intertemporal substitution matters; but it is not the whole story. Durables expenditure depends on other factors, some of which operate *more* strongly when the intertemporal elasticity of substitution is small.

- *Spending on durable fluctuates much more than spending on nondurables.* Following up on the previous point, while durables and nondurables consumption move in synch, spending on durables is much more volatile. During the boom phase, the percentage increase in durables expenditure is 3-9 times larger than the increase in nondurables expenditure. Conversely, when the slump hits, durables purchases contract far more than spending on nondurables. These results are in line with the numbers reported by De Gregorio, Guidotti, and Vegh (1998): in a sample of seven ERBS episodes spanning the period

1978-1993, the peak increase in durables consumption was 1.8-7.4 times as large as the peak increase in nondurables consumption; and in five of the seven episodes, the recession following the boom was precipitated by a huge reduction in durables spending.

- *Strong, sustained appreciation of the real exchange rate.* The trajectory of the real exchange rate depends on everything — the magnitude of the consumption boom, the speed of price adjustment in the nontradables sector, the length of the ERBS period, etc. Nevertheless, in every run, the real exchange rate appreciates at least 40% before the end of the stabilization program.

- *Persistent, large current account deficits.* The current account deficit jumps to 5-7% of GDP in the first year. While the deficit may decrease in subsequent years, it rarely drops below 2% of GDP.

- *Strong effects in some cases for successful, credible ERBS.* The existing literature cannot explain why the same stylized facts characterize successful and failed programs. Our model also struggles with this, but less so. Although intertemporal price variation does not stimulate spending when ERBS is credible, one new effect comes into play and several others continue to operate. These effects produce a strong, persistent expansion when domestic and foreign assets are close substitutes and successful ERBS attracts large, permanent capital inflows. In our best run, real consumption spending is 7-25% higher for three years and appreciation of the real exchange rate reaches 41%.

- *Recession triggered by a sharp downturn in consumption spending before the end of ERBS.* Booming consumption is invariably followed by a later collapse. Typically the collapse predates the end of the program (Calvo and Vegh, 1993).[8] A recent paper by Uribe shows that habit persistence can explain this phenomenon. But, as is often the case in models of ERBS, a better fit with one stylized fact implies a worse fit with others. In Uribe's model, consumption rises to a peak and then contracts. The inverted-U profile agrees with the data, but the peak is not nearly high enough to qualify as a consumption boom. Moreover, habit persistence seems to make the problem worse: the peak increase in consumption is *larger* in the runs without habit persistence.

    In our model the initial consumption boom is followed by deceleration and a sharp contraction in aggregate spending in the last year of the program. The downturn in spending coupled with ongoing appreciation of the real exchange rate always drives the economy into a recession before the government admits that the lower rate of crawl cannot be maintained. If anything, the model is overly pessimistic in predicting that recession before the policy collapse is inevitable.

The paper is organized into six sections. In the first two sections we lay out the model and discuss how it was calibrated to the data. Section 3 follows with a detailed intuitive explanation of how the model works. Section 4 presents numerical simulations for the main variant of the model and investigates the sensitivity of the results to key behavioral/structural parameters, while Section 5 examines the outcome when ERBS is permanent and credible. The

final section discusses shortcomings of the results and speculates about promising directions for future research.

1. The Model

We work with a currency substitution model of a small open economy that produces a nontraded good and a composite traded good. The private sector consumes a mix of durable and nondurable goods and both domestic and foreign currency provide liquidity services. The exchange rate regime is a crawling peg and real output in the tradables sector is fixed. Notational conventions are as follows: world prices equal unity; P_n and γ denote the relative price of the nontraded good and its share in aggregate consumption; Q_i is output in sector i; and m, F, and E are real money balances, the stock of foreign currency, and real nondurables expenditure measured in dollars (i.e., units of the traded good).

Prices

Consumption of multiple durable goods greatly complicates the model. To avoid this, we assume that one unit of an imported durable is always combined with a_1 units of the nontraded durable. Expressed in dollars, the price of the composite durable is

$$P_d = 1 + a_1 P_n. \tag{1}$$

The overall price level P is a geometric weighted average of the prices of the traded and nontraded goods. Since the nominal exchange rate sets the domestic price of the traded good,

$$P = e P_n^{\gamma} \tag{2}$$

and the inflation rate is

$$\pi = (1 - \gamma)\chi + \gamma \pi_n, \tag{3}$$

where $\gamma \equiv \gamma_{nd}\gamma_d + \gamma_{ne}\gamma_e$; γ_d and γ_e are the respective weights of durables and nondurables in the CPI; γ_{nj} is the share of nontradables in total spending on consumer good of type j; χ is the rate of currency depreciation; and π_n is price growth in the nontradables sector.[9]

The Nontradables Sector

The nontraded good is either consumed directly as a nondurable or combined with the imported durable to build a composite durable good. Consumption on nondurables is given by the Marshallian demand function $C_n(P_n, E)$. The demand for durable inputs depends on gross new purchases of the composite durable, S, and the input-output coefficient for the nontraded component, a_1. Thus the nontradables market clears when

$$C_n(P_n, E) + a_1 S = Q_n. \tag{4}$$

Prices in the nontradables sector are sticky à la Calvo and Vegh (1993). Output is determined by demand and firms adjust prices only when they receive a random "price-change signal." Firms that receive a signal choose a new price by forecasting the future paths of the price level and excess demand. Calvo (1983) shows that when forecasts are mathematically correct and the price-change signal obeys a Poisson process

$$\dot{P}_n = (\pi_n - \chi)P_n, \tag{5}$$

$$\dot{\pi}_n = -\alpha[C_n(P_n, E) + a_1 S - \bar{Q}_n], \quad \alpha > 0, \tag{6}$$

where $\bar{Q}_n$ denotes notional output (i.e., the level of output associated with a normal utilization rate) and a dot signifies a time derivative (i.e., $\dot{x} = dx/dt$). Equation (5) follows from the fact that, at any given point in time, the nominal price of the nontraded good is fixed by past price quotations. Equation (6) is a higher-order Phillips Curve that relates the *change* in π_n to excess demand. Calvo's model of staggered pricing imposes a good deal of structure on this relationship: $\dot{\pi}_n$ is a decreasing function of excess demand and the parameter α is larger the shorter the length of the average price quote.

The Private Agent's Optimization Problem

All economic decisions in the private sector are controlled by a representative agent who possesses an instantaneous utility function of the form $V[C(C_n, C_T), D] - R(\dot{D}/D)D$, where D is the stock of durables and $C(C_n, C_T)$ is an index of nondurables consumption. The $R(\cdot)D$ component of the utility function is taken from Bernanke (1985). It introduces a friction that prevents durables purchases from being absurdly volatile.[10] As Bernanke emphasizes,

new durables purchases are not easy or automatic: in contrast to spending on nondurables, the decision to buy a durable often involves time-consuming search and careful deliberation. The utility cost of worrying and lost leisure time is assumed to be increasing, symmetric, and convex in net purchases of durable goods: $R(0) = 0, R' \gtrless 0$ as $\dot{D} \gtrless 0$, and $R'' > 0$.

Domestic and foreign curency are held to reduce transactions costs. These costs are decreasing in the ratio of liquidity services ϕ to total spending. They enter the budget constraint via the term $(E + P_d S)L[\phi(m, F)/(E + P_d S)]$, where L is decreasing and strictly convex $(L' < 0, L'' > 0)$ and ϕ is homogeneous of degree one and increasing and strictly concave in m and F $(\phi_m, \phi_F > 0, \phi_{mm}, \phi_{FF} < 0)$. The same specification is employed by Rebelo and Vegh (1995), Reinhart and Vegh (1995), and Uribe (2002), but without the twist that both domestic and foreign currency produce liquidity services.

The private agent's optimization problem is solved in two stages. In the first stage, C_n and C_T are chosen to maximize $C(C_n, C_T)$ for given values of P_n and E. Write this part of the solution as $C^* = H(P_n, E)$. In the second stage, the private agent then chooses m, F, E and S to maximize

$$U = \int_0^\infty \{V[H(P_n, E), D] - R(S/D - c)D\}e^{-\rho t}dt, \tag{7}$$

subject to the wealth constraint

$$A = m + F, \tag{8}$$

the budget constraint

$$\dot{A} = Q_T + P_n Q_n + \tilde{g} - (E + P_d S)\left\{1 + L\left[\frac{\phi(m, F)}{E + P_d S}\right]\right\} - \chi m, \tag{9}$$

and

$$\dot{D} = S - cD, \tag{10}$$

where ρ is the time preference rate; $\tilde{g} = P_n^\gamma g + L(E + P_d S)$ is lump-sum transfers; and c is the depreciation rate for the durable good. Transfer payments are split into two components: real government transfers, g, and rebated profits of firms that supply transactions services, $L(E + P_d S)$. P_n^γ multiplies g because government transfers are indexed to the price level

but wealth is denominated in dollars. The artificial component $L(E + P_dS)$ ensures that transactions costs wash out in the budget constraint. This eliminates a potentially dubious income effect.[11] Variations in the cost of liquidity influence spending therefore only insofar as they affect the price of current vs. future consumption.

On an optimal path,

$$V_E = \omega_1(1 + L - L'\phi/X), \tag{11}$$

$$-L'(\phi_m - \phi_F) = \chi, \tag{12}$$

$$\omega_2 = \omega_1 P_d(1 + L - L'\phi/X) + R', \tag{13}$$

$$\dot{\omega}_1 = \omega_1(\rho + L'\phi_F), \tag{14}$$

$$\dot{\omega}_2 = \omega_2(\rho + c) + R - R'S/D - V_D, \tag{15}$$

where $X \equiv E + P_dS$ and ω_1 and ω_2 are the multipliers attached to the constraints in (9) and (10). Equation (11) states that the marginal utility of nondurables consumption equals the shadow price of wealth multiplied by the *effective* price of consumption (i.e., the actual price plus associated transactions costs). The other conditions are also familiar. Equation (12) requires the two currencies to yield the same financial return at the margin. Equation (14) is simply an Euler equation, while (13) and (15) define a Tobin's q model of durables purchases in which $\omega_2/\omega_1 P_d(1 + L - L'\phi/X) = \omega_2/V_E P_d$ is the ratio of the demand price (or shadow price) of a durable to its supply price and R' captures additional adjustment costs incurred by increasing S a small amount.

