DEVALUATIONS AND REVALUATIONS WITHOUT CAPITAL MOBILITY AND PPP

by

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Abstract

I study the effects of unanticipated permanent devaluations and revaluations in a small-open production economy under the assumptions of capital immobility and impediments to trade. The paper is motivated by a recent discussion about the business cycle-type effects of the exchange-rate-based stabilizations (ERBS). In the model, the quadratic labor costs involved in carrying out foreign transactions imply that, in general equilibrium, PPP is not instantaneously reestablished following changes in the nominal exchange rate. This endogenous lack of an instantaneous price adjustment drives a temporary wedge between prices faced by the domestic producers and consumers. The real effects of changes in the exchange rate turn out to be due to both the resulting substitution effects and the long-run absence of "money illusion". In contrast to the standard Keynesian theory of devaluation, the model stresses the intra- as well as intertemporal effects of price sluggishness. Although a devaluation produces the usual negative "real balance effect", it has an overall positive (negative) impact effect on the real wealth (the real interest rate). When extended by an introduction of the usual distinction between the traded and the nontraded goods, it explains the stylized facts about ERBS as documented by Kiguel and Liviatan (1990). In contrast to the existing literature, I demonstrate that in the presence of convex arbitrage costs, a devaluation (revaluation) leads to a combination of the trade surplus (deficit) and a *fall (increase)* in the relative price of traded goods in terms of the nontraded goods, and – finally – that a revaluation is *not* a reversed devaluation.

1. Introduction

This paper studies the effects of changes in the nominal exchange rate in a small-open production economy under the assumptions of capital immobility and impediments to trade. It is motivated by a recent discussion of the business cycle-type implications of the exchange rate-based stabilizations (ERBS). In the course of a ERBS the government tries to fight inflation by managing the nominal exchange rate (i.e., the exchange rate is either fixed or follows a preannounced path). ERBS's sharply differ from the money-based stabilizations, MBS, in the course of which the government slows down the growth of the nominal money supply but does not interfere with the market determination of the nominal exchange rate.

The question of the business cycle-type effects of ERBS was first raised by Kiguel and Liviatan (1990). They documented that the past ERBS's in Latin America and Israel were typically characterized by an initial output/consumption boom and real appreciation followed by a contraction and a real depreciation. Several arguments have been made to explain these stylized facts. The earliest use the well-known models that stress rigidities in either inflationary expectations (Rodriguez (1982)), or in nominal variables (Fischer (1986)). More recently, Calvo and Vegh (1990, 1991) highlight the importance of the known temporariness of the antinflationary program, while Drazen (1990) focuses on an uncertainty over the timing of its inevitable collapse. In contrast, the current model emphasizes the role played by an initial devaluation and the subsequent short run deviations from the purchasing power parity (PPP).

The empirical relevance of my argument relies on the fact that out

of 12 cases of ERBS's studied by Kiguel and Liviatan (1990), 8 involved

a maxi-devaluation followed by (usually) a complete freeze of the

exchange rate. The two stabilizations that seem to fit best the "boom

now and recession later" description of ERBS are the Brazilian in 1964,

and the Uruguayan in 1968. The Brazilian program started in May-June

1964 with a unification of exchange rates that effectively meant to a

devaluation by more than 100%. In Uruguay, the ERBS involved a 25%

devaluation in the late April of 1968. At the time of their

disinflation programs both countries maintained strict capital controls.

In a model studied below, the impediments to trade - pictured as

the quadratic costs involved in carrying out foreign transactions -

imply that, in general equilibrium, PPP is not instantaneously

reestablished following changes in the nominal exchange rate. This is

the Keynesian feature of the model. Its presence causes the devaluation

(revaluation) to affect the intra and intertemporal relative prices. In

particular, I show that a devaluation (revaluation) drives a temporary

wedge between the prices faced by the domestic producers and consumers.

