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The price–consumption puzzle of currency pegs ☆

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Abstract

A defining stylized fact associated with exchange-rate-based stabilization programs is that their initial phase is characterized by several years of continuous expansion in private consumption and a gradual appreciation of the real exchange rate. This paper shows that a large class of standard optimizing models is unable to account for this empirical regularity. In particular, models in this class predict that a gradual appreciation of the real exchange rate must necessarily be accompanied by a declining path of consumption. The paper suggests several possible solutions to this problem and develops one in detail. Namely, the relaxation of the assumption of time separability in preferences. Specifically, it shows that under habit formation currency pegs induce a positive comovement between consumption and the real exchange rate. The paper also establishes that habit formation provides an explanation for why in failed currency pegs a contraction in aggregate demand sets in before the collapse of the program. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

In the past 25 years, high-inflation countries, especially in Latin America, have recurrently used the exchange rate as a nominal anchor to stabilize prices. One defining empirical regularity associated with exchange-rate-based (ERB) stabilization programs is that their initial phase is characterized by several years of continuous expansion in consumption and a gradual appreciation of the real exchange rate defined as the relative price of nontradables in terms of tradables. The top panels of Fig. 1 illustrate this empirical regularity using data from the Argentine Convertibility Plan of 1991. Kiguel and Liviatan (1992) and Végh (1992) provide extensive evidence from other stabilization episodes. Formally, letting c_t denote consumption in quarter t and p_t the real exchange rate in t, we have that if the program is announced at $t = 0$ and the expansionary phase lasts until period $t' > 0$, then $c_t > c_{t-1}$ and $p_t > p_{t-1}$ for $t = 0, 1, \ldots, t'$.

The sectoral components of consumption also display a consistent pattern following the announcement of currency pegs. Of particular interest for the analysis that follows is the behavior of consumption of nontradables. The middle left panel of Fig. 1 uses value added in the service sector as a proxy for aggregate expenditure in nontradables. It shows that the response of this variable mimics that of total consumption. I formalize this empirical regularity by letting c_t^{N} denote consumption of nontradables and by writing $c_t^{\mathrm{N}} > c_{t-1}^{\mathrm{N}}$ for $0 \leqslant t \leqslant t'$. I refer to these facts involving the joint behavior of c_t, c_t^{N}, and p_t during currency pegs as the *price–consumption regularity*.

In this paper, I argue that the comovement between consumption (and its nontraded component) and the real exchange rate implied by a large class of standard optimizing models of exchange-rate-based stabilization is inconsistent with the price–consumption regularity. Specifically, existing theories imply that after the date of announcement of the stabilization program, consumption and the real exchange rate are either constant or move in opposite directions. That is, $(c_t - c_{t-1})(p_t - p_{t-1}) \leqslant 0$ and $(c_t^{\mathrm{N}} - c_{t-1}^{\mathrm{N}})(p_t - p_{t-1}) \leqslant 0$ for $0 < t \leqslant t'$. I refer to the inability of standard models to explain the price–consumption regularity as the *price–consumption puzzle of currency pegs.*

The price–consumption puzzle is present in a large number of optimizing models of exchange-rate-based stabilization that can be broadly classified into three groups: models of imperfect credibility (Calvo, 1986); models where real effects stem from expectations of future fiscal adjustment (Drazen and Helpman, 1987; Helpman and Razin, 1987; Rebelo, 1994); and models that emphasize the role of inflation as a distorting tax on domestic factors of production (Lahiri, 1995; Roldós, 1995; Uribe, 1997).[1] These theories capture important aspects of the data. In particular, most of the models predict an increase in consumption and a real exchange rate appreciation at the date the program is announced ($c_0 > c_{-1}$ and $p_0 > p_{-1}$). Some of them, such as models with real frictions (Uribe, 1997) or nominal rigidities (Calvo and Végh, 1993), are further able to replicate the gradual appreciation of the real exchange rate

[1] See Rebelo and Végh (1995) for a survey of these theories.

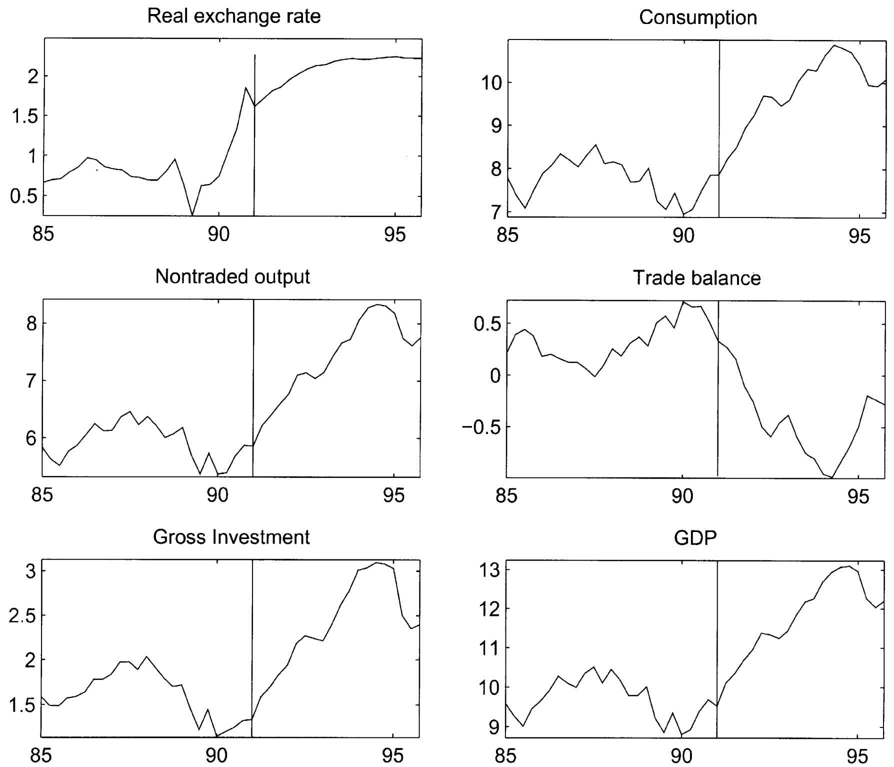


Fig. 1. The Argentine convertibility plan.

Note: All variables except for the real exchange rate are expressed in millions of Argentine pesos of 1986 and are seasonally adjusted. Nontraded output is defined as the sum of value added in the services sector. The real exchange rate is defined as the CPI-adjusted exchange rate between the Argentine peso and the US dollar (which in turn is defined as the dollar price of one peso).

Source: All series except for the real exchange rate are from the Ministry of Economics, Argentina. The real exchange rate is based on own calculations using data from Indicadores de Coyuntura (FIEL) and FAME database.

($p_t > p_{t-1}$ for $0 \leqslant t \leqslant t'$). However, in all of these models, a pattern in which the real exchange rate is gradually appreciating must necessarily be accompanied by a declining path of consumption.

I present the formal derivation of the price–consumption puzzle in Section 2. I then conduct a detailed evaluation of the assumptions that underlie this result as a way to identify possible solutions. Three candidates emerge: uncertainty regarding the duration of policy, credit constraints, and nonseparabilities in preferences across time. The discussion of uncertain duration summarizes my work with Mendoza (Mendoza and Uribe, 2001a, b), which is motivated to a large extent by the results obtained in Section 2. The role of credit constraints in resolving the price–consumption problem has, to my knowledge, not been fully explored yet. The third avenue, nonseparabilities in preferences, is the focus of the material following Section 2.

Specifically, in Sections 3–6 I show that the price–consumption puzzle can be resolved by allowing for preferences where the single-period utility function depends on a linear combination of present and past consumption. As is well known, this class of preferences encompasses the cases of habit formation and consumption durability. I show that under habit formation the dynamics of currency pegs are consistent with the price–consumption regularity.

To highlight the role of habit formation in resolving the price–consumption puzzle, in Section 3 I embed this type of preferences in a simple model of a small, open economy without capital and with a fixed aggregate supply of labor. Following Kimbrough (1986), a demand for money is motivated by assuming that purchases of goods are subject to a proportional transaction cost that is increasing in money velocity. In Section 4, I use this simple framework to study the dynamics of permanent exchange-rate-based stabilization programs. This type of program takes the form of a once-and-for-all reduction in the rate of devaluation of the domestic currency. Because under perfect foresight and perfect capital mobility uncovered interest parity must hold, the decline in the rate of devaluation is immediately reflected in a permanent decline in the nominal interest rate. In turn, the reduction in interest rates produces a decline in money velocity and a positive wealth effect as transactions costs fall.

Under time separable preferences, the positive wealth effect induces a once-and-for-all increase in households' spending in tradables and nontradables. This flat response in aggregate demand is driven by agents' preferences for consumption smoothing. Given a supply of nontradables that is less than perfectly elastic, the expansion in aggregate spending produces a corresponding once-and-for-all appreciation of the real exchange rate. The implied lack of gradual positive comovement between the real exchange rate and total (as well as sectoral) consumption spending is clearly at odds with the price–consumption regularity.

By contrast, under habit formation a once-and-for-all increase in consumption is not optimal because the increase in habit that results from higher consumption would make future marginal utilities of consumption larger than the current one, inducing agents to shift present consumption into the future. Thus, habit-forming agents rationally choose a gradually increasing path of consumption. This gradual expansion in aggregate spending causes a sluggish appreciation of the real exchange rate, thus making the comovement between this variable and consumption consistent with the price–consumption regularity.

The case of permanent, or fully credible, stabilization, although relevant for understanding the dynamics of currency pegs that are accompanied by important structural fiscal reforms (such as the Argentine Convertibility Plan of April 1991), is arguably too restrictive from an empirical standpoint. As Calvo and Végh (1993, p. 5) put it, "as a general rule, stabilization programmes are not fully credible at the time they are being launched". Accordingly, in Section 5, I study currency pegs under lack of credibility, or temporariness (Calvo, 1986). Under this type of stabilization program, the public is assumed to expect that the reduction in the devaluation rate is temporary. Driven by this perception, agents take advantage of the temporarily lower transaction costs by substituting present for future consumption. In Calvo's original model, which assumes time separable preferences, consumption and the relative price of nontradables jump up at the moment the program is announced. Then they remain constant until the date at which the program is expected to be abandoned. At this point both variables fall to their respective long-run levels. Thus, adding temporariness to the standard model does not resolve the price–consumption puzzle. Again, the problem can be overcome by incorporating habit formation. With this type of preferences, consumption and the real exchange rate first increase gradually, reach a peak at some point before the expected date of abandonment of the peg, and then begin to decline.

The prediction of the temporariness model with habit formation that the consumption boom ends before the collapse of the program is of particular empirical relevance (Kiguel and Liviatan, 1992; Végh, 1992). This important aspect of the data, which has proven difficult to replicate in standard theoretical frameworks, emerges in a natural way under habit formation: agents choose to cut consumption before the anticipated collapse of the program in an attempt to arrive at the date of collapse with a lower stock of habit thereby mitigating the pain of adjustment.[2]

In the endowment economies described above, the real exchange rate is exclusively determined by the state of aggregate demand. As a consequence, in those models the contractionary phase of an ERB program must necessarily be accompanied by a depreciation of the real exchange rate. This implication is empirically unrealistic, for typically the real exchange rate continues to appreciate after the recession sets in. To address this issue, in Section 6, I augment the simple habit formation model by allowing for capital accumulation and endogenous labor supply. In such a model, inflation introduces supply-side effects by altering both the consumption/leisure and the domestic/foreign investment margins. Using calibrated versions of the model, I show that if the traded sector is assumed to be capital intensive relative to the nontraded sector—clearly the case of greatest empirical relevance for developing countries—then temporary ERB stabilization programs induce dynamics for the real exchange rate and consumption that are consistent with the data not just during the expansionary phase, but also along the entire transition. This section also compares the dynamics of the habit formation model with that of an economy with time-separable preferences but with uncertainty regarding the duration of the program.