The Public Sector Budget Constraint

Money is injected into the economy whenever the central bank accumulates foreign exchange reserves Z or runs the printing press to finance transfer payments $P_n^\gamma g$ and purchases of traded goods k. The *consolidated* public sector budget constraint is thus

$$\dot{m} = P_n^\gamma g + k + \dot{Z} - \chi m. \tag{16}$$

8

Net Foreign Asset Accumulation and the Current Account Balance

Summing the private and public sector budget constraints produces the accounting identity that foreign asset accumulation equals the current account surplus

$$\dot{F} + \dot{Z} = Q_T + P_n Q_n - E - P_d S - k. \tag{17}$$

The Inconsistency of Fiscal and Exchange Rate Policy During ERBS

Most ERBS programs fail for want of adequate fiscal adjustment.[12] Accordingly, we assume that when the government lowers the rate of crawl from χ_o to χ_1 it does not cut spending. This implies that ERBS is not sustainable. Across steady states where $\dot{m} = \dot{F} = 0$,

$$
\begin{aligned}
E + P_d S &= P_n^\gamma g + P_n Q_n + Q_T - \chi_1 m, \\
\dot{Z} &= \chi_1 m - P_n^\gamma g - k.
\end{aligned}
$$

At the pre-ERBS equilibrium, the inflation tax covers the fiscal deficit and the current account is zero. When χ is lowered, the inflation tax falls ($\chi m \downarrow$) and spending and the relative price of the nontraded good increase. Consequently, in the steady state associated with the lower rate of crawl, the current account shows a persistent deficit and the central bank loses foreign exchange reserves year in and year out. ERBS is not credible because the economy cannot reach an equilibrium where its external accounts balance. Following the rest of the literature, we assume the public knows from the outset that ERBS is flawed and that events will force the government to abandon the policy at time t_1.

Policy Adjustments in the Post-ERBS Period

The collapse of ERBS is marked by a balance of payments crisis and dramatic adjustments in exchange rate and fiscal policy. For a couple of years, huge capital inflows finance the current account deficit with room to spare. Sadly, this does not last. At the end of ERBS, capital is flowing out but the current account deficit is still large. To speed the reduction in the deficit and place the economy on a path where current account surpluses replenish the central bank's stock of foreign exchange reserves, the government raises the crawl by the amount s and slashes transfer payments by w.[13] In specifiying the path of the crawl, we allow for the possibility that the initial adjustment may be grudging and inadequate. If χ

does not increase immediately to χ_o at t_1, then

$$\dot{\chi} = v(\chi_o - \chi), \quad v > 0, \quad t \geq t_1, \tag{18}$$

which yields

$$\chi(t) = \chi_1 + s + (\chi_o - \chi_1 - s)[1 - e^{-v(t-t_1)}], \quad t \geq t_1. \tag{19}$$

Fiscal adjustment, by contrast, is entirely frontloaded. After the large spending cut, g rises back toward its pre-stabilization level at the rate

$$\dot{g} = y(g_o - g), \quad y \geq 0, \quad t \geq t_1. \tag{20}$$

For $g(t_1) = g_o - w$, the solution to (20) is

$$g(t) = g_o + we^{-y(t-t_1)}, \quad t \geq t_1. \tag{21}$$

1.1 The Core Dynamic System

Under a crawling peg, the money supply adjusts endogenously through the capital account to satisfy money demand. But while the domestic currency can be swapped for foreign currency at the central bank, the total dollar value of currency holdings is predetermined. Thus $J \equiv m + F$ is a state variable in the model. To bring J into view, add equations (16) and (17). This gives

$$\dot{J} = Q_T + P_n Q_n + P_n^\gamma g - E - P_d S - \chi m. \tag{22}$$

During the ERBS phase, the equilibrium path is controlled by (5), (6), (10), (14), (15) and (22), a 6x6 system with three jump variables, π_n, ω_1, and ω_2, and three state variables, P_n, D, and J. After the policy reversal at time t_1, g and χ enter as additional state variables.

2. Model Calibration and Solution Technique

We calibrated the model using flexible, fairly general functions to describe preferences, transactions costs, and the production of liquidity services:

$$R(S/D - c) = \frac{x(S/D - c)^2}{2}, \quad x > 0,$$

$$L\left(\frac{\phi}{E + P_d S}\right) = h\left(\frac{\phi}{E + P_d S}\right)^{1-1/\beta}, \quad h > 0, \quad 0 < \beta < 1,$$

$$\phi(m, F) = [k_2 m^{(\sigma-1)/\sigma} + k_3 F^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)},$$

$$H(P_n, E) = E(1 + k_1 P_n^{1-\delta})^{1/(\delta-1)},$$

$$V(H, D) = \frac{[k_4 H^{(\psi-1)/\psi} + k_5 D^{(\psi-1)/\psi}]^{\psi(\tau-1)/\tau(\psi-1)}}{1 - 1/\tau},$$

where $k_1 - k_5$ are distribution parameters and τ, δ, σ, and ψ denote, respectively, the intertemporal elasticity of substitution, the elasticity of substitution between traded and nontraded (nondurable) goods, the elasticity of substitution between domestic and foreign currency, and the elasticity of substitution between durables and nondurables. Deliberation costs are a quadratic function of new durables purchases. The specification of transactions costs is the same as in Reinhart and Vegh (1995) and Uribe (2002), with liquidity services generated by a CES aggregate of domestic and foreign currency. Finally, the main part of the utility function, $V(H, D)$, has two tiers. In the lower tier, $H(P_n, E)$ is the indirect sub-utility function associated with the CES aggregator of nondurable consumer goods. [Recall that $C^*(C_n, C_T) = H(P_n, E)$.] At the upper tier, H and the service flow from durables combine in a nested CES-CRRA function.

The computer needs numbers for the substitution parameters, initial asset holdings, the rate of crawl before and after ERBS, etc., in order to solve the model. Table 1 lists the values for the base case and the range explored in alternative simulations. The value assigned to domestic money balances is normal for the set of Latin American country that have attempted ERBS. With respect to the other choices:

- *Length of the ERBS program (t_1).* The low-crawl period lasts three years in the base case and five years in the alternate run. Three years is a popular choice in the literature and close to the average value in Calvo and Vegh's (1999) dataset for major ERBS episodes.

Longer-lived programs, however, are not uncommon. Mexico's Solidarity Pact survived for seven years and several major ERBS episodes in the nineties ran for five years or longer (Argentina, 1991-2001; Uruguay, 1991-2000; Ecuador, 1993-1998 and 2000-present).

- *Elasticity of substitution between traded and nontraded nondurable consumer goods (δ).* Fixing δ at .40 is consistent with the finding in empirical studies that the scope for substitution is limited at high levels of aggregation.[14]

- *Time preference rate (ρ).* At 10%, the time preference rate is higher than in developed countries. Dropping ρ to 5% does not substantively alter the results.

- *Elasticity of substitution between domestic and foreign currency (σ).* Estimates of σ for Latin America range from one to six. Empirical work in this area suffers, however, from poor data, specification error, difficulties in modeling expectations, and a host of other problems. Not trusting most of the estimates, we decided to let σ vary from .40 to 2.

- *Ratio of foreign currency to national income (F_o).* The number for F_o is in line with data on dollarization ratios in Latin America in the nineties. (See Kamin and Ericsson, 1993; Savastano, 1996; and Balino, Bennett and Borensztein, 1999).

- *Elasticity of intertemporal substitution (τ).* Most estimates for LDCs place τ between .20 and .50 (Agenor and Montiel, 1999, Table 12.1). This also encompasses the range of values assigned to τ in the ERBS literature. We settled therefore on .25 and .50 as the low and high values for the intertemporal elasticity of substitution.

- *Speed of price adjustment in the nontradables sector (α).* There is no empirical information to guide the choice for α. The value in the base case (3) implies that price adjustment is fast but not instantaneous.

- *Convexity of the transactions cost function (β).* The sensitivity of asset demands to inflation and the interest rate depends on σ, the currency substitution parameter, and β, the parameter that determines the convexity of the transactions cost function. For $\beta = .10$, the interest-elasticity of money demand is .18 in the base case and .33 when $\sigma = 2$.[15] These numbers seem reasonable. It is difficult to say more because empirical estimates of the interest-elasticity in LDCs are all over the map. [See Table 2 in Reinhart and Vegh (1995).]

- *Consumption share of durables (γ_{cd}).* The share of durables in aggregate spending is $P_dS/(E+P_dS)$.[16] A figure close to this can be computed from the United Nations National Income Accounts (NIA). The NIA figures, however, impute a service flow to housing. Correcting for this and employing a broad definition of durables (housing + clothing and footwear + personal transport equipment + furnishings and household equipment) gives values of γ_{cd} in the .18-.22 range: .223 for Mexico (2000), .179 for Colombia (1998), .180 for Bolivia (1992), .203 for the Philippines, and .217 for S. Africa (2001) and S. Korea (2002).[17] The value in the model (.20) is the average of the values for Mexico and Colombia.

- *Depreciation rate for durables (c).* The Central Statistical Office of Great Britain and the U.S. Department of Commerce estimate the service life to be three years for clothing and

footwear and ten years for major appliances, cars, and other vehicles (Williams, 1998). We used these figures (there are no data for LDCs) and assumed a service life for housing of twenty-five years to calculate a weighted average depreciation rate for durables. The resulting value was consistently close to ten percent: .099 for Mexico, .101 for Colombia, .114 for Bolivia, .112 for S. Africa, and .105 for S. Korea and the Philippines.

- *q-elasticity of durables spending (Ω).* Write the first-order condition (14) as $1 + R'(S/D - c)/V_E P_d = \omega_2 / V_E P_d$ and note that $\omega_2 / V_E P_d$ is Tobin's q, the ratio of the demand price (ω_2 / V_E) to the supply price. This relationship can be used to calculate Ω, the q-elasticity of durables expenditure (i.e., the elasticity of S with respect to q). The values set for Ω and c pin down the degree of convexity of the adjustment cost function.[18]

  Needless to say, not much is known about the likely magnitude of Ω. The assigned value has the merit of delivering results that mimick the volatility of durables expenditure in ERBS programs.

- *Elasticity of substitution between nondurables and the service flow of durables (ψ).* The value for ψ is a pure guess. This is unfortunate, but the results differ little when ψ is .15 or .75. In the base case where $\tau = .25$, the utility function is separable between durables and the index of nondurables. For $\tau = .50$, durables and nondurables are mild Edgeworth complements ($V_{ED} > 0$).

- *Share of nontradables in nondurables expenditure and in durables expenditure (γ_{ne}, γ_{nd}).* Corbo (1985), Hanson and de Melo (1985), and Burstein, Neves, and Rebelo (2001) have observed that PPP does not hold for traded goods at the retail level in Chile, Uruguay, and Argentina. The reason is that traded consumer goods include a large nontraded distribution component. According to the data in Burstein, Neves, and Rebelo, distribution costs are fully 60% of the retail price for durable and nondurable goods in Argentina. Taking this into account raises the weight of nontradables in the Argentine CPI to .71.[19] In the absence of data for other countries, we used the Argentine shares to set the initial shares for γ_{ne} and γ_{nd}.