The real effects turn out to be due mostly to the resulting substitution

effects and the long-run absence of "money illusion", rather than the

usual "real balance effect" emphasized in models that assume PPP (see

e.g., Dornbusch (1973), Calvo (1981) and Obstfeld (1986)). In fact, I

show that, on impact, a devaluation increases the real wealth despite

the negative "real balance effect". In contrast to the standard

Keynesian theory of devaluation (see e.g., Meade (1952)), the model

stresses that price inflexibility creates not just intratemporal but -

perhaps more importantly - intertemporal profit opportunities that are

exploited by the rationally-behaving and forward-looking agents.

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As already said, the model stresses the short-run violations of PPP. This seems rather realistic. Several studies have found that PPP is not quite borne out in the data, even for the commodities (see e.g., Isard (1977), Kravis and Lipsey (1977), Kravis, Heston and Summers (1981), and Protopapadakis and Stoll (1983)). These findings have subsequently stimulated an extensive theoretical and empirical research on the exchange rate passthrough and pricing to market. See e.g., Krugman (1986), Giovannini (1988), Marston (1990), Clarida (1991).

The remainder of the paper is organized as follows. In section 2 I lay down the model. The effects of the unanticipated permanent changes in the nominal exchange rate are studied in section 3. Section 4 discusses robustness and possible extensions, and concludes.

2. The Model

Consider the following continuous-time model of a small open economy. I assume perfect foresight. The model economy is populated by a large number of immortal and identical households. Each household has three members: a manager, a shopper, and a worker. They all act independently. The manager runs the family-owned firm. It produces a perishable tradeable good using hired labor and a linear technology. The firm can sell its output either on the domestic market (for the domestic money) at price p, or on the foreign market (for the foreign money) at price p^*. Without the loss of generality I normalize p^* to unity. The nominal exchange rate is pegged by the central bank at a constant level of E units of domestic money for one unit of foreign money. The totality of the (gross) interest earnings on the stock of the central bank foreign exchange (which backs the domestic money

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supply) is used to pay for the wasteful government consumption.

Therefore changes in the nominal exchange rate do not produce the

long-run wealth effects of the type discussed in Obstfeld (1986).

Selling abroad is subject to the quadratic labor costs. One may

think of these selling costs as incurred in a preparation of sales

documents, labels, and catalogs in a foreign language. Denote by h the

productive employment (= output), and let a be the fraction of h that

the firm chooses to sell on the world market. Selling ah units of the

good abroad requires hiring a^2h hours of domestic labor at the

competitive nominal wage w units of domestic money per hour (i.e., aw is

the average selling cost.) The presence of some fixed factor, say, a

stock of human capital in foreign languages may justify the convexity of

the selling costs. The shopper's job is to buy the consumption good, c.

Buying goods abroad is costly (e.g., there is a time cost of translating

the foreign labels, etc.). Let e be the fraction of c that is purchased

on the foreign market. A purchase of ec units of the foreign-produced

good requires ce^2 hours of domestic labor. I assume that the foreign

agents are not allowed to hold the domestic money, and thus cannot sell

and buy goods on the domestic market (i.e., the foreign trade is

conducted solely by the domestic agents). The last family member, the

worker, sells n hours of his labor to the domestic employers.

Families are allowed to hold only the domestic-currency-denominated

assets. In addition to the home money, M, they hold the

privately-issued domestic-currency-denominated consol-type nominal

bonds, B. The nominal interest rate on these bonds equals i. The

domestic money is internally convertible. The internal convertibility

means that the central bank sells the foreign currency (to the domestic

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residents) only for the purpose of an importation of goods, and that all the export earnings (of the domestic firms) must be converted into the domestic money.

Households maximize a life-time integral of discounted intraperiod utilities subject to a life-time wealth constraint and the no Ponzi games condition. The momentary utility is a separable function of consumption, real money balances (M/p) and labor. The utilities of consumption and real balances have the standard properties (including the Inada conditions), and - to facilitate the algebra - the disutility of labor is linear (which, obviously, implies a perfectly elastic labor supply). Formally, for a given initial stock of nominal assets, A_0, each household solves the following problem:

(1) $$\max_{n,h,c,M,B,a,e} \int_0^\infty \{u(c) + v(m) - n\}\exp(-\delta t)dt$$

subject to:

(2) $$\dot{A} = Ai - iM + wn + h[aE + (1-a)p - a^2 w] - wh - c[eE + (1-e)p + e^2 w]$$

(3) $$A = M + B$$

(4) $$\lim_{t \to \infty} A\exp(-\int_0^t id\tau) = 0 \quad \text{(no Ponzi games)}$$

where: $\delta > 0$ is the subjective rate of time preference; the time subscripts are suppressed to economize on notation.