The remainder of the paper is organized as follows: Section 2 derives the price–consumption problem. Section 3 develops the basic theoretical framework. Sections 4 and 5 analyze, respectively, the dynamics of permanent and temporary ERB

[2] Calvo and Végh (1993) show that a model that incorporates sticky prices in combination with policy temporariness produces a contraction in consumption that begins before the collapse of the program. Specifically, in their model consumption of nontradables jumps up at the moment the program is announced and immediately begin to decline until the date of abandonment. However, unlike the habit-formation model, the sticky-price model cannot produce an initial phase during which consumption gradually expands.

inflation stabilization programs. Section 6 analyzes the dynamics of a calibrated model with capital accumulation and endogenous labor supply. An appendix to the paper compares the dynamics of the habit-formation model with those arising under consumption durability. Section 7 concludes.

2. The price–consumption puzzle

To see why a large family of standard optimizing models fail to replicate the price–consumption regularity (i.e., why for these models $(c_t - c_{t-1})(p_t - p_{t-1}) \leqslant 0$ and $(c_t^{\mathrm{N}} - c_{t-1}^{\mathrm{N}})(p_t - p_{t-1}) \leqslant 0$ for $t = 1, 2, \ldots t'$), consider an economy populated by a large number of identical households with preferences described by the following intertemporal utility function:

$$\sum_{t=0}^{\infty} \beta^t U(c_t), \tag{1}$$

where the period utility function $U(\cdot)$ is strictly increasing and strictly concave. Assume that c_t is a composite of tradables, c_t^{T}, and nontradables, c_t^{N},

$$c_t = A(c_t^{\mathrm{T}}, c_t^{\mathrm{N}}), \tag{2}$$

where $A(\cdot, \cdot)$ is a homogeneous-of-degree-one aggregator function, strictly increasing in both arguments, and concave. This preference specification defined by (1) and (2) is quite general. It includes, for example, the class of CRRA period utility functions and CES aggregator functions. Given these preferences, optimizing models of exchange-rate-based stabilization include the following two equations as part of the representative household's first-order conditions:

$$p_t = \frac{A_2(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1)}{A_1(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1)}, \tag{3}$$

$$U'(c_t)A_1(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1) = \lambda_t h(i_t). \tag{4}$$

The first equation is a familiar condition stating that households will always choose to allocate their consumption expenditures in such a way that the marginal rate of substitution of tradables for nontradables equals the relative price of nontradables in terms of tradables. The second equation states that the marginal utility of consumption of tradables must be equal to the product of the marginal utility of wealth, λ_t, and a monetary distortion $h(i_t)$. The monetary distortion is a nondecreasing function of the nominal interest rate, i_t, reflecting the role of money in reducing frictions in the process of exchange.[3]

[3] In models without money (Rebelo, 1993, 1994), $h(\cdot)$ is identically equal to one. In continuous-time, cash-in-advance models (Calvo, 1986; Calvo and Végh, 1993; Lahiri, 1995; Roldós, 1995), $h(i_t)$ takes the form $1 + \alpha i_t$, where $\alpha > 0$ is the fraction of consumption subject to a cash-in-advance constraint. In models where money reduces transaction costs (Rebelo and Végh, 1995; Reinhart and Végh, 1995; Mendoza and Uribe, 2001a, b), $h(i_t)$ is of the form $1 + s(v(i_t)) + v(i_t)s'(v(i_t))$, where $s(\cdot)$ and $v(\cdot)$ are positive, increasing functions denoting transaction costs per unit of consumption and money velocity, respectively.

Because the aggregator function is concave and homogeneous of degree one, the right-hand side of (3) is strictly increasing in $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$. Thus, Eq. (3) implies that

$$p_t \text{ is increasing in } c_t^{\mathrm{T}}/c_t^{\mathrm{N}} \text{ for } t \geqslant 0. \tag{5}$$

Intuitively, this expression states that as nontradables become more expensive relative to tradables, households consume relatively more tradables and less nontradables.

Let us now turn to Eq. (4). Under perfect foresight and assuming that agents have access to an internationally traded bond that pays a constant interest rate r in terms of tradables, the marginal utility of wealth satisfies the familiar Euler equation $\lambda_t = \beta(1+r)\lambda_{t+1}$. Under the usual simplifying assumption that $\beta(1+r) = 1$, the Euler equation implies that λ_t is constant from the period of announcement of the currency peg onward.[4] Furthermore, the fact that during a currency peg the rate of devaluation of the domestic currency is constant implies, by the interest rate parity condition, that the domestic nominal interest rate must be constant as well. Therefore, as long as the currency peg is in effect, the right-hand side of (4) is constant. Recalling that $U'' < 0$ and that $A_{11} < 0$, it then follows from (4) that

$$c_t \text{ is decreasing in } c_t^{\mathrm{T}}/c_t^{\mathrm{N}} \text{ for } t > 0. \tag{6}$$

Combining statements (5) and (6) implies that

$$c_t \text{ is decreasing in } p_t \text{ for } t > 0, \tag{7}$$

which is inconsistent with the price–consumption regularity. It is this inability to predict a gradual increase in both consumption and the real exchange rate what I refer to as the price–consumption puzzle. The price–consumption puzzle is not limited to the behavior of total consumption expenditure. In the family of optimizing models under consideration, the predicted dynamics of the nontraded component of consumption is also at odds with the observed behavior. To see why, note that because the aggregator function is linearly homogeneous, Eq. (2) can be written as $c_t = c_t^{\mathrm{N}} A(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1)$. This expression together with statements (5) and (7) implies that

$$c_t^{\mathrm{N}} \text{ is decreasing in } p_t \quad \text{for } t > 0, \tag{8}$$

so that if during the initial stage of the program the real exchange is gradually appreciating, as observed in the data, then consumption of nontradables must necessarily be falling, which is counterfactual.

It is important to note that the price–consumption puzzle concerns the joint behavior of the real exchange rate and consumption *after* and not *at* the moment of announcement of the stabilization program. In particular, the class of models considered here are not inconsistent with an increase in consumption and a real exchange rate appreciation at the date the stabilization program is announced ($p_0 > p_{-1}$ and $c_0 > c_{-1}$). In fact, a number of existing models of exchange-rate-based

[4] Assuming that the international real interest rate is exogenous but stochastic or that the rate of time preference differs from the international interest rate would introduce cyclical or trend components in consumption, but would clearly not alter the conclusions derived shortly regarding the ability of the class of models under analysis to explain the price–consumption regularity.

stabilization are capable of generating such an initial effect, such as models with lack of credibility (Calvo, 1986) or supply-side effects (Roldós, 1995; Uribe, 1997). It is the 'forecastable' comovement of the real exchange rate and consumption what is at odds with the empirical facts.

It is also noteworthy that although I have presented the price–consumption problem in terms of the behavior of the composite good, c_t, and the relative price of nontradables in terms of tradables, p_t, it can equivalently be interpreted in terms of the joint behavior of consumption expenditure measured in terms of a consumption price index and the real exchange rate measured as the relative price of a broad consumption basket in term of tradables. Specifically, let P_t^{T} and P_t^{N} be the nominal prices of tradables and nontradables, respectively, and define the consumption price index, P_t^c, as

$$P_t^c c_t = P_t^{\mathrm{T}} c_t^{\mathrm{T}} + P_t^{\mathrm{N}} c_t^{\mathrm{N}}.$$

P_t^c is a consumption price index in the sense that it can be expressed as an increasing, homogeneous-of-degree-one function of the prices P_t^{T} and P_t^{N} only. To see this, use Eq. (3) to write $P_t^{\mathrm{N}}/P_t^{\mathrm{T}}$ as $\rho(c_t^{\mathrm{T}}/c_t^{\mathrm{N}})$, where $\rho(\cdot)$ is an increasing function defined by the inverse of the marginal rate of substitution of tradables for nontradables. Then, using this expression and (2) to eliminate $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$ and c_t from the definition of P_t^c, the consumer price index can be written as

$$P_t^c = \frac{P_t^{\mathrm{T}} \rho(P_t^{\mathrm{N}}/P_t^{\mathrm{T}}) + P_t^{\mathrm{N}}}{A(\rho(P_t^{\mathrm{N}}/P_t^{\mathrm{T}}), 1)}.$$

Note further that this expression and the definition of P_t^c imply that c_t can be interpreted as real consumption measured as nominal consumption expenditure divided by a consumption price index. It is clear from the above expression that P_t^c/P_t^{T} is strictly increasing in $p_t \equiv P_t^{\mathrm{N}}/P_t^{\mathrm{T}}$. Thus, we can reformulate statement (7) as

$$\frac{P_t^{\mathrm{T}} c_t^{\mathrm{T}} + P_t^{\mathrm{N}} c_t^{\mathrm{N}}}{P_t^c} \text{ is decreasing in } \frac{P_t^c}{P_t^{\mathrm{T}}} \text{ for } t > 0.$$

In this form, the price–consumption puzzle states that the class of models under consideration fails to capture the observed behavior of real consumption expenditure and the real exchange rate, defined as the relative price of a broad consumption basket in terms of tradables.

2.1. *Identifying possible solutions*

As a way to identify avenues for solving the price–consumption puzzle, I analyze the role played by six important assumptions used in deriving it.

First, agents are assumed to operate under perfect foresight. A direct link between uncertainty and the dynamics of currency pegs arises when specific elements of the exchange rate regime are assumed to be stochastic. For example, in joint work with Mendoza (Mendoza and Uribe, 2001a, b), motivated by the results of the first part of this section, I have studied the dynamics of currency pegs of uncertain duration along the theoretical lines proposed by Drazen and Helpman (1988) and Calvo and

Drazen (1993). Under uncertain duration, both the marginal utility of wealth, λ_t, and the nominal interest rate, i_t, become random variables with time-dependent distributions. As a result, the right-hand side of (4) is no longer constant. Under certain assumptions about the form of the hazard function describing the probability of abandonment of the stabilization program at any given point in time, the presence of uncertain duration may generate dynamics that are consistent with the price–consumption regularity.[5]

Second, households are assumed to have frictionless access to international financial markets. This assumption implies that it is optimal for the representative agent to choose a constant path for the marginal utility of wealth. By contrast, when agents are subject to credit constraints, the marginal utility of wealth becomes time dependent and therefore so does the right-hand side of (4). However, the mere time dependence of the marginal utility of wealth is not sufficient to induce dynamics that are consistent with the price–consumption regularity. It is clear from Eqs. (3) and (4) that in order for both p_t and c_t to increase during the initial phase of the program, λ_t must display a declining trajectory. In general, this will not be a necessary consequence of the presence of credit constraints. But perhaps the main difficulty with an explanation based on borrowing constraints lies in its empirical relevance, particularly to recent stabilization episodes. A growing empirical literature argues that the marked trend toward diversification and globalization of international financial markets observed in the last decade has led to high, if not excessive, international capital mobility in developing countries (e.g., Calvo et al., 1996).

Third, consumers are assumed not to value leisure. It is straightforward to see that the puzzle remains when the period utility function depends on leisure but in a separable way. In the more general case in which the period utility function is not separable in leisure and consumption, Eq. (3) is unaffected, but Eq. (4) takes the form

$$U_c(c_t, h_t) A_1(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1) = \lambda_t h(i_t), \tag{9}$$

where h_t stands for hours worked, and $U(\cdot, \cdot)$ is strictly increasing in its first argument, strictly decreasing in its second argument, and strictly concave. Eqs. (3) and (9) imply that, as in the case in which leisure is not valued, an equilibrium in which the real exchange rate is gradually appreciating requires the marginal utility of consumption, $U_c(c_t, h_t)$, to increase over time. If both consumption and hours worked are to increase during the initial phase of the program—arguably the case of greatest empirical interest—then it follows that if U_{ch} is negative, then c_t must necessarily decline over time. Thus, $U_{ch} > 0$ is a necessary condition for leisure to be

[5] Clearly, the presence of uncertainty about elements of the economy other than the exchange rate arrangement, such as shocks to the international interest rate, the terms of trade, tastes, or technology, will not alter the nature of the price–consumption problem, insofar as the timing and duration of the exchange-rate-based stabilization policy is unrelated to the state of the underlying shocks. But even if such relation was in place, the extent to which the equilibrium dynamics will be consistent with the price–consumption regularity will depend on the nature and stochastic structure of the shocks involved as well as on the form adopted by the relationship itself.

able to resolve the price–consumption puzzle. In Section 6, I explore this avenue in greater detail. I find that models with endogenous labor supply might produce the right comovement between c_t and p_t, but fail to replicate the comovement between p_t and the nontraded component of consumption, c_t^{N}.