- *Rate of crawl before vs. during ERBS (χ_o, χ_1).* The numerical simulations cut the rate of crawl from an initial value of 100% to 10% during ERBS. This is larger than the reductions in the Chilean and Uruguayan tablitas but far smaller than the reductions in the Argentine tablita, Mexico's Solidarity Pact, or Argentina's Convertibility Plan.

- *Paths of currency depreciation and government spending in the post-ERBS period.* The end of ERBS is marked by a sudden increase in the rate of crawl from 10% to 30% and by a cut in government spending equal to 6% of initial GDP. Following the jumps, χ and g (or k) rise steadily at rates controlled by v and y.[20] The two jumps and the "slope" parameters v and y were chosen to be consistent with the evidence in Calvo and Vegh (1999) that it takes several years after ERBS is abandoned for the rate of crawl to return to its original level.

Solution Technique

The solution strategy in standard forward-shooting programs is to guess the values of the

jump variables at $t = 0$ and simulate the system forward for a long time horizon T. After solution paths have been computed for numerous guesses, it is possible to approximate the function mapping the initial jumps $x(0)$ to the solution at T, viz.: $[z(T), x(T)] = F[x(0)]$, where z is the vector of state variables. Setting $z(T)$ and $x(T)$ equal to their steady-state values (z^*, x^*) and solving for $x(0)$ yields the new best guess $\tilde{x}$. If the solution associated with $\tilde{x}$ does not generate a path where $[z(T), x(T)]$ is sufficiently close to (z^*, x^*), then the entire procedure is repeated.

Standard forward-shooting often fails because the terminal state $[z(T), x(T)]$ is extremely sensitive to small errors in the initial values for the jump variables. This is the case in our model. A different approach, based on a different distance mapping, is required therefore to locate the global nonlinear saddle path. In the program we devised, the mapping is between the initial values of the jump variables and the minimum distance of the resulting solution path from the new steady state (*not* the minimum distance at time T).[21] The solution is still highly sensitive to errors in the initial values of the jump variables; in fact, the problem is worse than normal because the global extremum lies at the bottom of a *very* narrow valley. (We are battling against an ill-behaved cousin of the classic Rosenbrock problem.) Our distance mapping has one big advantage, however: the zero of the mapping — the true solution — can be trapped by a highly refined, simplex-based shooting algorithm. The solution strategy and the algorithm are discussed in more detail in Atolia and Buffie (2005).

3. Remarks on the Specification of the Model and on How Things Work

In most of the models that populate the existing literature the private sector can borrow or lend in a perfect world capital market, all consumer goods are nondurable, and the path of fiscal policy satisfies a solvency constraint but is not explicitly specified.[22] The setup in the current model is quite different: domestic and foreign assets are imperfect substitutes, consumers buy a mix of durable and nondurable goods, and fiscal adjustment is delayed until the post-ERBS period. Each element in this list plays a role in determining the path of aggregate consumption expenditure. And since the dynamics for spending drive the dynamics for everything else (real output, inflation, the current account deficit, and the real

exchange rate), it is only a slight exaggeration to say that the same elements determine the nature of the entire ERBS cycle.

3.1 What Fuels the Consumption Boom?

Four factors influence consumption spending. The first, intertemporal substitution, is common to all models of temporary ERBS and does not require any comment. The second highlights the key difference in how durables and nondurables respond to variations in intertemporal prices. Durables expenditure is a form of investment because most of the good is consumed in the future, not at the time of purchase. Consequently, irrespective of whether the intertemporal elasticity of substitution is large or small, there is an incentive to make large purchases of the durable good when its price is temporarily low. This is what Calvo (1988) and Vegh (2005) call *intertemporal price speculation.* The sensitivity to opportunities for intertemporal price speculation is one of the reasons that durables lead in both the boom and the bust phases of the ERBS cycle.

The third influence on consumption spending arises from the interaction of imperfect asset markets with delayed fiscal adjustment. Because fiscal policy is passive during the ERBS phase, private disposable income rises when the inflation tax falls. This gain is strictly temporary — the collapse of the stabilization program is marked by resumption of the high inflation tax and a brutal reduction (6% of GDP) in lump-sum transfers. Naturally, the private agent wishes to save most of the temporary windfall. If the country were perfectly integrated into world capital markets, net purchases/sales of a tradable bond would be the preferred vehicle for saving.[23] But when access to external capital markets is limited, a large part of saving gets channeled instead into purchases of durables:[24] by making heavy outlays to accumulate durables in the ERBS phase, the private agent ensures that the stock of durables and the flow of consumption services will be higher than otherwise in the post-ERBS period.[25] We dub this the *saving-through-durables* (STD) effect. Although, STD is a second-round effect, it is *not* small change. The effect gains considerable potency from a multiplier process: when durables expenditure increases, so also does nontradables output; this pushes real income in the short run further above its long-run level, which spurs additional STD purchases, causing nontradables output to rise even more, etc. (More

concisely: STD↑→ Q_n ↑→STD↑). In passing, it should also be noted that the quantitative kick of the STD effect is greatest when the substitution parameters β and σ are small. To see the connection, consult the money demand function. Evaluated at a steady state, the elasticity of money demand with respect to inflation is $\epsilon = (\beta\theta_m + \sigma\theta_f)\pi/(\rho + \pi)$, where θ_j is the share of liquidity services provided by currency j. For small values of β and σ, the elasticity of money demand is small and the the temporary windfall gain conferred by lower inflation during ERBS is large. This strengthens the incentive to save through accumulation of durables.

To understand the fourth effect, consider a stripped-down version of the model where the financial structure is unchanged but the private sector consumes only a single non-durable traded good and the government adjusts lump-sum transfers to keep spending equal to revenue from the inflation tax ($g = \chi m, \forall t$). This model can be solved analytically for small changes. In the appendix we show that the jump in consumption at $t = 0$ is

$$C(0) - C_o = \frac{\pi\tau s\theta_m}{i\Delta(K\beta + \tau s)}e^{-\lambda_1 t_1}(\chi_o - \chi_1) - \lambda_2(1 - e^{-\lambda_1 t_1})(J_o - J_1), \tag{23}$$

where

$$s \equiv \frac{im + \rho F}{C} > 0,$$

$$K \equiv 1 + L - L'\phi/C > 0,$$

$$\Delta \equiv \frac{\pi^2\theta_m}{i\beta} + \frac{J(i\theta_F + \rho\theta_m)}{F\sigma} > 0,$$

$\lambda_1 > 0$ and $\lambda_2 < 0$ are eigenvalues; $i = \rho + \pi$; and J_1 is the value of J associated with the lower rate of crawl χ_1. The first business-as-usual term captures the impact of intertemporal substitution. The sign of the second term depends on how lower inflation affects the demand for *total* money balances J. It turns out (see the appendix) that $J_o > J_1$ iff

$$\sigma > \beta\left(1 + \frac{\rho}{\pi\theta_F}\right). \tag{24}$$

This condition admits of a straightforward intuitive explanation. Lower inflation increases the private agent's demand for liquidity services. An increase in liquidity services, however, does not necessarily require an increase in total currency holdings. Note from the first-order

condition (12) that a straight swap of foreign for domestic currency increases the supply of liquidity services by $\phi_m - \phi_F = \pi$ ($\pi = \chi$ in the stripped-down model). Consequently, when inflation is high and currency substitution easy (σ large), the private agent may respond as in Figure 1, increasing consumption of liquidity services by holding much more domestic currency but less total money.[26] The precise condition for this to happen is stated in equation (24). If σ satisfies the inequality, then currency substitution allows the private agent to enjoy more liquidity services while consuming part of his stock of broad-money assets. We label this the *spending down of wealth* (SDW) effect. It operates in all of our numerical simulations because σ is considerably larger than β.

4. Numerical Solutions

Figures 2-8 present the solution paths for the base case and for a variety of alternative cases. The paths track the percentage deviation of the stated variable from its pre-ERBS value. Aggregate consumption is nondurables consumption plus gross durables purchases, the current account balance is measured as a percentage of GDP, and positive values for the change in the real exchange rate signify appreciation. For ease of comparison, Tables 2 and 3 collect the results for the paths of consumption, the current account deficit, and the real exchange rate during the ERBS phase

A quick scan of the figures laid side-by-side shows that the dynamics are broadly similar across the different runs. Right after the new low crawl is announced, consumption and nontradables output jump upward, the current account worsens, and the path of the real exchange rate pivots sharply to the northeast. In the post-ERBS period, the nontradables sector struggles through a prolonged recession, the real exchange rate depreciates steadily, and the current account moves from a small deficit or a surplus. All of this matches up well with the qualitative properties of the ERBS boom-bust cycle. Moreover, the runs deliver the large quantitative effects long sought by the literature. The real exchange rate appreciates 38-53% and the current account soars to 5-7% of GDP before dropping back to 2-4%. Led by a spectacular surge in durables purchases, total consumption spending rises 12-20% in the first year and 8-11% in the second; durables expenditure also leads when spending contracts sharply in the last six months of the program.

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While all of the runs fit the general ERBS story, there is some variation in the persistance of the initial boom, the severity of the recession that follows the boom, and the degree of real exchange rate appreciation. Below we list and briefly comment on the logic underlying the most important results:

- *Ease of currency substitution affects mainly the magnitude of the consumption boom in the first year.* When $\sigma = 2$, the SDW effect is powerful while the STD effect is relatively weak. The opposite holds true in the run for $\sigma = .40$. Since the SDW effect weakens over time (eventually the private agent rebuilds total currency holdings), high values for σ trigger a huge expenditure boom in the short run followed by a rapid decline. Real consumption increases 20% in year one when $\sigma = 2$ vs. 12% when $\sigma = .40$. But after $t = 1.20$, spending is higher for $\sigma = .40$.

- *Stickier prices increase appreciation of the real exchange rate and cause a severe recession in the late stages of ERBS.* Future rates of crawl exert a stronger influence on π_n when price quotes are longer-lived. Consequently, in the scenario where $\alpha = 1$, firms raise π_n from 26% to 36% in the second half of the ERBS period (vs. 15-27% in the base case). The high U-shaped path for π_n leads to greater appreciation of the real exchange rate and larger reductions in spending and nontradables output just before the policy collapse.

- *The consumption path is only a little higher when the intertemporal elasticity of substitution is large.* Both intertemporal substitution and the STD effect depend on τ. Crucially, the STD effect is stronger when τ is small. Because of this and the robust, dominating influence of intertemporal price speculation, aggregate consumption spending is not especially sensitive to variations in τ. The spending boom is almost as strong for $\tau = .25$ as for $\tau = .50$.