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(1)-(4) define a convex optimal control problem. Hence the necessary conditions for its solution are also sufficient. A straightforward argument shows that a (e) is positive if and only if $E/p > 1$ ($E/p < 1$). It follows that a and e cannot be jointly positive. Accordingly, I separately account for a case when a is positive a and when e is positive. The primed equations refer to the latter case. Denote by, respectively, μ and η the multipliers on (2) (the marginal utility of the nominal wealth) and (3). Using Pontryagin's Maximum Principle the optimality conditions consist of (2)-(4), and:

(5) $\quad 1 = \mu w$

(6) $\quad aE + (1-a)p = w(1 + a^2)$

(6') $\quad w = p$

(7) $\quad u'(c) = \mu p$

(7') $\quad u'(c) = \mu[eE + (1-e)p + e^2 w]$

(8) $\quad E - p = 2aw$

(8') $\quad E - p = -2ew$

(9) $\quad \dot{\mu} = \mu\delta - (\mu i + \eta)$

(10) $\quad v'(m)/p = \mu i + \eta$

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(11) $\eta = 0$

where a prime, "'", indicates the first derivative.

As usual, (5) and (6)-(6') define the optimal labor supply and demand, respectively. (7)-(7') implicitly define the optimal demand for the consumption good. The "new" conditions, (8)-(8'), say that sellers (buyers) are - on the margin - indifferent between selling (buying) the traded good on the domestic or the foreign market. The latter is achieved by such a choice of the geography of transactions that sets the marginal cost of selling (buying) on the high (low) price location equal to the price differential between the two markets. It will turn out to be important below, that since the function a^2 is strictly convex and 0^2 = 0, the marginal trading cost is necessarily higher than the average trading cost. Therefore the sellers (buyers) on an expensive (cheap) market earn rents on the intramarginal units. (9)-(11) determine the nominal interest rate and (implicitly) the real money demand. Simply notice that they imply:

(12) $\dot{\mu} = \mu(\delta - i)$

and

(13) $v'(m)/\mu p = i$

As expected, at the optimum the marginal rate of substitution between real money and real wealth is equal to the nominal interest

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rate.

Using (5), (6)-(6'), and (8)-(8') it is easy to solve for the real
exchange rate (E/p), the real wage (w/p), and the marginal utilities of
the nominal and real wealth (μp):

(14) $E/p = [1-a^2+2a]/(1-a^2) \geq 1$

(14') $E/p = 1-2e \leq 1$

(15) $w/p = 1/(1-a^2) \geq 1$

(16) $\mu = (1-a^2+2a)/E \geq 1/E$

(16') $\mu = (1-2e)/E \leq 1/E$

(17) $\mu p = 1-a^2 \geq 1$

(17') $\mu p = 1$

where the inequalities in (14)-(17) are strict for any positive a or e;
below I will make assumptions which ensure that a and e are bounded
between zero and one and that 1-2e > 0;

It can be seen that the real exchange rate is rising (falling) in a
(e). I have established earlier that if e is positive, then the real
wage is equal to one (see (6')). (14) says that it is rising in a. In
particular, it is above unity for any positive a. The shadow value of

the nominal wealth is increasing (decreasing) in a (e). While the

shadow value of real wealth is decreasing in a, it is independent of e.

A bit of algebra performed using (7)-(7') and (14)-(17') yields:

(18) $u'(c) = \mu p = 1-a^2$

(18') $u'(c) = \mu[eE + (1-e)p + e^2 w] = \mu p[1-e^2] = 1-e^2$

I focus on (18') first. Its second equality shows that when e > 0,

then the marginal cost of the consumption good is lower than the

marginal utility of wealth or, equivalently, that consumption is

effectively subsidized. The subsidy $(-e^2)$ is due to the convexity of

the arbitrage costs and is earned on the intramarginal units acquired

abroad. As discussed earlier, since the function e^2 is convex and $0^2 =$

0, the marginal arbitrage costs are higher than the average costs. That

means that rents are earned on the intramarginal units. The marginal

utility of real wealth - and hence real wealth - do not depend on e and,

hence, the demand for consumption is affected solely the import subsidy

or, alternatively, by the substitution effects (it is easily seen that

the rate of subsidy is increasing in e).