Fourth, the devaluation rate is assumed to be constant. Obstfeld (1985) and Roldós (1993) have noted, using standard optimizing models, that stabilization programs consisting in the pre-announcement of a declining path for the devaluation rate—like the *tablita* programs of the late 1970s in the southern cone of Latin America—induce dynamics characterized by a gradual expansion in consumption and a gradual appreciation of the real exchange rate. To see why this is the case, note that if the devaluation rate is gradually declining, interest parity implies that the nominal interest rate must follow a declining path as well. Consequently the right-hand side of (4) will also decrease over time, allowing both c_t and the ratio $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$ to increase during the initial phase of the program. As an explanation of the price–consumption problem, however, this avenue is empirically limited. A large number of ERB programs, including, for example, the heterodox programs of the mid-1980s in Argentina, Brazil, Mexico, and Israel, and more notably the orthodox Argentine Convertibility Plan of 1991, did not establish a declining path for the devaluation rate and nevertheless displayed dynamics consistent with the price–consumption regularity.

Fifth, the derivation of Eqs. (3) and (4) does not require the specification of the supply side of the economy. Therefore, variations of the standard model based on alternative specifications of features such as production technologies, capital adjustment costs, capacity utilization, and nominal rigidities, will not provide a remedy to the price–consumption puzzle.

Finally, preferences are assumed to be time separable. The remainder of the paper is devoted to exploring a solution to the price–consumption puzzle consisting in relaxing this assumption by allowing for habit formation. Under this type of preferences, Eq. (3) is unchanged, as is the right-hand side of (4). But the marginal utility of consumption on the left-hand side of (4) becomes a function of past, present, and future consumption. As will be shown shortly, this new dynamic element in Eq. (4) is key for allowing consumption and the real exchange rate to move in tandem during the initial phase of currency pegs.

3. Currency pegs with habit-forming consumers

Consider a perfect-foresight, small, open economy populated by a large number of identical, infinitely lived consumers with preferences described by the utility function

$$\sum_{t=0}^{\infty} \beta^t U(c_t - \alpha c_{t-1}). \tag{10}$$

This utility function encompasses the cases of time separable preferences analyzed in the previous section ($\alpha = 0$), habit formation ($\alpha > 0$), and durability ($\alpha < 0$).[6] When preferences display habit formation, current consumption increases next period's marginal utility of consumption. More intuitively, the more the agent consumes at a given date, the hungrier he wakes up the following period. Thus, this preference specification features consumers that are addictive in nature.[7] On the other hand, in the case of durability, today's consumption provides utility in future periods. So the more the household consumes in the current period, the less it needs to spend in the following period in order to smooth the marginal utility of consumption over time. In this case, consumption goods are substitutes across adjacent periods.

The consumption good, c_t, is assumed to be a composite of tradables and nontradables as described by Eq. (2).

Households have access to two types of financial asset: money, M_t, and a foreign-currency-denominated bond, b_t, that pays the constant and exogenous interest rate r in foreign currency. To avoid unessential long-run dynamics, r is assumed to satisfy $\beta(1+r) = 1$. Each period $t \geqslant 0$, the representative household receives from the government a lump-sum transfer τ_t measured in terms of tradables and is endowed with one unit of labor. A fraction $h_t^{\mathrm{T}} \in (0,1)$ of the labor endowment is allocated to the production of tradable goods, y_t^{T}, and a fraction $h_t^{\mathrm{N}} \in (0,1)$ to the production of nontradable goods, y_t^{N}. Production technologies are described by the following functions:

$$y_t^{\mathrm{T}} = G(h_t^{\mathrm{T}}) \tag{11}$$

and

$$y_t^{\mathrm{N}} = F(h_t^{\mathrm{N}}), \tag{12}$$

where $F(\cdot)$ and $G(\cdot)$ are increasing functions satisfying the Inada conditions. The household supplies its entire time endowment to production activities so that

$$h_t^{\mathrm{T}} + h_t^{\mathrm{N}} = 1. \tag{13}$$

I assume that the law of one price holds for tradables. That is, $P_t^{\mathrm{T}} = E_t P_t^{\mathrm{T}*}$, where P_t^{T} and $P_t^{\mathrm{T}*}$ denote the domestic and foreign prices of tradables and E_t the nominal exchange rate, defined as the domestic-currency price of foreign currency. For simplicity, I assume that $P_t^{\mathrm{T}*}$ is constant and normalized to one.

[6] The results of the paper are qualitatively similar in the more general case in which the argument of the period utility function takes the form $c_t - \alpha S_t$, with $S_t = (1-\delta)S_{t-1} + \delta c_{t-1}$ and $\delta \in (0,1]$. The case analyzed throughout the paper, $\delta = 1$, was chosen for analytical convenience.

[7] Preferences displaying habit formation have been used intensively in the finance literature as a possible explanation to the equity–premium puzzle (Constantinides, 1990).

Letting $m_t \equiv M_t/E_t$ denote real balances measured in terms of tradables, P_t^{N} the domestic-currency price of nontradables, $p_t \equiv P_t^{\mathrm{N}}/E_t$ the real exchange rate defined as the price of nontradables in terms of tradables, and $\varepsilon_t \equiv E_t/E_{t-1} - 1$ the devaluation rate, the period-by-period budget constraint of the household takes the form

$$b_t + m_t + (c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}})(1 + s(v_t)) = (1+r)b_{t-1} + \frac{m_{t-1}}{1+\varepsilon_t} + y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}} + \tau_t. \quad (14)$$

Following Kimbrough (1986), money is assumed to facilitate transactions. Specifically, purchases of goods are subject to a proportional transaction cost $s(v_t)$ that is increasing in (expenditure-based) money velocity, v_t. Money velocity is in turn defined by

$$v_t = \frac{c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}}}{m_t}. \quad (15)$$

The function $s(\cdot)$ is assumed to be strictly increasing and to satisfy $2s'(v) + vs''(v) > 0$ $\forall v > 0$, which guarantees that total transaction costs are a convex function of expenditure and real balances (i.e., that $cs(c/m)$ is convex in c and m). In addition, households are subject to the following borrowing constraint that prevents them from engaging in Ponzi games:

$$\lim_{t\to\infty} \frac{b_t + m_t}{(1+r)^t} \geqslant 0. \quad (16)$$

The assumptions of perfect foresight and perfect international capital mobility imply that the domestic nominal interest rate, denoted by i_t, must satisfy the uncovered interest parity condition, that is,

$$1 + i_t = (1+r)(1+\varepsilon_{t+1}). \quad (17)$$

Constraints (14) and (16) are equivalent to the following intertemporal budget constraint:

$$(1+r)b_{-1} + \frac{m_{-1}}{1+\varepsilon_0} \geqslant \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t \left[(c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}})(1+s(v_t)) + \frac{i_t m_t}{1+i_t} - y_t^{\mathrm{T}} - p_t y_t^{\mathrm{N}} - \tau_t\right]. \quad (18)$$

This expression says that the present discounted value of the differences between expenditure and income cannot exceed the consumer's initial real wealth. The household's problem consists in choosing a set of sequences $\{c_t, c_t^{\mathrm{T}}, c_t^{\mathrm{N}}, y_t^{\mathrm{T}}, y_t^{\mathrm{N}}, h_t^{\mathrm{T}}, h_t^{\mathrm{N}}, m_t, v_t\}_{t=0}^{\infty}$ so as to maximize (10) subject to (2), (11)–(13), (15), and (18), taking as given b_{-1}, m_{-1}, ε_0, and the sequences $\{p_t, i_t, \tau_t\}_{t=0}^{\infty}$. In an interior optimum, the chosen sequences must satisfy (2), (3), (11)–(13), (15), (18) holding with equality, and

$$[U'(c_t - \alpha c_{t-1}) - \alpha\beta U'(c_{t+1} - \alpha c_t)]A_1(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1) = \lambda[1 + s(v_t) + v_t s'(v_t)], \quad (19)$$

$$v_t^2 s'(v_t) = \frac{i_t}{1+i_t}, \tag{20}$$

$$p_t F'(h_t^{\mathrm{N}}) = G'(h_t^{\mathrm{T}}), \tag{21}$$

where λ is the Lagrange multiplier associated with the present-value budget constraint (18) and represents the marginal utility of financial wealth. Eq. (19) is a generalization of Eq. (4) to the case $\alpha \neq 0$. The key difference between the two expressions is that when $\alpha \neq 0$, the marginal utility of consumption depends not only on current consumption but also on past and future expected consumption. Eq. (20) is a liquidity preference function featuring a strictly increasing relationship between the nominal interest rate and money velocity. We can therefore rewrite (20) as

$$v_t = v(i_t), \quad v' > 0. \tag{22}$$

Finally, Eq. (21) is an efficiency condition requiring that the value of the marginal product of labor be equalized across sectors.

3.1. The government

The consolidated government holds international bonds, f_t, makes lump-sum transfers, τ_t, and supplies money, m_t. Its period-by-period budget constraint is given by

$$f_t = (1+r)f_{t-1} + m_t - \frac{m_{t-1}}{1+\varepsilon_t} - \tau_t.$$

The government is also subject to a no-Ponzi-game borrowing constraint of the form

$$\lim_{t\to\infty} \frac{f_t - m_t}{(1+r)^t} = 0.$$

The above two constraints are equivalent to the following present-value budget constraint

$$(1+r)f_{-1} - \frac{m_{-1}}{1+\varepsilon_0} = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t\left[\tau_t - \frac{i_t m_t}{1+i_t}\right], \tag{23}$$

which states that the present discounted value of primary deficits net of seignorage revenue must not exceed the value of the government's initial net asset holdings.

3.1.1. The monetary-fiscal regime

In period zero, the monetary authority announces the entire time path of the devaluation rate, $\{\varepsilon_t\}_{t=0}^{\infty}$, and guarantees free convertibility of the domestic currency at the corresponding exchange rate ($E_t = E_{-1}\prod_{j=0}^{t}(1+\varepsilon_j)$, for $t \geqslant 0$). As a result of this exchange rate policy, the central bank loses control over the monetary aggregate. Note also that the specified exchange rate policy along with the interest parity condition (17) uniquely determines the time path of the nominal interest rate.

Fiscal policy is assumed to be fully accommodative. Specifically, the sequence of lump-sum transfers, $\{\tau_t\}_{t=0}^{\infty}$, is set endogenously so as to guarantee that the intertemporal budget constraint (23) is satisfied.

3.2. Equilibrium

In equilibrium, the nontraded goods market clears,

$$c_t^{\mathrm{N}} = F(h_t^{\mathrm{N}}). \tag{24}$$

Let $w_t \equiv b_t + f_t$ denote the economy's net foreign asset position in period t. Then, combining the intertemporal budget constraints (18) and (23), holding with equality, and the equilibrium condition (24) yields the country's intertemporal resource constraint:

$$(1+r)w_{-1} = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t \left[(c_t^{\mathrm{T}} - y_t^{\mathrm{T}}) + s(v(i_t))(c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}})\right], \tag{25}$$

which states that the country's initial net foreign asset position must equal the present discounted value of trade deficits (including transaction costs).

In equilibrium, the real exchange rate is a strictly increasing function of consumption:

$$p_t = p(c_t), \quad p' > 0. \tag{26}$$

To see why, use the market clearing condition (24) and the aggregator function (2) to express consumption as $c_t = F(h_t^{\mathrm{N}})A(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1)$. Thus, c_t is increasing in both $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$ and h_t^{N}. In turn, (3) and (21) imply, respectively, that $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$ and h_t^{N} are strictly increasing functions of p_t.