- *The boom phase is stronger in longer-lived ERBS programs.* Figure 7 shows how the dynamics change when the lower rate of crawl lasts six years instead of three. The general qualitative pattern is the same as for the three-year program but the boom phase of the cycle is stronger and more persistent. Compared to the base case, the paths of consumption and nontradables output are uniformly higher; in addition, the real exchange rate appreciates more and the current account deficit is larger. A more potent STD effect accounts for the stronger macroeconomic impact.

4.1 A Different Story About Fiscal Adjustment in the Post-ERBS Period

The method of fiscal adjustment in the post-ERBS period matters. When the government cuts purchases of traded goods instead of transfer payments, a new effect comes into play. Less government consumption of traded goods may involve a loss of valuable government services, but it does not affect private sector income or the marginal utility of consumption. Consequently, the representative agent treats the reduction in the inflation tax during ERBS

as an increase in wealth. This wealth effect appears in many ERBS models; its potential importance has been emphasized by Drazen and Helpman (1987, 1988).

Figure 8 shows how the results change when fiscal austerity is implemented entirely through spending cuts on traded goods. The paths for real expenditure, nontradables output, and the current account are similar to their counterparts in Figure 2, but the consumption boom is stronger and the real exchange rate appreciates much more. Total spending in the second year is 9-12% above above its pre-ERBS level, while appreciation of the real exchange rate reaches 53% (i..e., P_n rises 111%).

5. Successful ERBS

The stylized facts for successful ERBS programs look much like those for failed programs. This is a problem for theory because neither intertemporal substitution nor intertemporal price speculation are available to fuel a consumption boom when ERBS is credible. In the Calvo-Vegh model, for example, the economy jumps immediately to a new steady state where inflation is lower and the real equilibrium is unchanged. Adding durables to the model does not alter this result.

In our model other effects operate besides intertemporal substitution and intertemporal price speculation. The SDW effect increases spending on the transition path. As output rises in the nontradables sector, saving-through-durables comes into play as an induced, second-round effect. These two effects are likely to be augmented by a third effect. Capital inflows are not reversed when ERBS is permanent. This provides the government with a pile of dollars that it can sit on or spend; we assume policy makers opt for the latter, using the financial cushion to support a gradual reduction of the fiscal deficit to its sustainable level. Since transfer payments decrease more slowly than the inflation tax, private sector disposable income and spending are higher on the transition path. Greater spending leads to larger current account deficits, but, thanks to ongoing capital inflows, the central bank does not suffer a loss in foreign exchange reserves. Viewed from a different angle, once the public is convinced that inflation is permanently lower, the many years of past saving allocated to accumulation of foreign currency can be tapped to underwrite an extended period of dissaving and high spending. We call this the "cashing out" (CO) effect. Note that both

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the SDW and CO effects are large when domestic and foreign currency are close substitutes and that the CO effect strengthens the STD effect by magnifying the temporary increase in disposable income. (Disposable income is higher on the transition path because Q_n and $g - \chi m$ are higher.) Thus all three effects are strong or weak depending on whether σ is large or small. This gives the model a fighting chance to generate a respectable consumption boom; clearly, however, the results will be more sensitive to variations in parameter values and initial conditions (i.e., the degree of dollarization) than the results for temporary ERBS.

We carried out simulations for alternative values of the currency substitution parameter σ, alternative degrees of dollarization, and different types of spending cuts. In each run, transfer payments decreased to their sustainable level g^* at the rate

$$\dot{g} = v(g^* - g), \quad v > 0, \tag{25}$$

with v chosen so that the stock of foreign exchange reserves did not change in the long run. Although the policy rule in (25) does not preclude a temporary cumulative payments deficit, this never happened. In every case, reserves jumped upward at $t = 0$ and then declined monotonically, staying above their initial level throughout the adjustment process; there was never a phase in which low reserves threatened credibility of the program.

The results in Table 4 and Figures 9-10 confirm that much depends on how currency substitution and the degree of dollarization condition the response of capital inflows. In the base case, the boom dies out after a year and appreciation of the real exchange rate peaks at 13%. By contrast, when currency substitution is easy and dollarization widespread ($\sigma = 2$ and $F_o = 16\%$ of GDP), the boom lasts two years and appreciation of the real exchange rate reaches 23%.

After the CO effect plays out, the private sector is left with the same budget constraint as before. The 1-2 year boom is followed therefore by slow reversion to the initial real equilibrium. This changes in Figures 11-12 and in the last two panels of Table 4, where 50% of expenditure cuts fall on government consumption of traded goods (k). Since reductions in k increase wealth, real private consumption and the relative price of the nontraded good are higher at the new long-run equilibrium. The fit with the stylized facts is correspondingly better. With the wealth effect supplementing the SDW, CO and STD effects, the consump-

tion boom is very strong in the first two years and moderately strong in years three and four. The real exchange rate rises 31% in the long run, with cumulative appreciation overshooting to 34-41% on the transition path.

6.   Concluding Remarks

In this paper we have analyzed the repercussions of non-credible ERBS in a macroeconomic model that allows for consumption of both durable and nondurable goods. The central message of the paper is that the original Calvo and Vegh insight is correct: weak credibility and sticky prices can explain many of the stylized facts associated with ERBS. In standard models, the boom phase of ERBS is nothing more than a tepid expansion — changes in spending, real output, and the real exchange rate are unexceptional. But when durables are part of the choice set, the boom is truly a boom: following a temporary reduction in the crawl, total consumption spending rises 10-15%, the real exchange rate appreciates 40-60%, and the current account deficit swells to 5-7% of GDP. These result do *not* require easy intertemporal substitution in consumption. Since durables generate services long after the date of purchase, spending on cars, refrigerators, etc. is driven mainly by intertemporal price speculation (with assistance from the STD and SDW effects). A strong durables-led consumption boom is compatible therefore with very low values for the intertemporal elasticity of substitution.

While these results are promising, the present model does not provide a fully satisfactory explanation of the ERBS syndrome. Two weaknesses need to be addressed in future research. First, the consumption boom has the right heigth but not the right shape. In all of the simulations, consumption declines steadily after a huge spike at $t = 0$. This is plainly counterfactual: in the data, the path of consumption is flat or hump-shaped. The results in Uribe (2002) suggest that adding habit formation to the model might produce a strong hump-shaped consumption boom. It may also be worthwhile to explore the implications of time-varying credibility. If credibility diminishes over time in the face of mounting concerns about the size of the current account deficit and the lack of fiscal adjustment, then the incentive to engage in intertemporal substitution grows progressively stronger until the policy reversal actually occurs. This could impart an upward tilt to the consumption path over

much of the ERBS period.

The other shortcoming of the model is that it offers only a partial explanation of why the stylized facts are similar for credible, successful programs and for non-credible, failed programs. Two key effects, intertemporal substitution in nondurables consumption and intertemporal price speculation in durables purchases, operate weakly or not at all when ERBS is credible. The loss is not necessarily fatal, for the effects that remain are reinforced by a new effect unique to successful ERBS. In some scenarios, the stars line up right and the quantitative impact on the major macroeconomic aggregates is large. When foreign and domestic currency are close substitutes, dollarization is widespread, and 50% of government spending cuts fall on traded goods, the numbers for the consumption boom, the current account deficit, and appreciation of the real exchange rate are comparable to those associated with temporary ERBS. Unfortunately, this result is not robust. In the other cases we examined, the boom lacked staying power: by the end of the second year, appreciation of the real exchange rate and the increases in consumption and the current account deficit were only 40-70% as large as for a temporary program. Thus something else has to be thrown into the pot to bolster spending and get results consistently faithful to the stylized facts. Incorporating mechanisms for supply-side expansion may help, but experience with this strategy has not been encouraging. A more promising idea is to bring bank lending into the model. There is abundant casual evidence that capital inflows fuel the consumption boom by financing a massive expansion in domestic credit. Furthermore, under the assumption that domestic and foreign assets are imperfect substitutes, capital inflows and the credit expansion are permanent only when ERBS is successful. The permanent credit expansion counterbalances the stronger motives for intertemporal substitution and intertemporal price speculation that operate when credibility is weak.

Appendix: Solving a Stripped-Down ERBS Model

In the stripped-down model, the private sector consumes a single nondurable good and the government sets lump-sum transfers equal to revenue from the inflation tax ($g = \chi m, \forall t$). Without durables and nontraded goods, the private agent's utility function is $U = C^{1-1/\tau}/(1 - 1/\tau)$, where τ is the intertemporal elasticity of substitution. The first-order conditions for an optimum consist of (11), (12) and (14), with C replacing X in (11):

$$C^{-1/\tau} = \omega_1(1 + L - L'\phi/C), \tag{1a}$$

$$-L'\phi_m = r + \chi, \tag{2a}$$

$$-L'\phi_F = r, \tag{3a}$$

$$\dot{\omega}_1/\omega_1 = \rho - r. \tag{4a}$$

To express the model in more familiar terms, we introduced the real interest rate $r = \rho - \dot{\omega}_1/\omega_1$. This does not really add an extra equation to the model — equation (3a) is simply an alternative version of the co-state equation (4a).