Things are different when a is positive. As implied by the first

equality in (18), the demand for consumption is monotonically decreasing

in the shadow value of the real wealth or, alternatively, is determined

by the wealth effects.

(18)-(18'), the monotonicity of the marginal utility and the

convexity of a^2 (e^2) together imply that c is rising in a and e. It

follows that the net imports (ce) are an increasing function of e. The

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negative dependence of e and the real exchange rate implies that, as
expected, the net imports are decreasing in the real exchange rate.

In equilibrium the following must be true:

(19) $c = h(1-a)$

(19') $h = c(1-e)$

(20) $n = h(1+a^2) = c(1+a^2)/(1-a)$

(20') $n = h + e^2c = c(1-e+e^2)$

(21) $B = 0$

(22) $\dot{M} = haE$

(22') $\dot{M} = -ceE$

that is, the domestic goods and labor markets clear[1], the net supply of
private bonds is zero (since all the families are alike), and the change
in the stock of nominal money equals the net exports. The latter
condition restates the well-known endogeneity of money which
characterizes the fixed exchange rate regime in the absence of
sterilization.

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[1]   Remember that the foreign agents cannot sell nor buy on the
domestic market.

(18) and (19) imply that the total output is an increasing function of a and, thus the real exchange rate. This is due to the convexity of the arbitrage costs and can be explained as follows. When a > 0, then there are two offsetting effects on the firm's demand for labor. On one hand there is a subsidy to the marginal value product of labor. Namely, it is obvious that the term $aE + (1-a)p$ is larger than p. On the other hand, wages are now effectively taxed at the rate a^2. The convexity of the function a^2 and the envelope condition (8) imply that the subsidy is always larger than the tax. Precisely, one can use (14) and (15) to show that the effective price of output equals $p[1 + a^2/(1-a^2)]$, where the second term in a square bracket is the rate of the net subsidy. It is easy to see that the net subsidy is earned on the intramarginal units sold abroad, and that it is increasing in a (E/p). An increase in a (and hence in the net subsidy) shifts up labor demand leading to an increase in the real wage and employment. Manufacturing of an export good is characterized by the Leontief technology which combines in fixed proportions labor employed in production and marketing. Therefore an increase in the total hours translates into an increase in the productive employment or, equivalently, output (and real wealth). The resulting positive income effect and the substitution effect due to a higher real wage increase the consumption. Clearly, the net exports, ha, are an increasing function of a (or, equivalently, E/p).

There is no presumption on the relation between h and e. When e is positive, then the domestic output is demand-determined (see (19')). An increase (decrease) in e (E/p) raises consumption because it lowers its effective price (see (18')). At the same time it lowers the fraction of the consumption demand that falls on the domestically-produced goods.

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Therefore whether or not h is rising in e depends on the effective price
elasticity of demand or, equivalently, on the elasticity of marginal
utility. When the price elasticity is high in the absolute value (i.e.,
the elasticity of the marginal utility of consumption, $u''c/u'$, is small
in the absolute value), then output is increasing in e, and vice versa.
One can see from (20)-(20') that the total employment (i.e., in
production and trading) is increasing in a. It is easy to show that, in
general, it is nonmonotonic in e. However, if output is increasing in
e, so is the total employment.