Having established Eq. (26), it follows directly that in equilibrium c_t^{N}, c_t^{T}, h_t^{N}, y_t^{N}, $c_t^{\mathrm{T}}/c_t^{\mathrm{N}}$, and $-y_t^{\mathrm{T}}$ are all strictly increasing functions of c_t. Letting $H(c_t) \equiv A_1(c_t^{\mathrm{T}}/c_t^{\mathrm{N}}, 1)$, $I(c_t) \equiv c_t^{\mathrm{T}} - y_t^{\mathrm{T}}$, $L(c_t) \equiv c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}}$, and $h(i_t) \equiv 1 + s(v(i_t)) + v(i_t)s'(v(i_t))$, we can rewrite Eqs. (19) and (25) as

$$[U'(x_t) - \alpha\beta U'(x_{t+1})]H(c_t) = \lambda h(i_t), \tag{27}$$

$$x_t \equiv c_t - \alpha c_{t-1}, \tag{28}$$

$$(1+r)w_{-1} = \sum_{t=0}^{\infty} (1+r)^{-t}[I(c_t) + s(v(i_t))L(c_t)]. \tag{29}$$

Note that $h(\cdot) > 0$, $h'(\cdot) > 0$, $H(\cdot) > 0$, $H'(\cdot) < 0$, $I'(\cdot) > 0$, $L(\cdot) > 0$, and $L'(\cdot) > 0$. We are ready to define a perfect-foresight equilibrium.

Definition 1. A perfect-foresight equilibrium is a pair of sequences $\{c_t, x_t\}_{t=0}^{\infty}$ and a scalar $\lambda > 0$ satisfying (27)–(29), given the forcing sequence $\{i_t\}_{t=0}^{\infty}$ and the initial conditions c_{-1} and w_{-1}.

3.3. Pre-stabilization steady state

Assume that before period 0 the economy is in a steady state in which the devaluation rate, the nominal interest rate, and all real variables are constant. Let $\varepsilon^H > 0$ be the value taken by the devaluation rate. Then, by Eq. (17), the nominal interest rate is given by $i^H \equiv (1+r)(1+\varepsilon^H) - 1$, and by Eq. (29), c_{-1} is implicitly given by

$$rw_{-1} = I(c_{-1}) + s(v(i^H))L(c_{-1}). \tag{30}$$

According to this expression, the pre-stabilization steady-state level of consumption is increasing in the stock of wealth, w_{-1}, and decreasing in the nominal interest rate, i^H. The negative relation between c_{-1} and i^H reflects the negative wealth effect of expected inflation introduced by Kimbrough-type transaction costs.

I next turn to the analysis of the dynamics triggered by permanent and temporary currency pegs under habit formation.[8]

4. Permanent currency pegs

Suppose that at $t = 0$ the monetary authority unexpectedly announces an inflation-stabilization plan consisting in a permanent reduction in the devaluation rate from ε^H to $\varepsilon^L < \varepsilon^H$. Assume further that the program is perfectly credible, so that, by uncovered interest parity, the path of the nominal interest rate is given by $i_t = i^L < i^H \; \forall t \geqslant 0$, where i^L satisfies $1 + i^L = (1+r)(1+\varepsilon^L)$.

Consider first the case of time-separable preferences, $\alpha = 0$. In this case, it is clear from Eqs. (27) and (28) that when the program is announced, x_t and c_t jump to their long-run steady-state levels. Specifically, letting c^* denote the new steady-state level of consumption, we have that $c_t = c^*$ for $t \geqslant 0$. Then resource constraint (29) implies that c^* is given by

$$rw_{-1} = I(c^*) + s(v(i^L))L(c^*). \tag{31}$$

Comparing (30) and (31) and taking into account that I', L ,L', and $s'v'$ are all positive, it follows that $c^* > c_{-1}$. That is, the permanent exchange-rate-based stabilization program induces a once-and-for-all increase in consumption. In turn, Eq. (26) implies that the real exchange rate experiences a once-and-for-all appreciation. The entire effect of the stabilization program is therefore concentrated at the date of the announcement. The equilibrium comovement between c_t and p_t after time zero is nil. This pattern is clearly at odds with the price–consumption regularity.

Consider now the case of habit formation, $\alpha \in (0,1)$. Panel (a) of Fig. 2 displays the phase diagram corresponding to the difference equations (27) and (28). The locus AA' displays the pairs (c_{t-1}, x_t) satisfying Eq. (27) for $x_{t+1} = x_t$ and $i_t = i^L$. Because both $U'(\cdot)$ and $H(\cdot)$ are strictly decreasing, AA' is negatively sloped. Moreover,

[8] I study the case of consumption durability in Appendix A.

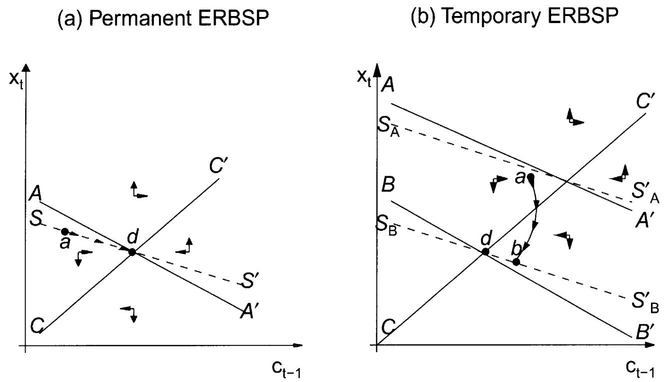


Fig. 2. Exchange-rate-based stabilization programs (ERBSP) under habit formation: phase diagrams.

because $\alpha\beta \in (0, 1)$, it follows from (27) that if in any period $t \geqslant 0$ the system is above (below) AA', then $x_{t+1} > (<) x_t$.[9] The ray CC' displays the pairs (c_{t-1}, x_t) satisfying (28) for $c_t = c_{t-1}$. Clearly, if the system is above (below) CC' then $c_t > (<)\, c_{t-1}$. The arrows display the direction of motion.

The system is saddle-path stable. The saddle path is given by the locus SS'. The post-stabilization steady state is given by point d at the intersection of AA' and CC'. The economy must travel along the saddle path if it is to converge to the steady state d. The initial position of the system, the pair (c_{-1}, x_0), must be a point such as a located on the saddle path and to the left of the steady state. To see why, assume that (c_{-1}, x_0) is on SS' but to the right of d. Because such a position is below CC', it follows that $c_0 < c_{-1}$. That is, consumption falls when the stabilization program is announced. Moreover, it is clear from the figure that c_t would continue to fall along the entire transition. Thus, $c_t < c_{-1}\ \forall t \geqslant 0$. But this clearly violates resource constraint (29), because c_{-1} satisfies that constraint for $i_t = i^H > i^L$.

The fact that the initial position a is located above CC' implies that $c_0 > c_{-1}$. That is, consumption increases in the period in which the currency peg is announced. After the announcement, the system travels smoothly from a to d along the saddle path. In particular, consumption increases monotonically toward its higher steady-state level. Because in equilibrium c_t^{N} and p_t are both strictly increasing functions of c_t, it follows that along the transition the real exchange rate gradually appreciates and consumption of nontradables continuously expands. The joint behavior of consumption and the real exchange rate is therefore consistent with the price–consumption regularity. In addition, the predicted gradual appreciation of the real exchange rate implies that the model is also able to capture the slow convergence, from above, of the inflation rate of nontradables to the devaluation rate typical of

[9] This is the case near AA'. The statement is globally valid if U' is convex. The convexity of U' is guaranteed by a large family of period utility functions that includes the class of CRRA functions.

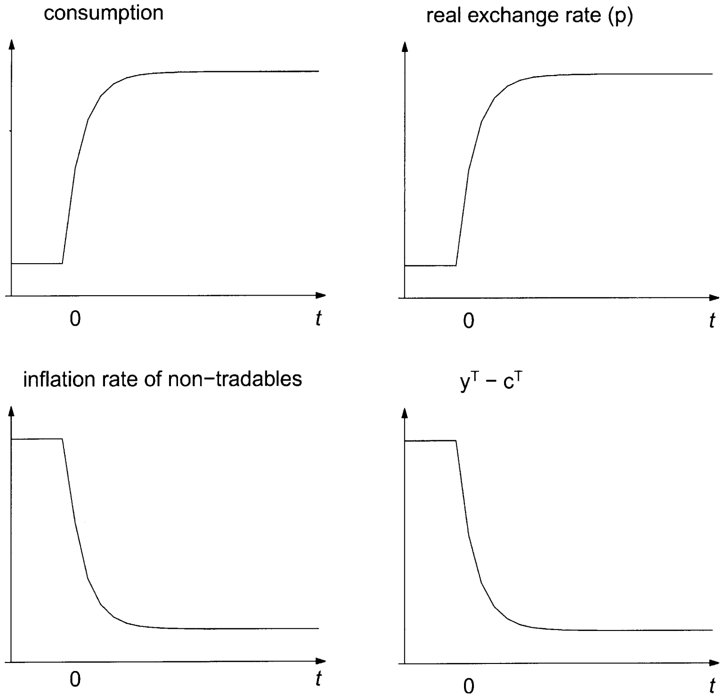


Fig. 3. Permanent currency peg under habit persistence.

exchange-rate-based disinflation programs.[10] Fig. 3 summarizes the implied equilibrium dynamics in the time space.

The intuition for why the habit formation model is capable of generating dynamics that are consistent with the price–consumption regularity is as follows. The permanent reduction in the nominal interest rate induces a permanent decline in money velocity. This decline in money velocity, in turn, generates a positive wealth effect by reducing transaction costs.[11] In response to this wealth effect, agents rationally choose to adjust consumption upward. However, conscious of their addictive nature, agents choose to expand expenditure gradually. In this way, they initially build up their stock of assets so as to be able to maintain a higher level of habit in the future.

[10] To see this, let $\pi_t \equiv P_t^N/P_{t-1}^N - 1$ denote the rate of inflation of nontradables. Then, recalling that the real exchange rate is defined as $p_t = P_t^N/E_t$ and that for $t \geqslant 0$ the devaluation rate is given by $E_t/E_{t-1} - 1 = \varepsilon^L$, it follows that $\pi_t = \varepsilon^L + (1 + \varepsilon^L)(p_t/p_{t-1} - 1)$.

[11] Clearly, this initial impulse would be absent in any model where inflation does not generate shoe-leather costs, such as in the cash-in-advance specification. But inflation may generate wealth effect through channels other than shoe-leather costs. This is the case, for instance, in models with endogenous labor supply and capital accumulation, where inflation can affect the leisure/consumption and consumption/investment margins. I study this case in detail in Section 6.

The response of the real exchange rate is shaped by the behavior of consumption. Because the supply of nontradables is less than perfectly elastic, the gradual expansion in aggregate expenditure generates an equally gradual increase in the relative price of nontradables (an appreciation of the real exchange rate), which induces agents to make the necessary expenditure switch toward tradables.

The simple model studied in this section makes an important first step in providing a solution to the price–consumption puzzle. However, two important difficulties remain: First, as pointed out by Calvo and Végh (1993), exchange-rate-based stabilizations are characterized by a contraction in aggregate demand following the initial expansionary phase. This contraction typically sets in before the demise of the stabilization program. Clearly, the model fails to produce such a boom–recession path for consumption. Second, following the implementation of exchange-rate-based stabilization programs the trade balance generally deteriorates (see Kiguel and Liviatan (1992) and Végh (1992) and the middle right panel of Fig. 1). However, our simple model counterfactually induces an initial improvement in the trade balance. This is because, as pointed out above, in response to the initial increase in disposable income generated by the decline in transaction costs, habit-forming households choose to increase savings (in the form of foreign assets) in order to be able to support higher consumption in the future.[12] Clearly, a variation of the basic framework that overcomes these two counterfactual implications is in order. This is the focus of the next section.

5. Temporary currency pegs

Consider augmenting the basic theoretical framework studied thus far by allowing for imperfect credibility (Calvo, 1986). Specifically, assume that the monetary authority announces a stabilization program whereby the devaluation rate is lowered for only a finite period of time. Formally, let $T > 0$ be a finite integer and assume that the government sets ε_t at ε^L for $0 \leqslant t < T$ and at $\varepsilon^H > \varepsilon^L$ for $t \geqslant T$. As will be clear shortly, the dynamics unleashed by this type of stabilization program are identical to those of a permanent program in which the public *expects* the policy to be abandoned in period T. It is in this sense that the assumption of policy temporariness can be interpreted as imperfect credibility.