Recall that total currency holdings $J = m + F$ is a state variable in the model. With $g = \chi m$ and $S = P_n Q_n = 0$, equation (22) reduces to

$$\dot{J} = Q - C. \tag{5a}$$

Turn next to the first-order conditions. From (1a) and (4a),

$$\dot{C} = \tau C(r - \rho) - \frac{L'\phi\tau}{\beta K}\left[\frac{\phi_m m}{\phi}\frac{\dot{m}}{m} + \frac{\phi_F F}{\phi}\left(\frac{\dot{J}}{F} - \frac{\dot{m}}{F}\right) - \frac{\dot{C}}{C}\right], \tag{6a}$$

where $K = 1 + L - L'\phi/C$, $\beta = -L'/L''(\phi/C)$, and we have made use of the fact that $\dot{F} = \dot{J} - \dot{m}$. Linear homogeneity of ϕ ($\phi = \phi_m m + \phi_F F$), (2a) and (3a) imply

$$-L'\phi = im + rF,$$

$$\theta_m \equiv \frac{\phi_m m}{\phi} = \frac{im}{im + rF},$$

$$\theta_F \equiv \frac{\phi_F F}{\phi} = 1 - \theta_m,$$

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where $i = r + \chi$ is the nominal interest rate and θ_j denotes the share of liquidity services supplied by currency j. Using the above relationships allows (6a) to be rewritten as

$$\dot{C} = \tau C(r - \rho) + \frac{\tau(im + rF)}{\beta K}\left(\frac{\chi\theta_m}{i}\frac{\dot{m}}{m} + \theta_F\frac{\dot{J}}{F} - \frac{\dot{C}}{C}\right). \tag{7a}$$

To get (7a) in a form suitable for linearization, we need to solve (2a) and (3a) to determine how r and m depend on J and C. Straightforward algebra produces

$$dm = n_1\frac{m}{F}dJ + n_2 dC, \tag{8a}$$

$$dr = -\frac{n_3}{F}dJ + \frac{n_3 J}{FC}dC, \tag{9a}$$

where

$$n_1 = \frac{(\beta - \sigma)\theta_F i + (\beta\theta_m + \sigma\theta_F)r}{\beta\sigma\Delta},$$

$$n_2 = \frac{\chi m}{\beta\Delta C},$$

$$n_3 = \frac{ri}{\beta\sigma\Delta},$$

$$\Delta = \frac{\chi^2\theta_m}{i\beta} + \frac{J(i\theta_F + r\theta_m)}{F\sigma},$$

Substituting $\dot{m} = n_1(m/F)\dot{J} + n_2\dot{C}$ and $\dot{J} = Q - C$ into (7a) leads to

$$\dot{C} = \frac{\tau C}{H}(r - \rho) + \frac{\tau sC}{K\beta FH}\left(\frac{\chi\theta_m}{i}n_1 + \theta_F\right)(Q - C), \tag{10a}$$

where

$$H = 1 + \frac{\tau sJ}{K\beta\Delta\sigma F}(\theta_F i + r\theta_m),$$

$$s = \frac{im + rF}{C}.$$

Now linearize (5a) and (10a) around a stationary equilibrium (J^*, C_o) where $r = \rho$ and $Q = C$. After making use of (9a), we get

$$\begin{bmatrix} \dot{C} \\ \dot{J} \end{bmatrix} = \begin{bmatrix} n_4 & -n_5 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} C - C_o \\ J - J^* \end{bmatrix}, \tag{11a}$$

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where

$$n_4 = \frac{\tau(n_3 J/F - n_6)}{H},$$

$$n_5 = \frac{\tau n_3 C}{FH},$$

$$n_6 = \frac{sC}{K\beta F}\left(\frac{\chi\theta_m}{i}n_1 + \theta_F\right).$$

The stationary equilibrium is a saddle point. In what follows, we designate $\lambda_1 > 0$ and $\lambda_2 < 0$ to be the system's two eigenvalues.

During the ERBS phase, the dynamics are governed by a nonconvergent path of the system associated with the low value of χ. For this phase, (11a) gives

$$C(t) - C_o = -\lambda_1 h_1 e^{\lambda_1 t} - \lambda_2 h_2 e^{\lambda_2 t}, \quad t < t_1 \tag{12a}$$

$$J(t) - J_1 = h_1 e^{\lambda_1 t} + h_2 e^{\lambda_2 t}, \quad t < t_1, \tag{13a}$$

where (J_1, C_o) is the steady state paired with the low crawl.

After the policy reversal at time t_1, the economy follows the saddle path that leads back to the pre-ERBS equilibrium:

$$C(t) - C_o = -\lambda_2 h_3 e^{\lambda_2 t}, \quad t \geq t_1, \tag{14a}$$

$$J(t) - J_o = h_3 e^{\lambda_2 t}, \quad t \geq t_1. \tag{15a}$$

The analysis is restricted to small changes. Hence the eigenvalues and eigenvectors in (14a) and (15a) are the same as in (12a) and (13a).

Three boundary conditions are needed to pin down h_1- h_3. Two conditions are obtained by evaluating the solution for the state variable at the beginning and the end of the ERBS program. At $t = 0$, equation (13a) yields

$$h_1 + h_2 = J_o - J_1. \tag{16a}$$

Furthermore, equations (13a) and (15a) must return the same solution at t_1. Thus

$$h_1 e^{\lambda_1 t_1} + h_2 e^{\lambda_2 t_1} = h_3 e^{\lambda_2 t_1} + J_o - J_1. \tag{17a}$$

Deriving the third boundary condition entails more work. Return to (1a) and note that ω_1 does not jump when χ rises at time t_1. (The abrupt increase in χ is an *anticipated* shock.) Since ω_1 is constant, C, m and r must jump to preserve the first-order conditions in (1a)-(3a). The jump in C is

$$dC|_{t_1} = C(t_1^+) - C(t_1^-) = -Cn_7(\chi_o - \chi_1) < 0, \tag{18a}$$

where

$$n_7 = \frac{\tau s \chi \theta_m}{(K\beta + \tau s)i\Delta} > 0$$

and $\chi_o - \chi_1$ is the jump in χ at t_1. The jump in (18a) must be consistent with the jump implicit in (12a) and (14a):

$$C(t_1^+) - C(t_1^-) = \lambda_1 h_1 e^{\lambda_1 t_1} + \lambda_2(h_2 - h_3)e^{\lambda_2 t_1}. \tag{19a}$$

Equating the two solutions provides the third boundary condition:

$$\lambda_1 h_1 e^{\lambda_1 t_1} + \lambda_2(h_2 - h_3)e^{\lambda_2 t_1} + Cn_7(\chi_o - \chi_1) = 0. \tag{20a}$$

Equations (16a), (17a) and (20a) can be solved for h_1- h_3 as a function of the jump in $\chi_o - \chi_1$ and $J_o - J_1$. The solutions for h_1 and h_2 are

$$h_1 = \frac{e^{-\lambda_1 t_1}}{\lambda_2 - \lambda_1}[n_7(\chi_o - \chi_1) + \lambda_2(J_o - J_1)], \tag{21a}$$

$$h_2 = J_o - J_1 - h_1. \tag{22a}$$

Substituting these solutions into (12a) gives

$$C(0) - C_o = e^{-\lambda_1 t_1} n_7(\chi_o - \chi_1) - \lambda_2(1 - e^{-\lambda_1 t_1})(J_o - J_1) \tag{23a}$$

for the impact effect on consumption. The second term captures a spending-down-of-wealth effect when $J_1 < J_o$. To ascertain the sign of $J_o - J_1$, consult the steady-state versions of (2a) and (3a). These read

$$-L'\phi_m(m, F) = \rho + \chi, \tag{2a$'$}$$

$$-L'\phi_F(m, F) = \rho. \tag{3a$'$}$$

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Solving for m and F produces

$$dm \;=\; -\frac{\sigma\theta_F + \beta\theta_m}{i}md\chi, \tag{24a}$$

$$dF \;=\; \frac{\theta_m(\sigma - \beta)}{i}Fd\chi. \tag{25a}$$

Adding the two solutions gives the solution for dJ:

$$dJ = J_o - J_1 = \frac{\chi\theta_m F}{i^2}\left[\sigma - \beta\left(1 + \frac{\rho}{\chi\theta_F}\right)\right](\chi_o - \chi_1). \tag{26a}$$

Since χ is lower during the ERBS phase $(\chi_1 < \chi_o)$, $J_o < J_1$ iff

$$\sigma > \beta\left(1 + \frac{\rho}{\chi\theta_F}\right).$$

NOTES

* We are indebted to Guillermo Calvo, Carlos Vegh, and Martin Uribe for helpful comments on an earlier draft of this paper.

1. See Corbo (1985), Hanson and de Melo (1985), Kiguel and Liviatan (1992), Calvo and Vegh (1994a), Reinhart and Vegh (1994), and Rebelo and Vegh (1995).

2. On the other hand, the evidence in Fischer, Sahay, and Vegh (2000) supports the earlier view of a distinct, well-defined ERBS syndrome.

3. This description of the stylized facts is based on the stabilization time profiles in Calvo and Vegh (1999), Hamann (2001), and Hamann et al. (2005). The Uruguayan tablita is the most striking example of a late collapse in consumption occuring in conjunction with a strong improvement in the current account balance. (In 1982, real consumption decreased 10% and the current account registered a surplus.)

   There is little or no evidence of a late recession in the panal datasets analyzed by Easterly (1996), Hamann (2001), and Hamaan et al. (2005). For several reasons, however, the evidence presented in these studies is problematic: (i) the stabilization window is truncated at three years after the start of ERBS even though many programs have lasted much longer; (ii) de facto ERBS programs may have been misclassified as money-based programs [especially in Easterly (1996)]; (iii) the selection procedure may give the wrong start date for ERBS. [Hamann et al.'s (2005) procedure, for example, says the Uruguayan tablita started in November, 1980 instead of October, 1978.]

4. The nontradables sector may enter into a recession before the policy reversal.

5. The Reinhart-Vegh model delivers much larger increases in consumption when the nominal interest rate falls several hundred percentage points (according to their calculations, 1,270 points in the case of Argentina's Austral Plan). But then doubts arise about how the change in the nominal interest rate is computed and about the story told by the cash-in-advance (liquidity costs) constraint: Are Reinhart and Vegh correct in assuming that the difference between the initial interest rate and the lowest rate observed during ERBS is close to the average change in the rate? And is it believable that temporary huge variations in the nominal interest rate generate equally huge variations in the price of current vs. future consumption?

6. For example, Corbo, de Melo, and Tybout (1986, p.633) state "These results suggest that the Central Bank of Chile was wrong in assuming that a perfect capital mobility model was a good characterization of Chile's financial markets." See also Corbo (1985), Hanson and de Melo (1985), Mathieson and Rojaz-Suarez (1993), and Agenor and Montiel (1999).

7. Related to this, both Reinhart and Vegh (1995) and Rebelo and Vegh (1995) are careful to note that, due to the omission of durables, their models supply only lower-bound predictions for consumption growth during the boom phase of ERBS.

8. The path of aggregate consumption is fairly flat in the models surveyed in Rebelo and

Vegh (1995). Consumption decreases after jumping upward in Calvo and Vegh (1993), but it is not clear how much it decreases or whether recession before the collapse is a frequent occurence.

9. We do not assume Cobb-Douglas preferences. In the numerical simulations, the consumption weights change over time.

10. The data for the U.S. and other developed countries indicate that durables spending is far smoother than predicted by a frictionless Permanent Income/Life Cycle model.

11. Our results are stronger if the income effect is allowed to operate.

12. See the accounts in Corbo and de Melo (1985), Fernandez (1985), Kiguel (1991), Blejer and Cheasty (1988), and Mathieson and Rojaz-Suarez (1993). Calvo and Vegh (1994a, p.35) observe that "More often than not, the failure of stabilization plans reflects the absence of *lasting* (my emphasis) fiscal adjustment."