I will now establish the relationships between the levels and
changes in a (e) and the nominal (i) and ex post real interest rates
(ρ). (12), (13), (16)-(16'), (18)-(18'), and the Fischer equation imply
the following chain of equalities:

(23) $i = v'(m)/(1-a^2) =$

$$\overset{(12)}{=} \delta - (\dot{\mu}/\mu) =$$

$$\overset{(18)}{=} \delta - (u''/u')\dot{c} + (\dot{p}/p) \equiv$$

$$\equiv \rho + (\dot{p}/p) =$$

$$\overset{(16)}{=} \delta - 2[(1-a)/(1-a^2+2a)]\dot{a}$$

(23') $i = v'(m) =$

$$\overset{(12)}{=} \delta - (\dot{\mu}/\mu) =$$

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(18')
$$= \delta - (u''/u')\dot{c} + (\dot{p}/p) + 2\dot{e}/(1-e^2) \equiv$$

$$\equiv \rho + (\dot{p}/p) =$$

(18')
$$= \delta + (\dot{p}/p) =$$

(16')
$$= \delta + 2\dot{e}/(1-2e)$$

It will be shown momentarily that a, e and c are monotonically falling on the transition. The third and fourth equalities in (23') can be understood by noting that when e is positive and falling, then an instantaneous ex post real interest rate reflects the discounting of the future (δ), an instantaneous rate of return on consumption, u''c/u', <u>and</u> a capital loss on the real wealth caused by an increase in a effective price of consumption (i.e., a decline in the subsidy), $\dot{e}[-2e/(1-e^2)]$. However, the rate of return on consumption and the capital loss exactly offset each other implying that the real wealth and, consequently, the real interest rate are both constant (the latter remains at the level δ). When a > 0, then the concavity of the function u and the fact that $\dot{c}$ < 0 (to be shown below) jointly imply that on the transition the real interest rate is below the long-run level (see the third and fourth equalities in (23)). The fifth equality in (23) (the sixth in (23')) implies that if a (e) is positive and falling, then the nominal interest

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rate is above (below) the subjective rate of time preference.

The laws of motion of a and e can be derived by substituting (13)

and (16)-(17') into (12). This yields after simplifying:

(24) $\dot{a} = [(1-a^2+2a)]/2(1-a)][\delta - v'(m)/(1-a^2)]$

(24') $\dot{e} = - [(1-2e)/2][\delta - v'(m)]$

where: m is computed using (14)-(14').

The dynamic behavior of the economy is described by the

differential equations (22)-(24) and (22')-(24'), the initial nominal

stock of money, M_0. The steady-state of the system is determined by:

(25) $a^* = e^* = 0$

(26) $M^* = E[(v'^{-1})(\delta)] \equiv m^*E$

(27) says that in the long run the real balances of money are

constant and independent of the price level. Recalling the previous

results, it is easy to see that (26) says that in the steady-state the

trade balance is zero, PPP holds (i.e., E/p = 1), and all the nominal

and real variables are constant. In particular, the nominal and real

interest rates equal the subjective rate of time preference.

It is not difficult to establish that the dynamic system (22)-(24)

and (22')-(24') is saddle-point stable. On the saddle path a (e) moves

in the opposite (same) direction to M.[2] The solutions to the linearized system can be conveniently written as:

(27) $M = M^* + (M_0 - M^*)\exp(\lambda t)$

(28) $a = -\{(M_0 - M^*)/[M^*(1+F)]\}\exp(\lambda t) = \dot{a}/\lambda$

(28') $e = \{(M_0 - M^*)/[M^*(1+F)]\}\exp(\lambda t) = \dot{e}/\lambda$

where: $\lambda = [(v''m^*)/2]\{-1 + [1 - 2h^*/(v''m^*]^{1/2}\} \equiv [(v''m^*)/2](-1+F)$ is the negative (stable) root of the linearized system; note that the number F is independent of E and M_0 and is larger than one; v'' is evaluated at m^*; it follows from (18)-(19') that h^* is implicitly determined by the equation $u'(h^*) = 1$;

These solutions are valid only if a and e lie, respectively, between 0 and 1, and 0 and 1/2. Since on the transition a and e are falling (see the second equalities in (28)-(28')), this requirement needs to be imposed only at time zero. It is easy to verify that a_0 is always below 1. $1 - 2e_0$ is positive if the nominal exchange rate is not too low. Precisely, one needs to impose the following condition:

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    Strictly, the negative slope of the da/dt = 0 curve requires an assumption that the elasticity of the marginal utility of real balances is less than minus one. This is equivalent to the interest rate elasticity of real money demand being larger than minus one. Such assumption is, essentially universally, supported by the international empirical evidence (see e.g., a survey by Goldfeld and Sichel (1990), and a recent work by Hendry and Ericsson (1991)).