Given the expected path of the devaluation rate, the uncovered interest parity condition implies that the time path of the nominal interest rate is given by

$$i_t = \begin{cases} i^L \equiv (1+r)(1+\varepsilon^L) - 1, & 0 \leqslant t < T-1, \\ i^H \equiv (1+r)(1+\varepsilon^H) - 1, & t \geqslant T-1. \end{cases} \tag{32}$$

[12] Formally, letting tb_t denote the trade balance in period t, we have that $tb_t \equiv -[I(c_t) + s(v(i^L))L(c_t)]$. Note that (a) because $c_t > c_{t-1}$ for $t > 0$, it must be the case that $tb_t < tb_{t-1}$ for $t > 0$; and (b) comparing. Eqs. (29) and (30), it follows that $\sum_{t=0}^{\infty} (1+r)^{-t} tb_t = -(1+r)w_{-1} = (1+r)/r\, tb_{-1}$. Clearly, (a) and (b) imply that $tb_0 > tb_{-1}$.

To isolate the intertemporal effects arising from the assumption of temporariness, I will eliminate all wealth effects associated with changes in inflation by assuming that transaction costs are fully rebated to the public in a lump-sum fashion.[13] In this case, the equilibrium resource constraint of the economy, Eq. (29), simplifies to

$$(1+r)w_{-1} = \sum_{t=0}^{\infty} (1+r)^{-t} I(c_t). \tag{33}$$

A competitive equilibrium is thus given by a pair of sequences $\{c_t, x_t\}_{t=0}^{\infty}$ and a scalar $\lambda > 0$ satisfying (27), (28), and (33), given the sequence of nominal interest rates described by (32) and the initial conditions c_{-1} and w_{-1}. As in the previous section, I will assume that prior to the announcement of the program, the economy is in a steady state in which all real variables are constant so that c_{-1} is implicitly given by

$$rw_{-1} = I(c_{-1}). \tag{34}$$

Consider first the case of time-separable preferences (Calvo, 1986). Eq. (28) implies that x_t equals c_t for all $t \geqslant 0$. Thus, from Eq. (27) we have that c_t satisfies $U'(c_t) = \lambda h(i^L)$ for $0 \leqslant t < T-1$ and $U'(c_t) = \lambda h(i^H)$ for $t \geqslant T-1$. That is, consumption is constant between periods zero and $T-2$ and falls to its long-run level in period $T-1$. The fact that c_t is constant from period zero on except for a once-and-for-all decline in $T-2$, implies, by comparison of Eqs. (33) and (34), that it must jump up in period zero ($c_0 > c_{-1}$). Given the path of consumption, Eq. (26) implies that p_t jumps up on impact, stays constant until period $T-2$ inclusive, and falls to its steady-state level in period $T-1$. It is clear from this analysis that when preferences are separable across time, the temporariness hypothesis cannot produce paths for consumption and the real exchange rate in which the former gradually expands and the latter gradually appreciates during the expansionary phase of the stabilization program.

Consider now the case of habit formation. Panel (b) of Fig. 2 depicts the phase diagram associated with Eqs. (27) and (28). The locus AA' displays the set of pairs (c_{t-1}, x_t) satisfying (27) for $x_{t+1} = x_t$ and $i_t = i^L$. Similarly, the locus BB' shows the pairs (c_{t-1}, x_t) satisfying (27) for $x_{t+1} = x_t$ and $i_t = i^H$. The loci $S_A S'_A$ and $S_B S'_B$ represent the saddle paths of the system for $t < T-1$ and $t \geqslant T-1$, respectively. The arrows display the direction of motion for $t < T-1$. The long-run steady-state position is given by point d, located at the intersection of BB' and CC'.

Because at $t = T-1$ the nominal interest rate jumps from i^L to its long-run level i^H, the system must reach the saddle path $S_B S'_B$ at exactly that date. This implies that at $t = 0$ the system must be somewhere between the saddle paths $S_A S'_A$ and $S_B S'_B$. Consider now the initial position of the system. The economy cannot start above CC' and to the left of d. For such an initial situation would imply that $c_t > c_{-1}$ $\forall t \geqslant 0$, which violates resource constraint (33). Similarly, the system cannot be initially located below CC' and to the right of d, because in that case $c_t < c_{-1}$ $\forall t$, which also violates the resource constraint. Consequently, the initial position must be a point

[13] One can rationalize this assumption by thinking of transaction costs as representing pure profits of financial institutions owned by domestic households.

such as a located between $S_A S'_A$ and $S_B S'_B$, above CC', and to the right of the steady state d.

The fact that point a lies above the locus CC' implies that $c_0 > c_{-1}$. That is, consumption jumps up when the program is announced. Along the transition, consumption initially grows gradually. This smooth expansion continues until the system crosses the locus CC'. At that moment, consumption begins to fall. Note that because the system crosses the locus CC' before period $T-1$, the contraction in consumption begins before the collapse of the currency peg. In period $T-1$, the economy reaches point b on the saddle path $S_B S'_B$ and begins to travel along that path toward the steady state d. Consumption continues to fall after the demise of the stabilization program.

Having characterized the dynamics of consumption, the response of all other endogenous variables of interest follows directly. Fig. 4 depicts the time paths of consumption, the real exchange rate, inflation of nontradables, and the trade balance. Three characteristics of the model's dynamics are of particular importance. First, the model captures the price–consumption regularity: during the expansionary phase of the program, total consumption and its nontraded component expand gradually, and, at the same time, the real exchange rate continuously appreciates. Second, a contraction in aggregate spending sets in *before* the expected date of abandonment of the stabilization policy. This pattern did not emerge when the

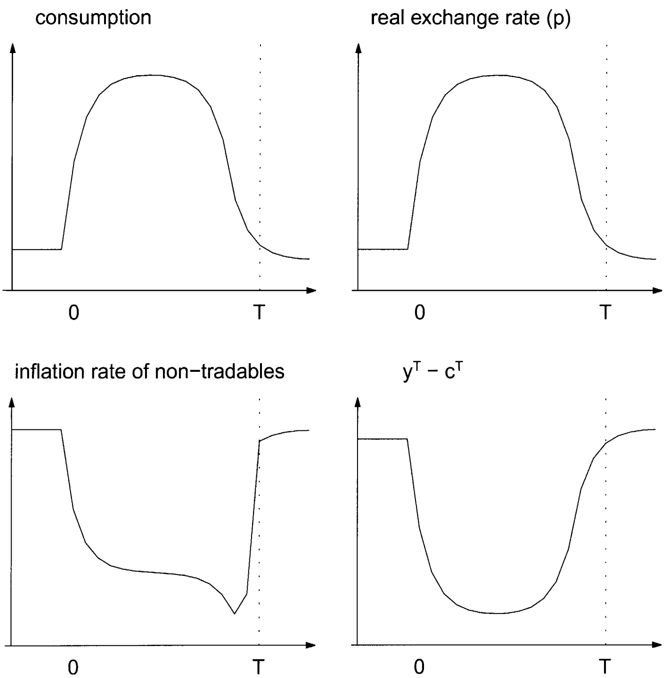


Fig. 4. Temporary currency peg under habit persistence.

inflation stabilization program was assumed to be permanent. The intuition behind this new result is clear. In anticipation of the end of the low-inflation policy, habit-forming (but rational) agents choose to cut consumption while the policy is still in place so as to reduce their levels of addiction and, in that way, avoid a traumatic adjustment when economic conditions change. Finally, the expansionary phase of the program is characterized by a deterioration in the current account. This effect was also absent in the case of permanent stabilization. Under lack of credibility the trade balance deteriorates because the boom in consumption is driven not by an increase in current disposable income, as was the case under permanent currency pegs, but by a pure intertemporal substitution effect; agents choose to consume part of their future income in their desire to take advantage of a temporarily lower inflation tax.

We have characterized the precise way in which the assumption of lack of credibility enriches the predictions of the basic habit-formation model. Equally important, however, is to highlight the dimensions along which habit formation enhances the plausibility of the lack-of-credibility hypothesis. Two such dimensions are the ability of habit formation to resolve the following well-known shortcomings of lack-of-credibility models. First, as shown at the beginning of this section, standard models of imperfect credibility fail to capture the price–consumption regularity, as they predict a nonpositive comovement between consumption and the real exchange rate. Second, in line with the empirical facts, standard lack-of-credibility models predict a boom–recession cycle in aggregate spending. However, counterfactually the contraction necessarily takes place at (and not before) the date at which the program is expected to be abandoned.

6. Habit formation in an economy with capital and endogenous labor supply

The endowment economy models analyzed thus far leave a number of important open questions: First, is the price–consumption problem present in model economies with more realistic technology and preference specifications? As noted in Section 2, if the assumption that preferences are separable in leisure and consumption is relaxed—specifically, if the cross derivative of the period utility function with respect to consumption and leisure is assumed to be negative—it is no longer necessarily the case that consumption falls as the real exchange rate appreciates during the initial phase of ERB stabilization programs. Second, in a more realistic model economy with capital and endogenous labor supply, is habit formation still a useful way to fix the price–consumption problem? Third, can the interaction of habit formation, leisure, and capital accumulation help explain aspects of the observed adjustment process that the endowment economy is unable to capture? Of particular interest is the behavior of the real exchange rate during the contractionary phase of ERB programs. The data suggest that as the contraction sets in, the real exchange rate continues to appreciate. In the endowment economies like the one studied thus far, the real exchange rate is purely demand determined. Thus, a contraction in aggregate demand is necessarily associated with a depreciation of the real exchange rate.

Finally, how does habit persistence affect the quantitative predictions of standard models? A well-known quantitative difficulty of the model with time separable preferences is that it generates consumption booms and real exchange rate appreciations that are too small relative to those observed in the data (Rebelo and Végh, 1995). The fact that habit persistence introduces additional smoothness in the response of consumption to changes in expected inflation raises the question of whether habit formation makes the quantitative problems worse.

To address these questions, I extend the model presented in the previous section by including capital accumulation and endogenous labor supply. In the resulting model, a permanent reduction in expected inflation generates real effects stemming from three different sources: (1) purchases of investment goods are assumed to be subject to transaction costs, thus inflation creates a wedge between the rate of return on physical capital and the rate of return on foreign bonds; (2) because consumption is subject to transaction costs while leisure is not, expected inflation introduces a wedge between the wage rate and the marginal rate of substitution between consumption and leisure; and (3) changes in expected inflation create income effects by altering the amount of resources spent by households in reducing their exposure to the inflation tax (shoe-leather costs). The first two effects are usually referred to as supply-side effects (see Lahiri, 1995; Roldós, 1995; Uribe, 1997, 2000).

I will limit the presentation of the model to a description of the components that distinguish it from the endowment economy. Let $h_t \in [0, 1]$ denote the fraction of time devoted to work by the representative household in period t. Then the household's utility function is given by

$$\sum_{t=0}^{\infty} \beta^t \frac{[(c_t - \alpha c_{t-1})(1 - h_t)^{\psi}]^{1-\sigma} - 1}{1 - \sigma},$$

where σ, $\psi > 0$ and $\sigma \neq 1$. Note that if $\sigma > 1$, then the cross derivative of the period utility function, with respect to c_t and $1 - h_t$ is negative. This condition was identified in Section 2.1 as necessary for leisure to provide a solution to the price–consumption puzzle. Consumption is a composite of traded and nontraded goods. The aggregator function is Cobb–Douglas. Formally,

$$c_t = (c_t^{\mathrm{T}})^{\gamma}(c_t^{\mathrm{N}})^{1-\gamma}, \quad \gamma \in (0, 1).$$

In addition to money and bonds, households can now invest in physical capital, k_t^{T}. Investment, i_t^{T}, is made of traded goods and is, like consumption, subject to transaction costs. The evolution of asset holdings is then given by

$$b_t + m_t + (c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} + i_t^{\mathrm{T}})(1 + s(v_t))$$
$$\leqslant (1 + r_{t-1})b_{t-1} + \frac{m_{t-1}}{1 + \varepsilon_t} + y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}} + \tau_t,$$

where money velocity is now defined as

$$v_t = \frac{c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} + i_t^{\mathrm{T}}}{m_t}.$$

The accumulation of physical capital is subject to adjustment costs. Specifically, the law of motion of k_t^{T} is given by

$$k_{t+1}^{\mathrm{T}} = \phi(i_t^{\mathrm{T}}/k_t^{\mathrm{T}})k_t^{\mathrm{T}} + (1-\delta)k_t^{\mathrm{T}},$$

where $\phi(\cdot)$ satisfies $\phi(\delta) = \delta$, $\phi'(\delta) = 1$, and $\phi''(\delta) < 0$. As is well known, in small open economy models capital adjustment costs are needed in order to avoid excessive volatility in investment (e.g., Schmitt-Grohé, 1998).