13. If the government can institute large spending cuts at time t_1, why doesn't it do so earlier when the cuts might enhance credibility? There is a straightforward answer to this question: the evidence in ERBS and other stabilization episodes argues that most governments resist fiscal adjustment until circumstances (galloping inflation, unsustainable payments deficits) force their hand. The path of government spending in the model is consistent with this observation and with the stylized fact that fiscal policy in LDCs is often strongly procyclical (Ocampo, 2004).

14. See Lluch et al. (1977, chapter 3), Deaton and Muellbauer (1980, p.71), Blundell (1988, p.35) and Blundell, Pashardes and Weber (1993, Table 3b, p.581).

15. Across steady states, the nominal interest rate is $i = \rho + \pi$. The interest-elasticity of money demand is $\beta\theta_m + \sigma\theta_f$, where θ_j is the share of liquidity services supplied by currency j.

16. The share of the service flow from durables in aggregate consumption is $\gamma_d = (\rho + c)P_dD/[(\rho + c)P_dD + E]$, evaluated at a steady state. This share (the weight of durables in the CPI) can be derived from the value assigned to γ_{cd}.

17. These figures assume a depreciation rate of 4% for housing. For S. Korea, the data are from the Bank of Korea's *Monthly Statistical Bulletin* (April, 2003) and the calculation of $\bar{\gamma}_d$ assumes the share of personal transport equipment in total transport expenditure is the same as in Mexico. The figure for the Philippines assumes that the share of personal transport equipment in total consumption is the same as in Colombia.

18. Evaluated at a steady state, $R''/V_E = P_d/\Omega c$.

19. We do not have distribution costs in the model. But, as Burstein, Neves, and Rebelo note, a model with nontraded distribution costs is analytically equivalent to a model with a higher consumption share of nontradables.

20. We calibrated the model for $k = 0$. This is the neutral case where variations in the real exchange rate do not directly affect the fiscal deficit (measured as a % of GDP). In the

runs where k decreases in the post-ERBS period, we interpret the negative value of k as income from state export monopolies (or aid flows) net of government consumption of traded goods.

21. The transition path leads to a new steady state only when ERBS is permanent. In the runs for temporary ERBS, the economy eventually returns to the initial equilibrium.

22. The exact path of fiscal policy is irrelevant when both the public and the private sector enjoy access to a perfect world capital market.

23. The currency substitution framework in the model is a stand-in for imperfect asset markets. Everything works in the same way, however, if the foreign asset is a tradable bond that yields some type of non-pecuniary service. The motive to save by stocking up on durables operates as long as the foreign financial asset is not a perfect instrument for smoothing the path of consumption.

24. "Saving" here means less dissaving. (Spending is higher during the ERBS phase, so net holdings of the foreign asset decrease.)

25. Adding domestic bonds to the menu of financial assets does not change the results. Since the stock of government bonds is fixed, in general equilibrium the private sector as a whole cannot save/dissave by buying more/less bonds.

26. Note from (12) and (14) that the slope of the iso-ϕ schedule in Figure 1 is $-\phi_F/\phi_m = -(1 + \pi/\rho)^{-1}$, as $\pi = \chi$ and $\rho = -L'\phi_F$ across steady states.

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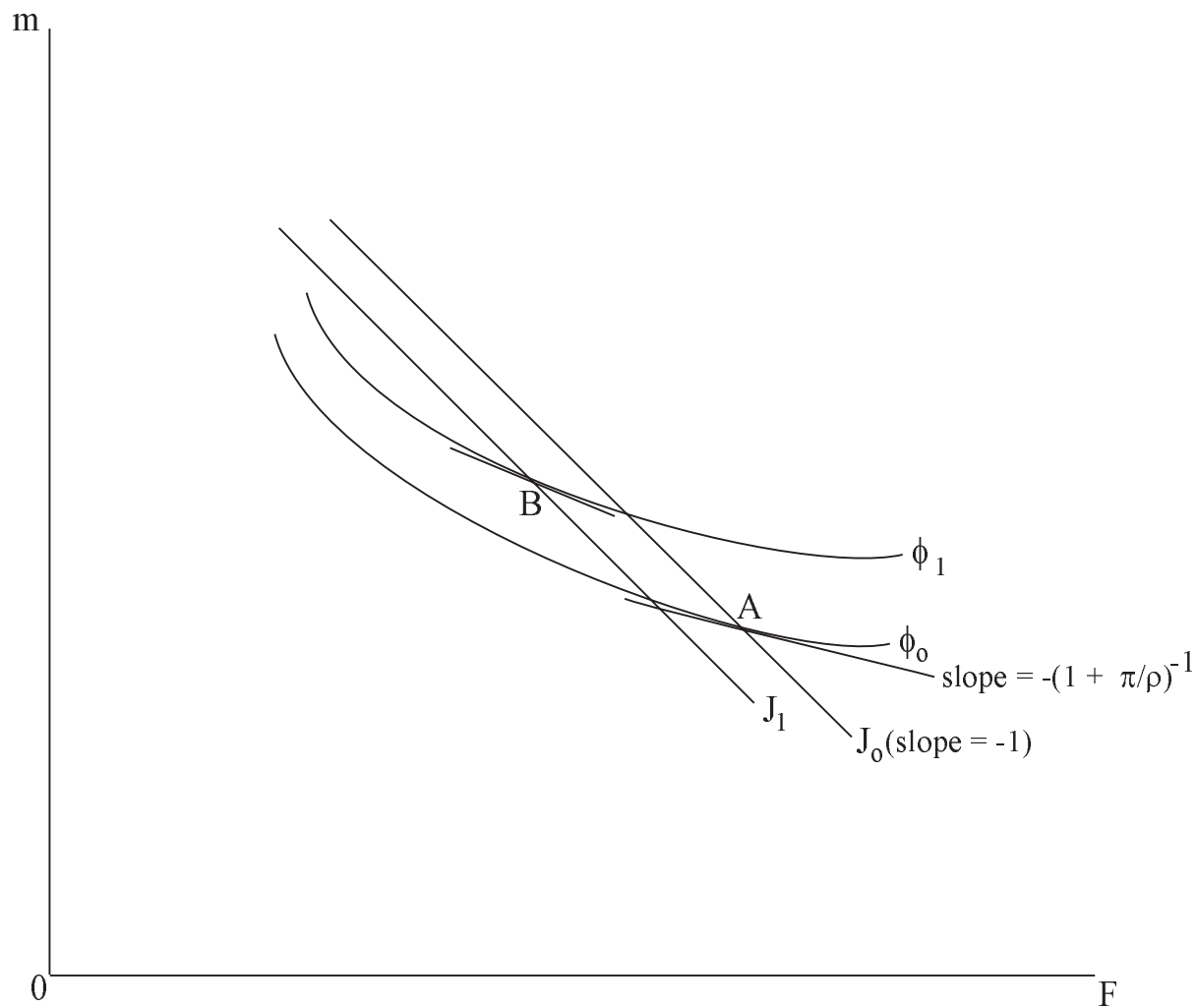
Figure 1: Outcome when the condition in equation (24) holds.
(Increase in liquidity services equals $\phi_1 - \phi_o$. Decrease
in total currency holdings equals $J_1 - J_o$.)
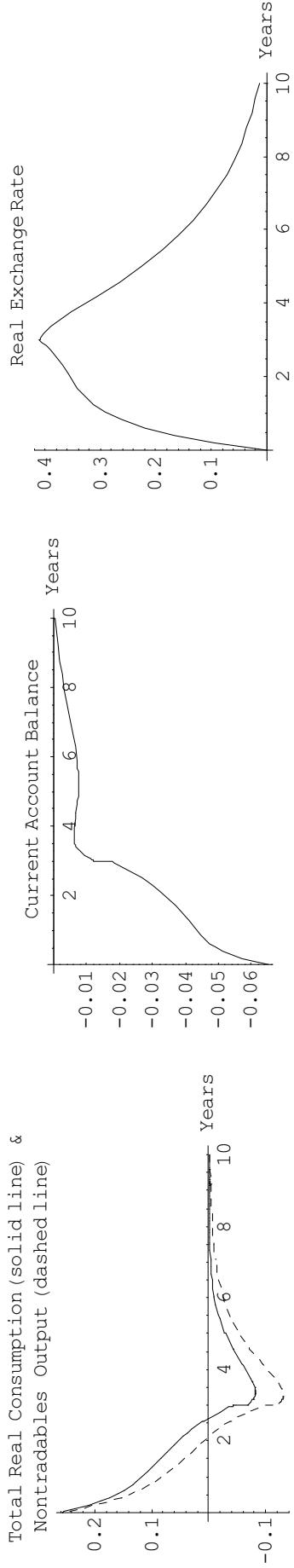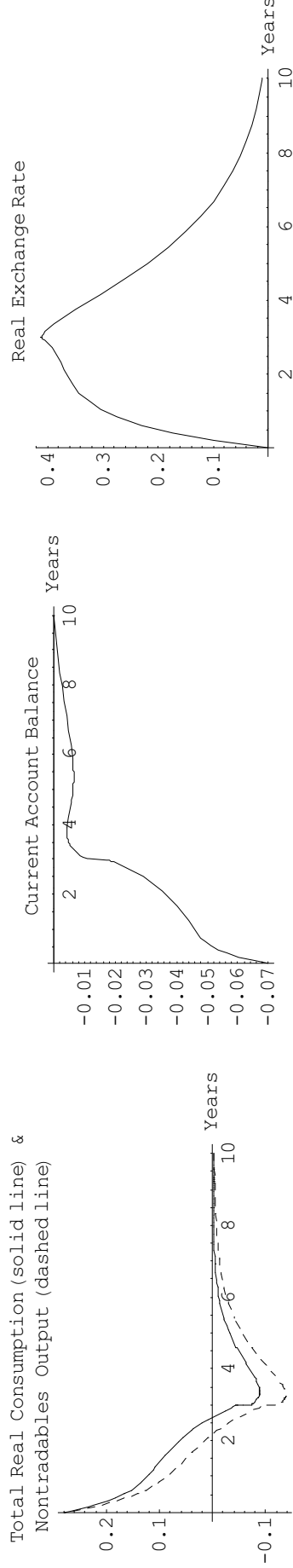
Figure 2: Temporary ERBS in the base case