(29) $M_0 \left[2/\{(3+F)[(v'^{-1})(\delta)]\} \right] < E$

It follows from the second equalities in both (18)-(18') and (28)-(28') that consumption is falling on the transition. Figure 1 shows the phase diagram. The saddle-path is denoted by SS. Assume that a (e) is initially zero. When E is such that M_0 is below (above) M^* (= $E[(v')^{-1}(\delta)]$), then an adjustment involves an instantaneous upward jump in a (e) followed by a combination of its gradual fall and an increase (decrease) in nominal balances. Notice that a (e), and subsequently all the nominal and real variables, are differentiable everywhere except at time zero where they are right-continuous and right-differentiable.

I will now use (14)-(14') and (27)-(28') to study the transitional behavior of the real balances of money. It has been established above that when a > 0 (e > 0), then both nominal balances and the price level are increasing (decreasing) during the transition (see (14)-(14') and (27)-(28')). Thus, what happens to real balances is not obvious a priori. Solving (27)-(28') for M as a function of a (e) and M^*, and substituting the resulting expression and (14)-(14') into the definition of real balances yields:

(30) $M/p = (M^*/E)[1-a(1+F)]\{[1-a^2+2a]/(1-a^2)\}$

$= m^*[1-a(1+F)]\{[1-a^2+2a]/(1-a^2)\}$

(30') $M/p = (M^*/E)(1+e+eF)(1-2e) =$

$$= m^*(1+e+eF)(1-2e)$$

Differentiation with respect to a (e) gives:

(31) $d(M/p)/da < 0$

(31') $d(M/p)/de \underset{>}{\overset{<}{=}} 0$ for $e \underset{<}{\overset{>}{=}} (F-1)/[4(1+F)]$

The first equality in (23), (28) and (31) jointly imply that when $\dot{a} > 0$ (and $\dot{a} < 0$), then the transition is characterized by the increasing real balances and a falling nominal interest rate. When $\dot{e} > 0$ (and $\dot{e} < 0$), then it follows from the first equality in (23'), (29) and (31) that real balances (the nominal interest rate) are increasing (decreasing) for e relatively high and decreasing for e relatively low.

It remains to establish the behavior of the real interest rate. The only case that needs to be considered is when a > 0 (recall that $\rho = \delta$ when e > 0). Using (18), the fourth equality in (23), and (28) the real rate can be expressed as:

(32) $\rho = \delta - (u''/u')c = \delta + [2a/(1-a^2)]\dot{a} =$

$$= \delta + 2\lambda a^2/(1-a^2)$$

Differentiation yields:

(33) $d\rho/da < 0$

which, given (28) and the (right-hand) continuity of a, means that the
real interest drops on impact and is rising during the transition.
Having solved the model I now move to investigate the effects of the
unanticipated permanent devaluations and revaluations.

3. Unanticipated Permanent Changes in the Nominal Exchange Rate

I assume that the economy is in the steady-state, and consider the
unanticipated permanent changes in the exchange rate from E_1 to E_2.
Obviously, $E_2 > E_1$ means a devaluation, while the opposite inequality
means a revaluation.

An instantaneous impact of a devaluation (revaluation) on a (e)
is obtained by setting t = 0 in (28)-(28'). This gives after
simplifying:

$$(34) \quad 1 > a_{0+} = -[(E_1/E_2)-1]/(1+F) > a_{0-} = 0$$

$$(34') \quad 1/2 > e_{0+} = [(E_1/E_2)-1]/(1+F) > e_{0-} = 0$$

where x_{0-} (x_{0+}) denotes the value of some variable x an instant before
(after) an exchange rate change; the inequality on the LHS of (34') is
true under (29). Actually, given (26), (29) becomes:

$$(35) \quad E_1/E_2 < (1/2)(3+F)$$

that is, the revaluation cannot be too large.