Traded goods are assumed to be produced with capital and labor via a homogeneous-of-degree-one technology, while nontraded goods are produced with labor only. Specifically,[14]

$$y_t^{\mathrm{T}} = (h_t^{\mathrm{T}})^{\alpha_{\mathrm{T}}}(k_t^{\mathrm{T}})^{1-\alpha_{\mathrm{T}}}, \quad \alpha_{\mathrm{T}} \in (0,1)$$

and

$$y_t^{\mathrm{N}} = (h_t^{\mathrm{N}})^{\alpha_{\mathrm{N}}}, \quad \alpha_{\mathrm{N}} \in (0,1),$$

where h_t^{T} and h_t^{N} denote the fractions of time devoted to work in the traded and nontraded sectors, respectively, and satisfy

$$h_t = h_t^{\mathrm{T}} + h_t^{\mathrm{N}}.$$

The market clearing conditions in the nontraded goods market is

$$c_t^{\mathrm{N}} = y_t^{\mathrm{N}}.$$

Let w_t denote the country's net foreign asset position in period t. Then w_t evolves according to the following expression:

$$w_t = (1 + r_{t-1})w_{t-1} + tb_t,$$

where

$$tb_t = y_t^{\mathrm{T}} - c_t^{\mathrm{T}} - i_t^{\mathrm{T}} - s(v_t)(c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} + i_t^{\mathrm{T}})$$

denotes the trade balance in period t. Note that transaction costs are not rebated.

I base the analysis that follows on simulations of a log-linearized version of the equilibrium conditions. Under the assumption of a constant international interest rate maintained in the previous sections, the log-linearized model contains a unit root that invalidates the use of standard theoretical arguments linking its dynamic properties to those of the original, nonlinear model. To circumvent this difficulty, I induce stationarity by assuming that the country pays a premium over the world interest rate that is decreasing in the country's net foreign asset position. Specifically,

$$r_t = r^*\mu(-w_t)$$

with $1 + r^* = \beta^{-1}$, $\mu(-w) = 1$, and $\mu'(-w) < 0$; w denotes the steady-state net foreign asset position. In computing equilibrium dynamics, I set the elasticity of μ with

[14] Uribe (1997) analyzes the dynamics of ERB programs in a model where both the traded and nontraded sectors use capital as an input of production.

Table 1
Calibration

Symbol	Value	Description
β	0.984	Subjective discount factor
σ	5	Inverse of intertemporal elasticity of substitution
α	0.7	Habit-formation parameter
ψ	2.6	Preference parameter
γ	0.28	Elasticity of aggregator function w.r.t. tradables
α_T	0.48	Elasticity of traded output w.r.t. labor
α_N	0.63	Elasticity of nontraded output w.r.t. labor
δ	0.025	Depreciation rate (quarterly)
$\delta\phi''(\delta)$	$-1/15$	Capital adjustment cost parameter
ξ	1.5	Parameter of transactions cost technology, $s(v) = Av^{\xi}$
A	0.0089	Parameter of transactions cost technology, $s(v) = Av^{\xi}$
r^*	1.63%	Steady-state interest rate on external debt (quarterly)
$-w\mu'(-w)$	10^{-4}	Debt elasticity of interest-rate premium
ε^L	0	Devaluation rate during stabilization plan
ε^H	33%	Devaluation rate before and after stabilization plan (quarterly)

respect to $-w$ at a value close to zero to ensure that at business cycle frequencies the model behaves as if the real interest rate was exogenous.[15]

6.1. Calibration

I calibrate the model using data from the Argentine economy during the period 1970–1990. Table 1 displays the resulting parameter values. The time unit is meant to be a quarter. I set the pre-stabilization devaluation rate at 35 percent per quarter, the average level prevailing over the calibration period (Uribe, 1997). The steady-state world interest rate r^* takes a value of 1.62 percent per quarter, which corresponds to the average real rate of return on U.S. equity between 1948 and 1981 (King et al., 1988). The transaction cost is assumed to be of the form

$$s(v) = Av^{\xi}, \quad \xi > 0.$$

This specification implies a (log–log) money demand elasticity with respect to $i/(1+i)$ equal to $1/(1+\xi)$. I set this elasticity at -0.4, a value consistent with the estimates for Argentina reported by Arrau et al. (1995). The scale parameter A takes a value consistent with a steady-state seignorage revenue of 7 percent of GDP (Rebelo and Végh, 1995). The sectorial labor shares α_T and α_N were set at 0.48 and

[15] Two alternative ways to avoid the unit-root problem are to assume that the subjective discount factor is a decreasing function of a weighted average of current and past consumption (Obstfeld, 1981) and to introduce finite lives as in Blanchard's (1985) perpetual youth model.

0.63, respectively, following Uribe (1997). The depreciation rate was set at 2.5 percent per quarter. The elasticity $\phi''(\delta)\delta/\phi'(\delta)$ was set at $-1/15$ following Rebelo and Végh (1995). Based on the estimate of the intertemporal elasticity of substitution for Argentina obtained by Reinhart and Végh (1995), I set σ at 5. I choose a value for ψ such that households allocate on average 20 percent of their time to work. The share of traded goods in the aggregator function, γ, takes a value consistent with a share of traded output in GDP of 42 percent (Uribe, 1997). The steady-state level of wealth, w^*, was set so as to be consistent with a long-run trade balance to GDP ratio of 2.67 percent reported by Uribe (1997)—which implies that in the long run the country is a net debtor. The steady-state wealth elasticity of the real interest rate, $-\mu'(-w)w$, was set at a low value, 10^{-4}, so that in the short run the model behaves as if the interest rate was constant. Finally, due to scarce econometric evidence on the size of the habit persistence parameter α for developing countries, I simulate the model under two alternative values, 0 and 0.7.[16]

6.2. Dynamics

I first consider the model's response to an unexpected, credible, and permanent ERB stabilization program that reduces the devaluation rate from 35 to zero percent per quarter. Fig. 5 displays with solid lines the case of habit persistence ($\alpha = 0.7$) and with dashed lines the case of time-separable preferences ($\alpha = 0$). Under both habit persistence and time-separable preferences, the model correctly predicts a gradual real exchange rate appreciation that begins immediately after the program is announced. However, under time-separable preferences the model counterfactually predicts a virtually flat path for total consumption and a decreasing path for consumption of nontradables. By contrast, under habit persistence the model is consistent with the price–consumption regularity, as both total consumption and consumption of nontradables expand gradually along the transition. Note that by the third year of the program the increase in consumption and the appreciation of the real exchange rate are roughly of the same magnitude under both preference specifications considered. On the supply-side, the main difference between habit-forming and time-separable preferences lies in the behavior of sectorial employment in the early phase of the program. Under time separable preferences, there is a more pronounced shift in employment away from the traded sector and toward the nontraded sector than under habit persistence. Gross investment displays a similar pattern under both types of preferences, increasing by over 25 percent on impact and then declining gradually along the transition.[17]

[16] In the macro-finance literature for industrialized countries, authors have used values of α as high as 0.8 (Constantinides, 1990).

[17] This pattern is not completely consistent with the observed investment booms, during which investment increases for several years before reaching its peak. Uribe (1997) shows that this pattern can be accounted for by introducing gestation lags.

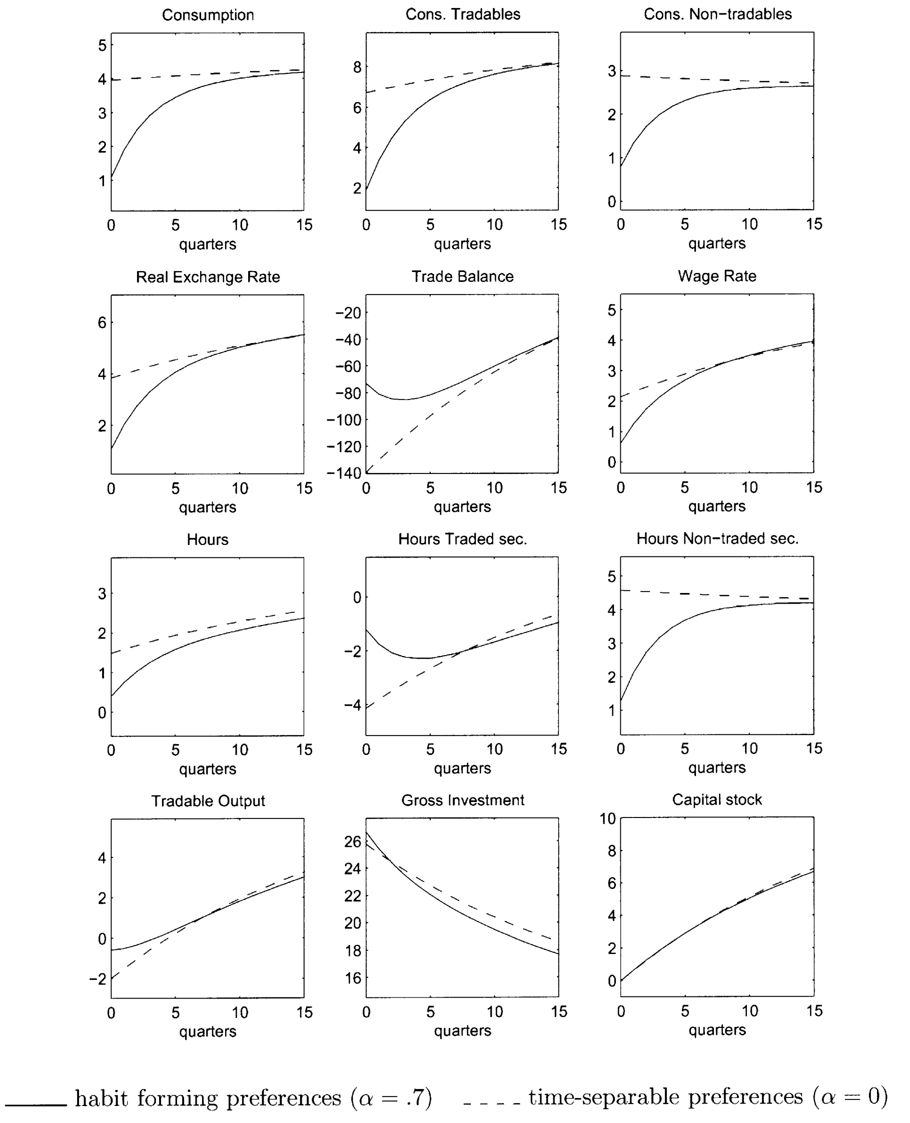
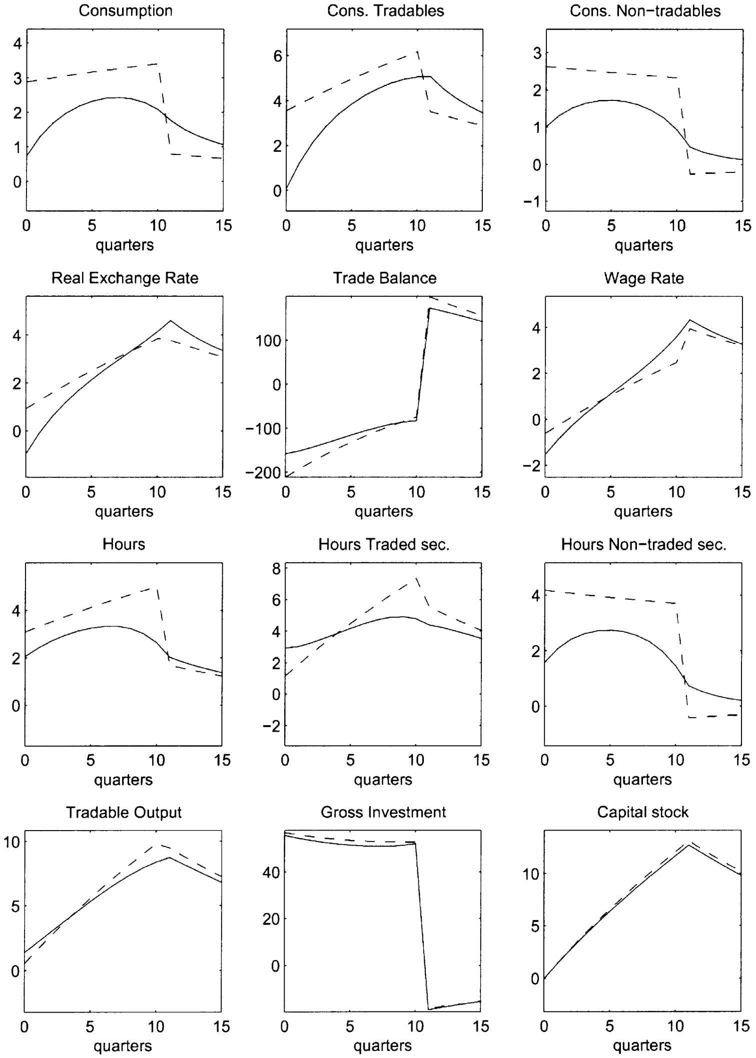


Fig. 5. Permanent exchange-rate based stabilization under habit persistence in an economy with capital and endogenous labor supply.