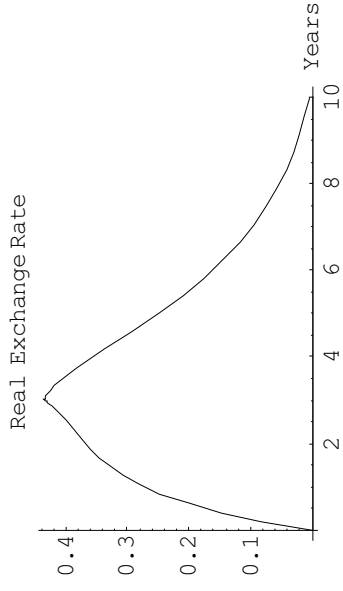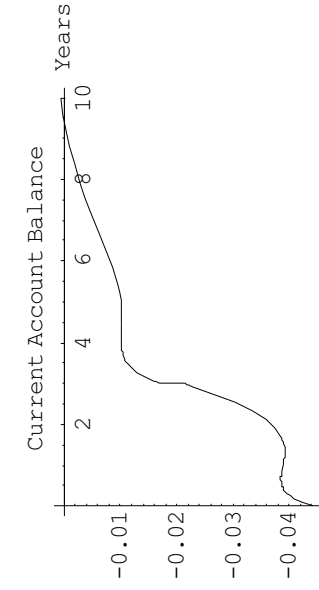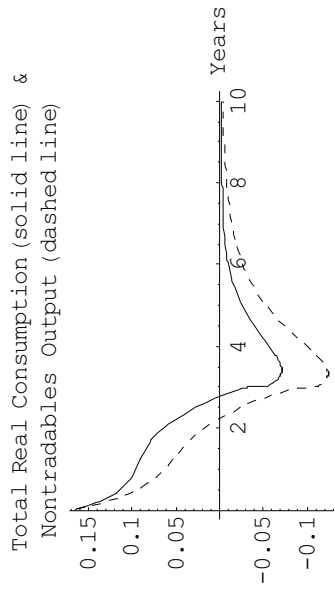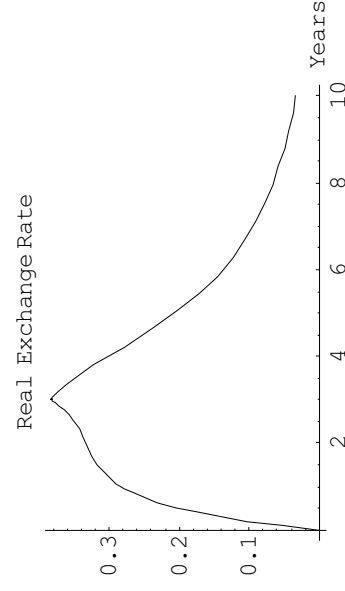Figure 3: Temporary ERBS when $\tau = .5$

Figure 4: Temporary ERBS when σ = .4
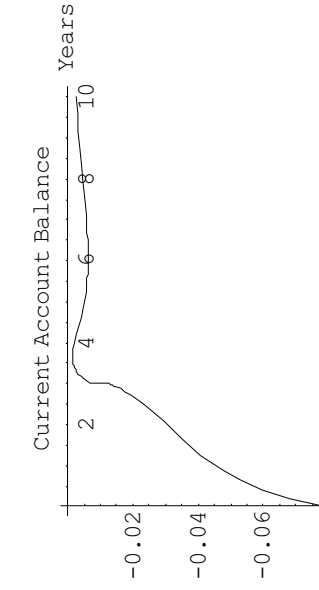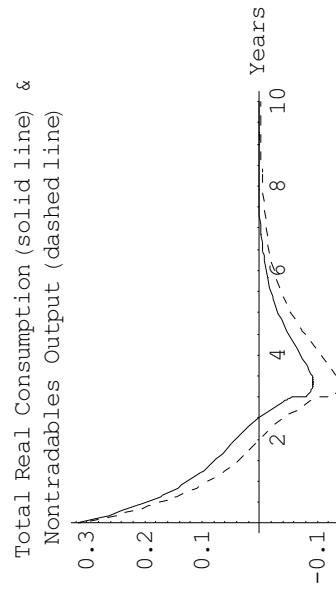
Figure 5: Temporary ERBS when σ = 2

Total Real Consumption (solid line) &
Nontradables Output (dashed line)

Current Account Balance

Real Exchange Rate
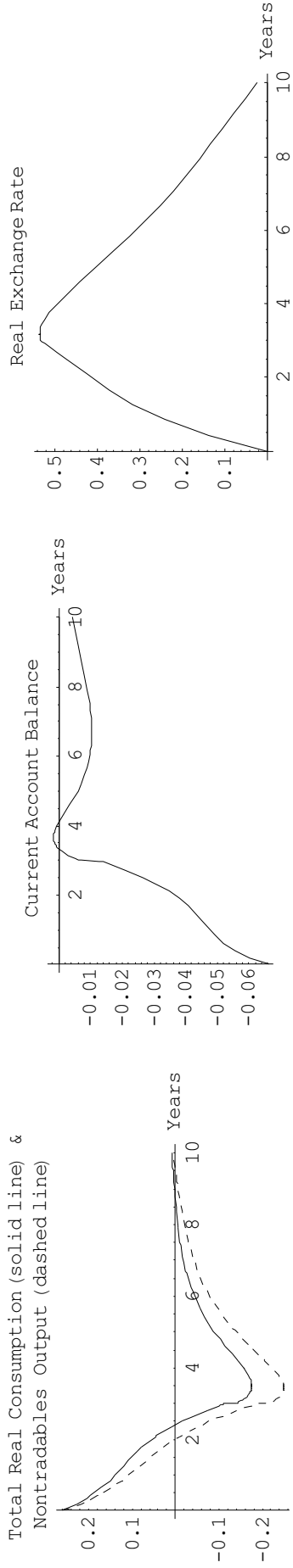
Figure 6: Temporary ERBS with stickier prices ($\alpha = 1$)

Total Real Consumption (solid line) &
Nontradables Output (dashed line)

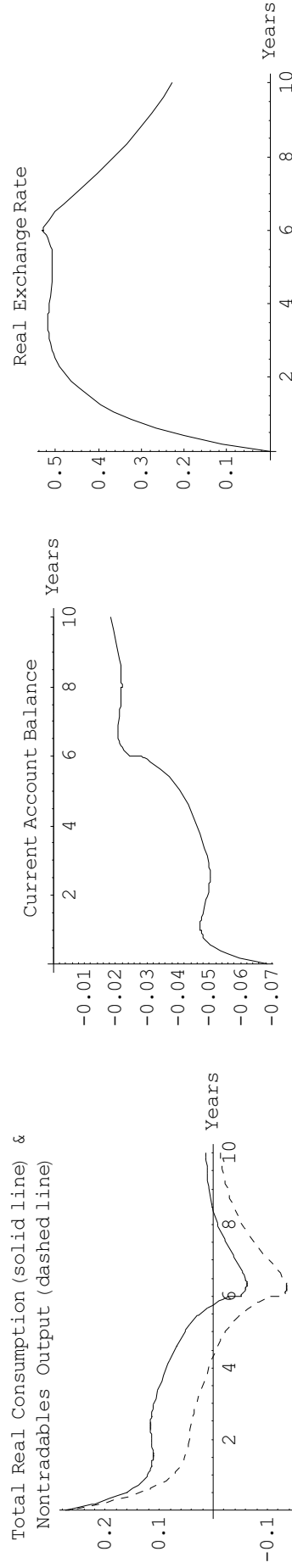Current Account Balance

Real Exchange Rate

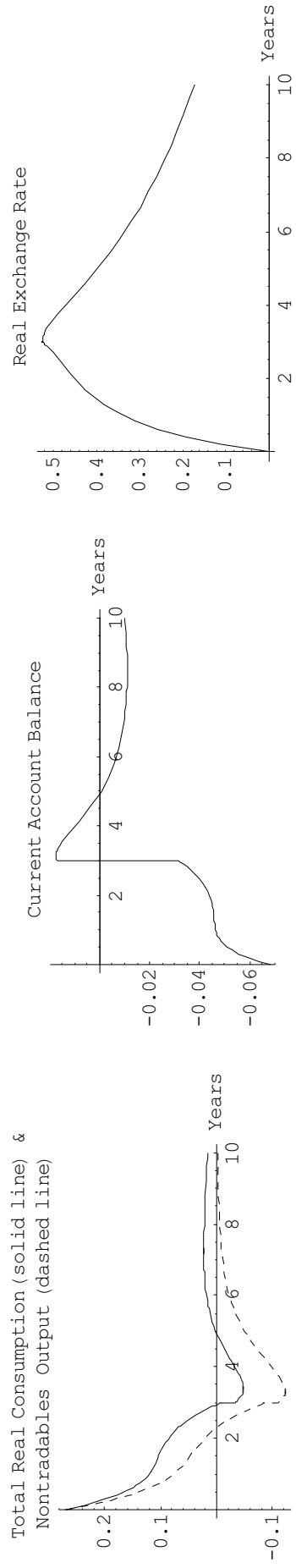Figure 7: Temporary ERBS when the program lasts 6 years

Figure 8: Temporary ERBS when government cuts purchases of traded goods in the post-EBRS period.

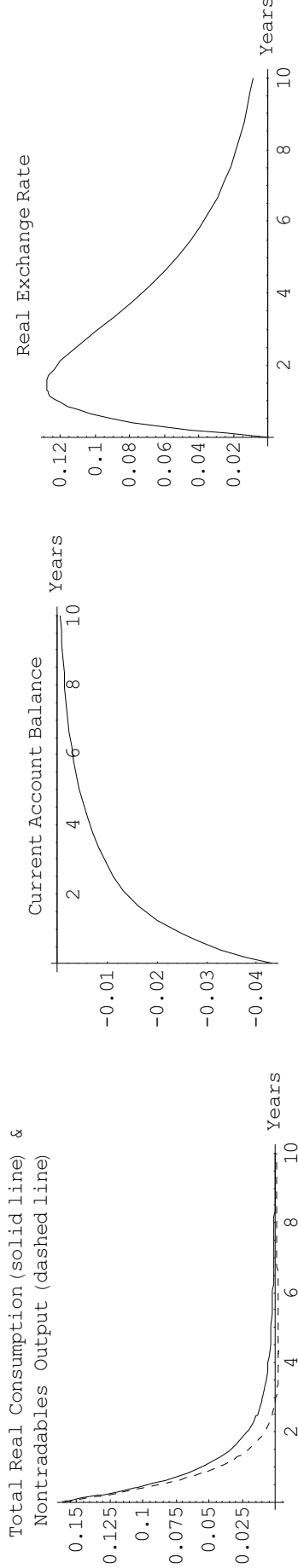Figure 9: Permanent ERBS in the base case
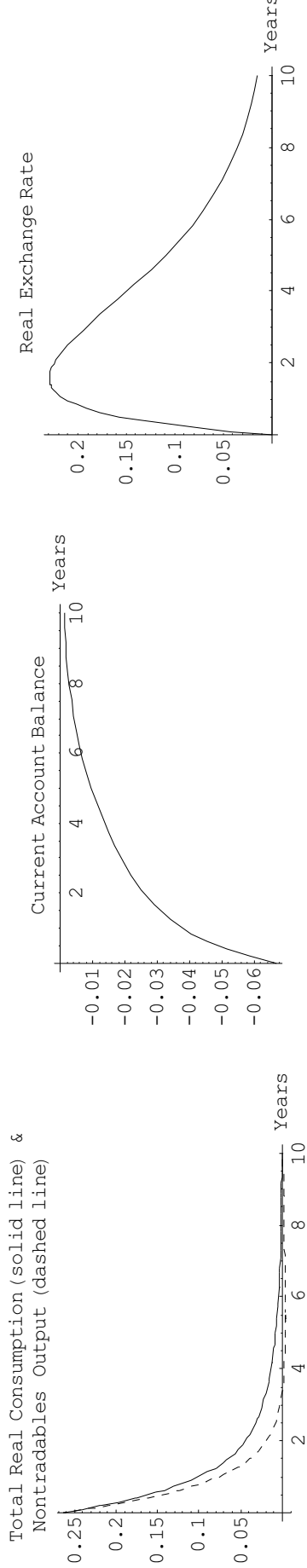