Quite intuitively, (34)-(34') show that the date zero a (e) is

monotonically decreasing (increasing) in the ratio of the old to the new
level of the exchange rate. As expected, a change in E causes an upward
jump in a (e). The devaluation (revaluation) provides an incentive to
redirect sales (purchases) towards the foreign market. Since there are
impediments to trade this redirection is incomplete (i.e., a (e) does
not reach unity). Plugging (34)-(34') into the expressions for the
price level (from (14)-(14')) gives:

(36) $\quad E_2 > P_{0+} = E_2(1-a_{0+}^2)/(1-a_{0+}^2+2a_{0+}) > P_{0-} = E_1$

(36') $\quad E_2 < P_{0+} = E_2/(1-2e_{0+}) \begin{array}{c} < \\ = \\ > \end{array} P_{0-} = E_1 \text{ for } \begin{cases} 1 < z < z_1 \\ z = z_1 \\ z_1 < z < F \end{cases}$

where: $z \equiv E_1/E_2$; $\quad z_1 \equiv (1/2)(1+F)$; $\quad$ notice that $z_1 > 1$;

Thus, upon the devaluation the price level takes an upward jump.
Note, however, that this jump is not nearly enough to reestablish the
Law of One Price. Since trade (and hence goods arbitrage) is costly, a
sluggish adjustment of domestic prices is not surprising. In the
result, the devaluation causes the relative price of domestic-market
goods in terms of foreign-market goods to fall below 1.

I will now show that an initial increase in the price level after
the revaluation is inconsistent with the equilibrium. Suppose the the
price level does jump up. The first equality in (23') implies that the

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nominal interest rate jumps up as well. On the transition, the real interest rate is constant at δ and prices are falling (see (14'), (23') and (28')). Therefore the nominal interest rate is necessarily below the (old as well as new) steady-state level of δ. Given the continuity of e, a contradiction follows. Accordingly, it what follows I limit my attention to small revaluations, i.e., when

(37) $E_1/E_2 < (1/2)(1+F)$

In view of the discussion in section 2, the instantenous and transitory effects of a devaluation and revaluation are clear. These effects are summarized in Table 1. The reader should note that - in contrast to all existing theories of devaluations - in the current model a revaluation is not a reversed devaluation.

As revealed in Table 1, the devaluation is expansionary in that it generates an instantaneous increase in output, consumption, employment and the real wage. This matches exactly the type of an initial boom that Kiguel and Liviatan (1990) document for countries which historically embarked on ERBS. The exception is the behavior of the external accounts. While Kiguel and Liviatan emphasize a deterioration of the trade balance, it is clear that - in the current model - a jump in h and a cause an instantaneous trade surplus. This may not be a totally wrong prediction, after all. The IMF IFS data shows that at least the two archetypical EBRS's, the Brazilian in 1964 and Uruguayan in 1968, were at the early stages associated with a significant improvement of the trade balance. Brazil's net exports increased from $112 million in 1963 to $350 million in 1964, while Uruguay's moved from

minus $12.7 million in 1967 to plus $19.9 million in 1968.

The effects that a devaluation has on output, consumption and trade are exactly the same as in the Keynesian theory (see e.g., Meade (1952)). This comes as no surprise as the source of the nonneutrality is the same here and there: changes in the relative prices due to an incomplete adjustment of the domestic nominal prices. The exact avenues that lead to these results are quite different. The Keynesian theory stresses the demand side. The post-devaluation expansion is demand-driven, while the response of the trade balance depends on the demand elasticities. In particular, with sticky domestic prices a devaluation lowers the relative price of the domestic exportable goods thus raising the foreign imports (= domestic exports). An export boom has a positive multiplicative effect on income, consumption and imports. When the Marshall-Lerner condition holds, the value of exports increases more than the value of imports and the trade balance improves.

The current model highlights the role of the substitution effects on the supply/demand side (i.e., the initial and declining export/import subsidy implied by the convexity of the selling costs) and – only in the case of a devaluation – the wealth effects on the demand side. The behavior of the real exchange rate reflects both the long-run lack of money illusion and the presence of trading costs. The long run neutrality of the level of nominal exchange rate implies that following a devaluation (revaluation) the nominal balances must eventually change in the same proportion as the exchange rate (and thus prices). Without capital mobility the nominal money stock can go up (down) only if the country runs a transitory trade surplus (deficit), i.e., agents temporarily choose to sell (buy) on the foreign market. But as foreign

sales (purchases) involve transaction costs no profit (utility) maximizing firm (agent) would do so if the domestic and foreign prices were the same. It follows that for the foreign sales (purchases) to ever occur in the equilibrium it must be the case that the foreign price is higher (lower) than the domestic price. This explains why a devaluation (revaluation) must bring a real depreciation (appreciation).