Note: The program consists in a credible, permanent reduction of the devaluation rate from 35 to 0 percent per quarter. All variables are expressed in percentage deviations from their pre-stabilization steady states.

Fig. 6 displays the dynamics of a temporary ERB stabilization program that reduces the devaluation rate from 35 to zero percent per quarter for only 12 quarters. After this period the devaluation rate returns to its pre-stabilization level of 35



—— habit forming preferences ($\alpha = .7$) - - - - time-separable preferences ($\alpha = 0$)

Fig. 6. Temporary exchange-rate based stabilization under habit persistence in an economy with capital and endogenous labor supply.

Note: The program consists in a reduction of the devaluation rate from 35 to 0 percent per quarter for 12 quarters, after which the devaluation rate returns to its pre-stabilization level of 35 percent per quarter. All variables are expressed in percentage deviations from their pre-stabilization steady states.

percent. Like the endowment economy model, the model with capital and labor predicts that under habit formation total consumption as well as consumption of nontradables display a smooth boom–recession cycle, with the recession beginning before the expected date of abandonment of the program. This pattern is absent in the economy with time-separable preferences.

The presence of supply-side effects induces a more realistic response of the real exchange rate than the endowment economy. As pointed out before, in the endowment economy a contraction in aggregate demand is necessarily associated with a depreciation of the real exchange rate. When the stabilization program is assumed to be temporary, this property of the endowment economy model produces the counterfactual implication that the real exchange rate begins to depreciate several periods before the collapse of the program. In reality one observes that the real exchange continues to depreciate throughout the transition. The leftmost panel in the second row of Fig. 6 shows that in the economy with capital and endogenous labor supply, the real exchange rate, as in the data, continues to appreciate after the contraction in aggregate demand sets in. This is because the continuous increase in the capital stock that takes place in the traded sector raises the marginal product of labor in that sector, thereby inducing a re-allocation of hours away from the nontraded sector that reduces the supply of nontradables.

6.3. Uncertain duration of currency pegs

I conclude this section with a brief discussion of the role of uncertain duration of currency pegs in resolving the price–consumption puzzle.[18] To isolate the role of uncertainty, I assume that preferences are separable across time ($\alpha = 0$). Instead, I assume that each period $t \geqslant 0$ in which the stabilization program is in place, the public expects it to be abandoned in period $t+1$ with some probability. Formally, let $z_t = \text{Prob}\{\varepsilon_{t+1} = \varepsilon^H | \varepsilon_t = \varepsilon^L\}$, where ε^H denotes the rate of devaluation prevailing in the pre-stabilization and post-collapse periods, and $\varepsilon^L < \varepsilon^H$ denotes the devaluation rate in effect while the program is in place. I refer to z_t as the hazard rate and to the function of time $\{z_t\}_{t=0}^{\infty}$ as the hazard function. I assume that ε^H is an absorbent state for $t \geqslant 0$, that is, $\text{Prob}\{\varepsilon_{t+1} = \varepsilon^H | \varepsilon_t = \varepsilon^H\} = 1$, $t \geqslant 0$. Also, I assume that there is a date $T > 0$ at which the program is abandoned for sure (i.e., $z_{T-1} = 1$).

Fig. 7 displays the implied dynamics of the model under uncertain duration of the currency peg. The rightmost panel on the bottom row of the figure shows the assumed hazard function. Existing empirical studies of the duration of currency pegs (e.g., Blanco and Garber, 1986; Klein and Marion, 1997) suggest that hazard functions are nonmonotonic. Exchange-rate-based stabilization programs tend to start out with low credibility. As time goes by, the public initially gains confidence in the ability of the program to last. But at some point this credibility begins to erode, and by the time of the collapse the public assigns very little chances to the survival of the stabilization policy. Accordingly, I assume a stylized J-shaped hazard function. To facilitate comparison with the case of temporary, perfect-foresight programs, I assume that the maximum duration of the program is 12 quarters ($T = 11$, with the program starting in period zero). The hazard function equals 0.4 at the beginning of the program, is decreasing between the first and fourth periods of life, reaching

[18] The material in this subsection draws on Mendoza and Uribe (2001a).

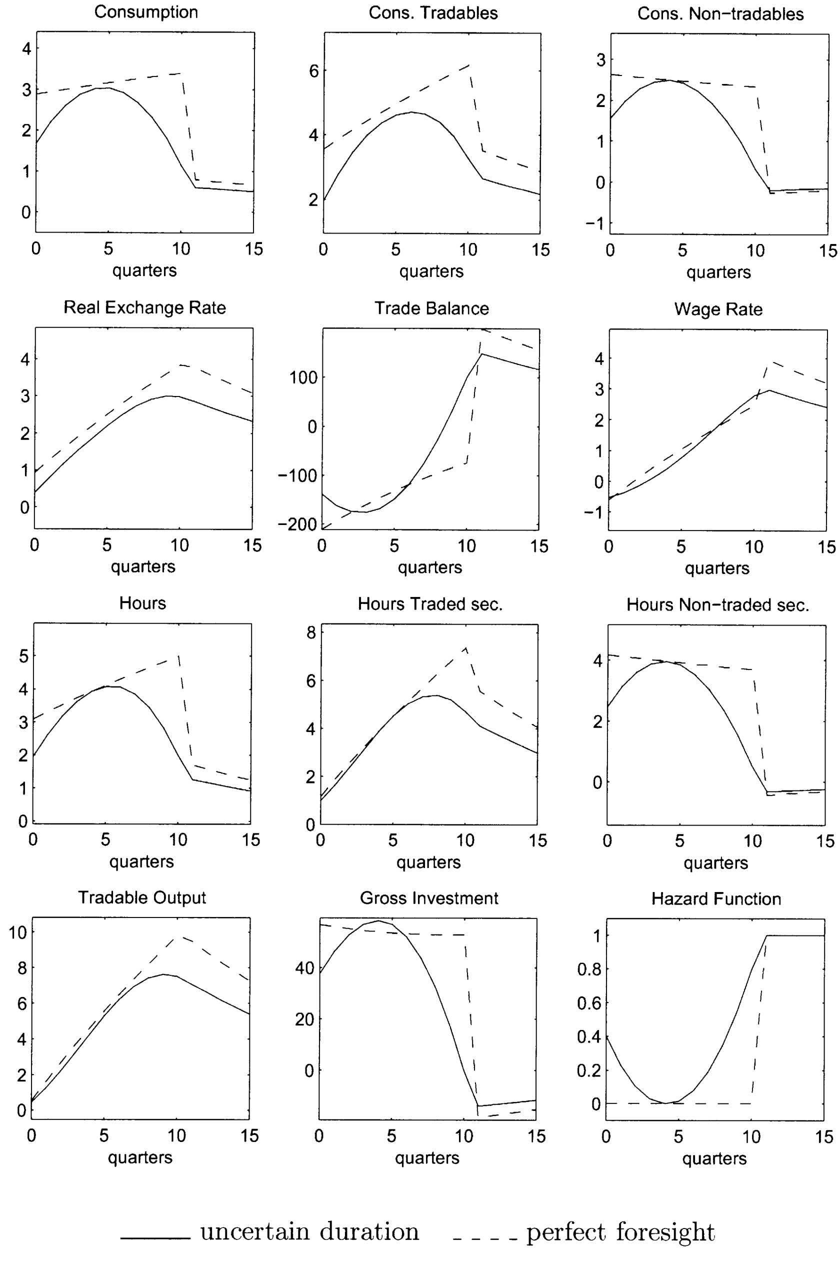


Fig. 7. Exchange-rate based stabilization under uncertain duration in an economy with capital and endogenous labor supply.

Note: In this figure, preferences display no habit formation ($\alpha = 0$). The program consists in a reduction of the devaluation rate from 35 to 0 percent per quarter for 12 quarters, after which the devaluation rate returns to its pre-stabilization level of 35 percent per quarter. Under uncertainty, the program may be abandoned before quarter 12, with probabilities governed by the hazard function shown on the bottom right panel. All variables are expressed in percentage deviations from their pre-stabilization steady states.

a minimum of 0 at this latter date, and is strictly increasing between the 5th and 11th periods, achieving a value of 0.8 in the 10th period and of 1 in the 11th period of life.

As anticipated in Section 2, the model successfully replicates the price–consumption regularity. In particular, total consumption and its nontraded component display a boom–recession cycle with the recession beginning before period T. In addition, the real exchange rate gradually appreciates along the expansionary phase of the program. The intuition behind this result is straightforward. In this model the hazard rate z_t acts as a time-varying tax on domestic absorption. This is because the higher is z_t the higher is expected devaluation in period t and thus the higher is the domestic nominal interest rate in t. Because agents need to hold money to purchase final goods, high interest rates tend to depress current spending.[19]

7. Conclusion

This paper has two main objectives. The first is to identify a difficulty that a large family of optimizing models share in explaining the empirical regularities associated with exchange-rate-based inflation stabilization. Specifically, during the initial phase of currency pegs, consumption and the relative price of nontradables increase gradually for several years. Most existing models cannot replicate this fact. For they imply that a pattern in which the real exchange rate gradually appreciates must necessarily be accompanied by a continuous decline in consumption. The paper identifies three possible avenues to resolve this price–consumption puzzle. Namely, uncertain duration of currency pegs, borrowing constraints, and habit formation in consumption. The first possibility was studied in detail in Mendoza and Uribe (2001a, b) and summarized briefly in Section 6 of this paper. The second has not yet been explored. The third represents the second main objective of the present study.

Habit formation in combination with lack of credibility brings theory closer to the data in two fundamental dimensions. First, it represents a solution to the price–consumption puzzle, as consumption and the real exchange rate move in tandem during the expansionary stage of currency pegs. Second, it produces a boom–recession cycle with the recession setting in before the expected date of demise of the currency peg. Interestingly, these cycles emerge even when product and factor prices are fully flexible and the duration of the currency peg is known with certainty.

[19] The quantitative predictions of the model differ from those presented in Mendoza and Uribe (2001a). Specifically, the benchmark simulation in Mendoza and Uribe displays a much larger consumption boom and real appreciation than the one shown in Fig. 7. The discrepancy is due to differences in the calibration of the structural parameters. Of particular importance is the fact that in this paper seignorage revenue (which is given by $m_t - m_{t-1}/(1+\varepsilon_t)$) is assumed to be fully rebated to the public in a lump-sum fashion. By contrast, in their benchmark calibration, Mendoza and Uribe assume that two thirds of seignorage revenue is allocated to unproductive government consumption. Another source of quantitative discrepancies is given by differences in the values assigned to the parameters defining the transaction technology $s(v_t)$.

A natural question that emerges from these findings is to what extent the introduction of habit formation affects the quantitative response of existing models. A key conclusion of the survey of theories conducted by Rebelo and Végh (1995) is that 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 shows that adding habit formation to an otherwise standard model does not help resolve this quantitative problem.

Recent work has yielded promising results in the quest for understanding the quantitative effects of inflation stabilization episodes. This progress stems from two alternative approaches to the problem. One is to modify the standard model so as to magnify the consumption boom and the initial real exchange rate appreciation. For example, Burstein et al. (2000) show that adding distribution costs to the standard open economy setup greatly improves its ability to replicate the observed magnitude of real exchange rate appreciations during the initial stage of currency pegs.