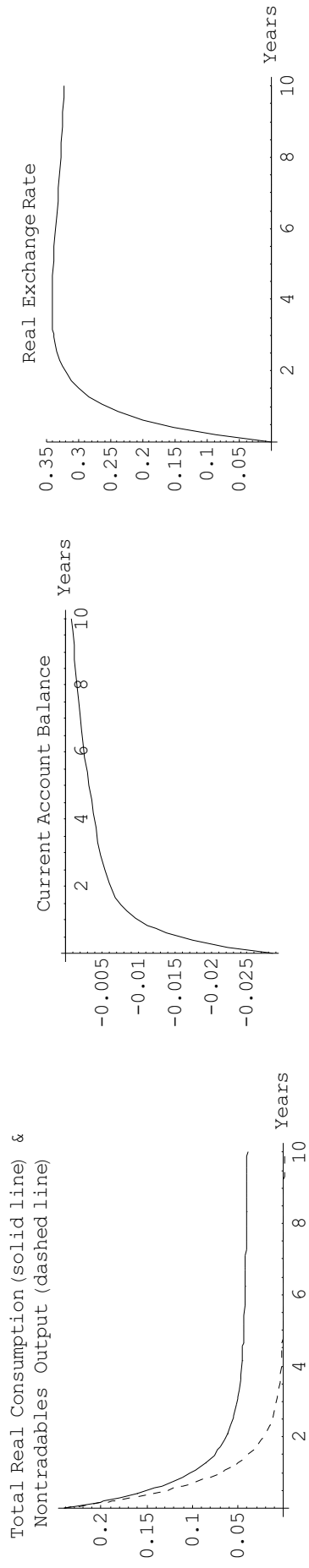Figure 10: Permanent ERBS when σ = 2 and holdings of foreign currency are initially 16% of GDP

Figure 11: Permanent ERBS when 50% of government spending cuts fall on the purchase of traded goods
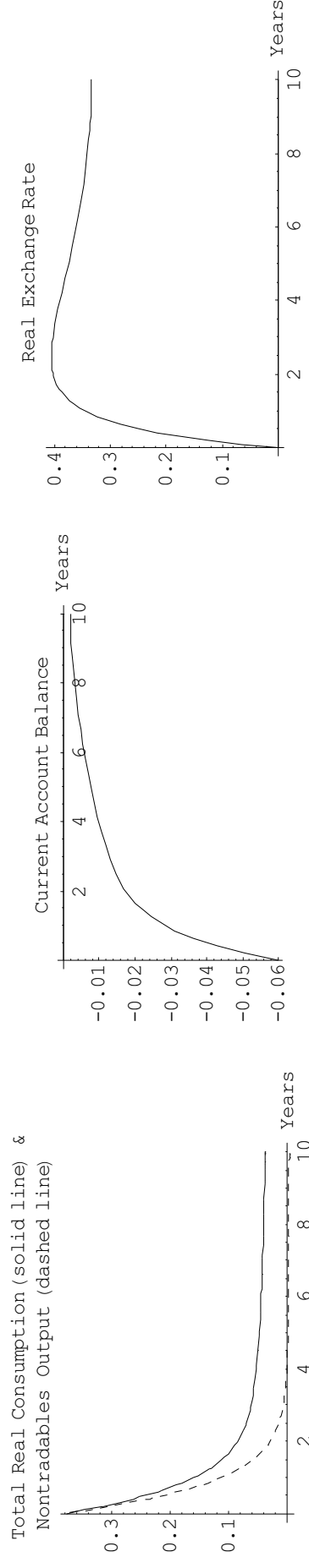

Figure 12: Permanent ERBS when σ = 2, holdings of foreign currency are initially 16% of GDP, and 50% of government spending cuts fall on the purchase of traded goods

Table 1: Calibration of the Model

Parameter	Base value	Alternative value
Length of ERBS program (t_1)	3	6
Elasticity of substitution between tradable and nontradable nondurable consumer goods (δ)	.40	-
Time preference rate (ρ)	.10	-
Elasticity of substitution between domestic and foreign currency (σ)	.75	.40, 2
Ratio of domestic currency to national income	.08	-
Ratio of foreign currency to national income	.12	-
Elasticity of intertemporal substitution (τ)	.25	.50
Speed of price adjustment in the nontradables sector (α)	3	1
Convexity of the transactions costs function (β)	.10	-
Consumption share of durables (γ_{cd})	.20	-
Depreciation rate of durables (c)	.10	-
q-elasticity of durables spending (Ω)	3	-
Elasticity of substitution between durables and nondurables (ψ)	.25	-
Share of nontradables in nondurables expenditure and in durables expenditure (γ_{ne}, γ_{nd})	.70	-
Rate of crawl before vs. during ERBS	100% vs. 10%	-
Path of currency depreciation in the post-ERBS period	crawl jumps from 10% to 30% at t_1; v = 1	-
Path of government spending in the post-ERBS period	transfer payments decrease by 6% of initial GDP at time t_1; y = .35	government consumption of traded goods adjusts instead of transfer payments

Table 2: Summary of solutions for the paths of total consumption, durables spending, and non-durables consumption during the ERBS period.*

	Base Case		
	t = 1	t = 2	t = 3
Total	16.9	8.4	1.1
Durables	53.0	23.3	-2.3
Non-durables	7.8	4.7	1.9

	$\sigma = .40$		
	t = 1	t = 2	t = 3
Total	11.8	8.3	2.4
Durables	37.2	23.8	2.8
Non-durables	5.5	4.4	2.4

	$\sigma = 2$		
	t = 1	t = 2	t = 3
Total	20.4	7.8	-.1
Durables	64.0	21.2	-6.0
Non-durables	9.5	4.5	1.4

	$\tau = .50$		
	t = 1	t = 2	t = 3
Total	17.9	9.4	1.6
Durables	50.0	20.1	-5.1
Non-durables	9.9	6.8	3.3

	Stickier prices ($\alpha = 1$)		
	t = 1	t = 2	t = 3
Total	19.0	10.0	-1.8
Durables	65.4	34.5	-9.7
Non-durables	7.4	3.9	.1

	ERBS program lasts six years					
	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Total	17.5	11.4	11.5	9.9	7.2	2.1
Durables	47.0	23.2	21.7	17.1	9.9	-6.2
Non-durables	10.1	8.5	8.9	8.1	6.5	4.2

	Govt. cuts purchases of traded goods at t_1		
	t = 1	t = 2	t = 3
Total	17.4	10.3	4.7
Durables	51.2	25.0	4.1
Non-durables	8.9	6.6	4.9

* Percentage deviations from the pre-ERBS value. Consumption is measured as the integral over the year.

Table 3: Summary of solution paths for the real exchange rate (RER) and
the current account deficit (CA) during the ERBS period.*

	Base Case		
	t = 1	t = 2	t = 3
RER	28.4	35.4	41.0
CA	-5.1	-3.9	-2.7

	σ = .40		
	t = 1	t = 2	t = 3
RER	27.2	36.8	43.5
CA	-4.0	-3.9	-3.0

	σ = 2		
	t = 1	t = 2	t = 3
RER	28.4	33.3	38.3
CA	-5.8	-3.7	-2.3

	τ = .50		
	t = 1	t = 2	t = 3
RER	29.6	36.6	41.2
CA	-5.3	-4.2	-2.8

	Stickier prices (α = 1)		
	t = 1	t = 2	t = 3
RER	27.1	41.5	53.3
CA	-5.5	-4.3	-2.6

	ERBS program lasts six years					
	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
RER	35.2	47.1	51.3	51.5	50.6	53.0
CA	-5.3	-4.8	-5.0	-4.8	-4.4	-3.6

	Govt. cuts purchase of traded goods at t_1		
	t = 1	t = 2	t = 3
RER	33.8	45.4	52.5
CA	-5.3	-4.5	-3.9

* The real exchange rate $(1/P_n)$ is measured as the percentage deviation from its pre-
ERBS value at the end of the year. The current account deficit is measured as the
integral over the year, expressed as a percentage of GDP.

Table 4: Summary of solutions for the paths of total consumption, durables
spending, and non-durables consumption when ERBS is permanent.*

	Base Case				
	t = 1	t = 2	t = 3	t = 4	t = 5
Total	9.9	3.5	1.4	.7	.4
Durables	30.1	7.5	.1	-1.3	-1.8
Non-durables	4.9	2.6	1.7	1.2	.9
	σ = 2				
	t = 1	t = 2	t = 3	t = 4	t = 5
Total	14.6	5.6	2.4	1.1	.5
Durables	43.4	11.8	1.6	-1.8	-2.9
Non-durables	7.4	4.0	2.6	1.9	1.4
	σ = 2 and F = 16% of GDP initially				
	t = 1	t = 2	t = 3	t = 4	t = 5
Total	16.8	6.7	3.2	1.8	1.0
Durables	49.1	14.2	2.8	-.9	-2.3
Non-durables	8.8	4.9	3.3	2.5	1.9

Lower government purchases of traded goods account for 50% of expenditure cuts

	Base Case				
	t = 1	t = 2	t = 3	t = 4	t = 5
Total	15.6	7.8	5.6	4.8	4.5
Durables	43.0	14.3	6.2	3.7	2.9
Non-durables	8.8	6.1	5.4	5.1	4.9
	σ = 2 and F = 16% of GDP initially				
	t = 1	t = 2	t = 3	t = 4	t = 5
Total	25.2	11.5	7.1	5.7	5.0
Durables	67.8	21.5	6.9	3.1	2.2
Non-durables	14.5	8.9	7.2	6.3	5.7

* Percentage deviations from the pre-ERBS value. Consumption is measured as the
integral over the year.