The second approach to reconciling the small quantitative effects predicted by the existing models with the data starts by recognizing that the timing of stabilization policies is likely to depend on a number of factors that define the state of the economy. For example, a period of low world interest rates and/or favorable terms of trade might be seen as particularly propitious to implement currency pegs, for they are times when the government can have inexpensive access to external credit. But the world interest rate or the terms of trade may themselves represent quantitatively important sources of aggregate fluctuations quite independently of the monetary or exchange-rate regime in place. Indeed, a number of empirical studies, most notably Calvo et al. (1993), shows that in emerging markets a significant fraction of movements in macroeconomic variables, such as output or the real exchange rate, is explained by movements in external variables, such as U.S. interest rates. It is thus likely that, by focusing on raw, unfiltered data, researchers might overestimate the real effects of stabilization programs. Mendoza and Uribe (2001a) perform an econometric test of this hypothesis. They find that after controlling for the world interest rate, the magnitude of the consumption boom and the real exchange rate appreciation is roughly half the size of the expansion observed using raw data.

The present study can therefore be understood as part of a larger, ongoing research agenda aimed at achieving a better understanding of the qualitative as well as the quantitative regularities that define business cycles in emerging market economies.

Appendix A

A.1. Exchange-rate-based stabilization under consumption durability ($\alpha < 0$)

In this appendix, I present a simple endowment economy to illustrate the way in which consumption durability affects the dynamics of exchange-rate-based stabilization. In this example, the endowments of tradables and nontradables, y^{T}

and y^N, are exogenous and constant. The consumption aggregator function takes the form

$$A(c^T, c^N) = c^T f(c^N), \tag{A.1}$$

where $f, f' > 0$. The function $A(\cdot, \cdot)$ is not homogeneous of degree 1, so it violates an assumption maintained throughout the main text. This deviation is introduced for analytical convenience and does not imply a loss of generality.

The equilibrium conditions can then be written as

$$U'(x_t) - \alpha\beta U'(x_{t+1}) = \lambda h(i_t), \tag{A.2}$$

$$x_t \equiv c_t - \alpha c_{t-1}, \tag{A.3}$$

$$(1+r)(w_{-1} + y^T/r) = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t [1 + g(i_t)]c_t, \tag{A.4}$$

where $g(i_t) \equiv (1 + f'(y^N))s(v(i_t))$ and $h(i) \equiv 1 + s(v(i_t)) + v(i_t)s'(v(i_t))$ are both positive and increasing in i_t. A perfect-foresight equilibrium is defined as a pair of sequences $\{c_t, x_t\}_{t=0}^{\infty}$ and a scalar $\lambda > 0$ satisfying (A.2)–(A.4), given the initial conditions c_{-1} and w_{-1} and the forcing sequence $\{i_t\}_{t=0}^{\infty}$. Normalizing the endowment of nontradables so that $f(y^N) = 1$, it follows that the equilibrium real exchange rate is given by

$$p_t = c_t f'(y^N). \tag{A.5}$$

Suppose that at $t = 0$ the monetary authority unexpectedly announces an ERB stabilization plan consisting in a permanent reduction in the devaluation rate from ε^H to $\varepsilon^L < \varepsilon^H$. Assume further that the program is sustainable over time and is perfectly credible so that by the uncovered interest parity condition the path of the nominal interest rate is given by $i_t = i^L < i^H \;\forall t \geq 0$, where i^L satisfies $1 + i^L = (1 + r)(1 + \varepsilon^L)$.

Given the path of the nominal interest rate, Eq. (36) is a first-order linear difference equation in $U'(x_t)$ with a constant forcing term given by $\lambda h(i^L)$. Furthermore, because $|\alpha\beta| < 1$, it follows that Eq. (A.2) is globally unstable in $U'(x_t)$. Therefore, the only nonexplosive solution is one in which $U'(x_t)$ reaches its new steady state, $\lambda h(i^L)/(1 - \alpha\beta)$, instantaneously. Since $U'(\cdot)$ is a monotone function, x_t must also attain its new steady-state level at $t = 0$. Eq. (28) then implies that consumption evolves according to the following first-order linear difference equation:

$$c_t = \alpha c_{t-1} + (1 - \alpha)c^*, \tag{A.6}$$

where $c^* \equiv x^*/(1 - \alpha)$ denotes the steady-state value of c_t. Using (30) and (A.6) to eliminate w_{-1} and $\{c_t\}_{t=0}^{\infty}$ from (A.4), c^* can be written as

$$\frac{c^* - c_{-1}}{c_{-1}} = \left(\frac{1 - \alpha\beta}{1 - \alpha}\right) \left[\frac{(g(i^H) - g(i^L))}{1 + g(i^L)}\right]. \tag{A.7}$$

According to this expression, $c^* > c_{-1}$, that is, a permanent ERB stabilization program generates a long-run increase in consumption.

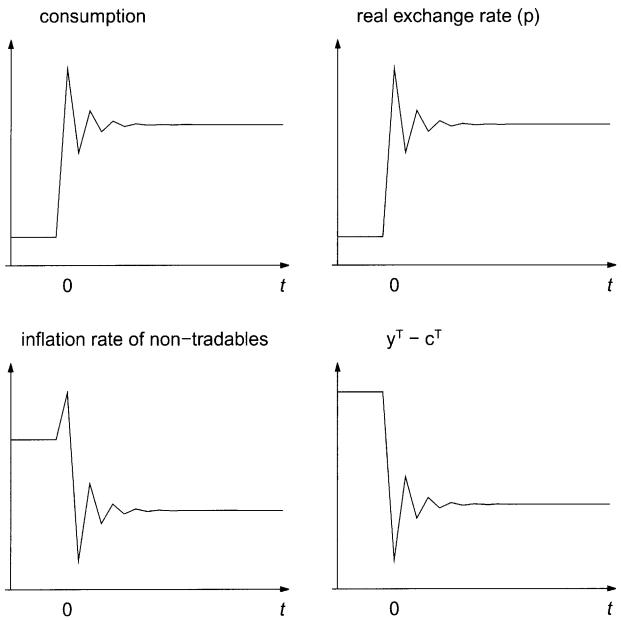


Fig. 8. Permanent ERB program under durability.

Under consumption durability ($-1<\alpha<0$), Eq. (A.6) and the fact that $c_{-1}<c^*$ imply that when the program is announced consumption jumps above its steady-state level and then converges to it in an oscillating fashion. The real exchange rate and inflation follow a similar pattern (Fig. 8).[20] In isolation, the assumption of durability does not provide a satisfactory explanation of the initial effects of ERB programs, as it fails to capture the gradual appreciation of the real exchange rate as well as the protracted expansion in aggregate consumption. However, I will argue later that in combination with the assumption of habit formation, durability, by exacerbating the initial response of the economy to the decline in expected inflation, indeed enriches the predictions of the model.

Consider now the case of a temporary stabilization program. The dynamics are depicted in Fig. 9.[21] Again, the oscillating nature of the equilibrium dynamics suggests that durability is not a good explanation for the price–consumption problem. But durability introduces a realistic feature in the dynamics of temporary stabilization programs. Namely, as Fig. 9 shows, it generates turbulence around the dates of announcement and collapse of the stabilization program, with a period of

[20] De Gregorio et al. (1998) find a similar adjustment pattern in an (s,S) model of consumption durability. See also Calvo (1988) and Drazen (1990).

[21] This figure as well as Fig. 10, displays the exact equilibrium dynamics arising from an economy in which $U(\cdot)$ belongs to the family of CRRA functions.

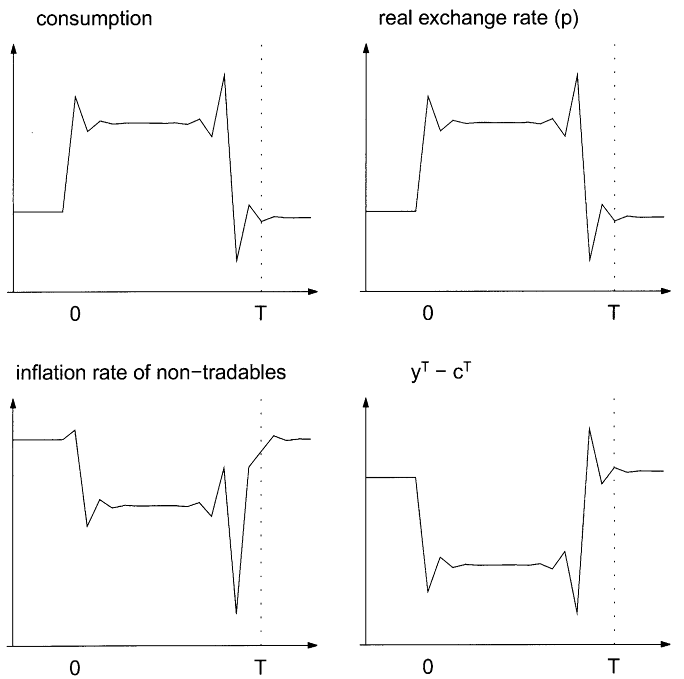


Fig. 9. Temporary ERB program under consumption durability.

tranquility in between. This result suggests that durability and habit persistence are complementary rather than competitive explanations of the dynamics of ERB programs. I expand on this point in the next and final subsection.

A.2. Habit formation and durable goods

To formalize the conjecture that habit formation and durability are complementary rather than competitive explanations of the dynamics of ERB stabilization programs, consider an economy in which preferences are given by (10) and (A.1) and display habit formation so that $\alpha > 0$. Assume also that the tradable consumption good, c_t^{T}, is a composite of a perishable traded good, z_t, and services from a durable traded good, s_t. Specifically, assume that c_t^{T} is given by

$$c_t^{\mathrm{T}} = z_t^{\theta} s_t^{1-\theta}, \quad \theta \in (0, 1).$$

The evolution of the stock of durables is assumed to be given by

$$s_t = w_t + \omega w_{t-1}, \quad \omega > 0,$$

where w_t denotes purchases of new durable goods.

Fig. 10 displays the equilibrium dynamics induced by a temporary ERB stabilization program. The presence of durables makes the abandonment of the

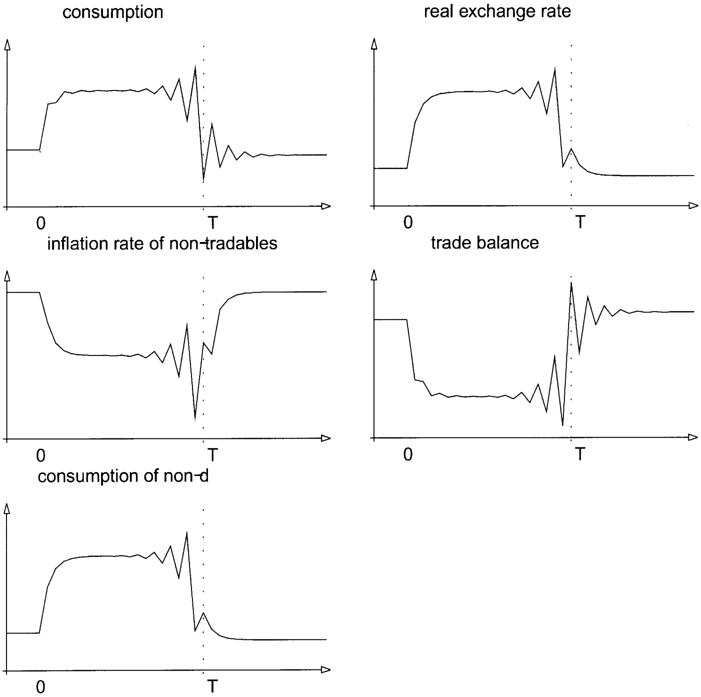


Fig. 10. Temporary ERB program under consumption durability and habit persistence.

program look traumatic: the volatility of consumption, inflation and the trade balance increases as t approaches $T-1$. At the same time, the model inherits from the habit-formation model an initial transition characterized by a gradual real exchange rate appreciation, a smooth consumption boom, and a slow convergence of the inflation rate to the devaluation rate. The combination of durability, habit persistence, and policy temporariness generates dynamics that look as if shortly before period $T-1$ the economy is hit by an adverse shock that leads to the eventual abandonment of the program.

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