The other key element in the model, the dependence of output (consumption) on the real exchange rate, is due to the convexity of the trading costs. As stressed before, the convexity means that the marginal transaction costs are higher than the average costs. Therefore the domestic producers (consumers) effectively earn an export (import) subsidy on the intramarginal units sold (bought) abroad. Recall that the subsidy to production (consumption) is increasing (decreasing) in the real exchange rate. It is easy to show that if the arbitrage costs were linear instead of being quadratic (convex), then there will be no export/import subsidy and hence a devaluation/real depreciation (revaluation/real appreciation) would not affect an aggregate output (consumption). Instead, the adjustment will be borne entirely on the consumption (output) side.

It is the presence and the convexity of the trading costs and the resulting link between the real exchange rate and the aggregate output (consumption) that make this model quite different from the well-known literature which assumes the complete price flexibility and PPP and attributes the short-run nonneutrality of a devaluation to a fall in real wealth caused by the negative "real balance effect" (see e.g., Dornbusch (1973), Calvo (1981), Obstfeld (1986)). As the reader recalls (see (17)-(17') and (34)-(34')), in the current model a devaluation

(revaluation) actually increases (does not change) the real wealth.
That is why a devaluation temporarily lowers the real interest rate.
This is in contrast to Maurice Obstfeld's (1986) finding that when the
post-devaluation negative "real balance effect" dominates, then -
assuming a restricted capital mobility - the real rate increases on
impact.[3] The current model's prediction seems to be validated by the
experience of the Southern Cone stabilizations in the late 1970s (see
Kiguel and Liviatan (1990)).

4. Extensions and Conclusions

I have studied the effects of unanticipated devaluations and
revaluations in a small-open production economy under the assumptions of
capital immobility and impediments to trade. I have demonstrated that
the model can provide a consistent explanation for the stylized facts
about the exchange-rate-based disinflations. As documented by Kiguel
and Liviatan (1990), ERBS's were historically characterized by an early
consumption/output expansion and a subsequent recession. My explanation
stresses the intratemporal and intertempotral substitution effects.
These effects arise due to changes in the relative prices which are, in
turn, caused by the delayed adjustment of the domestic prices of traded
goods to changes in the level of the nominal exchange rate.

I have shown that in the presence of the convex arbitrage costs a
revaluation is not exactly the reversed devaluation. This is in
contrast to all existing theories of devaluations. The model also

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[3]   Obstfeld (1986) has studied an endowment economy. However, it is
easy to show that the result concerning the real interest rate will also
hold in a production version of his model.

explains why the trading costs and the resulting gradual adjustment of the domestic prices of traded goods may be responsible for (the empirically noticeable) failure of many ERBS's in instantaneously stopping inflation. However, it is clear from the analysis that the delayed price adjustment is not necessarily indicative of the terminal inappropriateness of the initially chosen level of the nominal exchange rate. Consequently, hasty government actions to abandon the seemingly unsuccessful ERBS, and try anew may not always be the best strategy.

The principal results in this paper seem rather robust. Qualitatively, they do not depend on the assumed forms of preferences, production technology, and trading costs. As discussed earlier, what is important is the convexity. In particular, my findings remain true as long as the total costs incurred in selling (buying) ha (ce) units abroad are given by some function $k(a)h$ $(k(e)c)$ where k is increasing, convex, and such that $k(0) = 0$ (in the current model $k(a) = a^2$).

The model can be straightforwardly extended by introducing the nontraded goods. Under the usual assumption of the decreasing marginal rate of transformation (i.e., a concave production frontier) the striking new result is that a devaluation (revaluation) initially causes a decrease (decrease) in the relative price of the traded goods in terms of the nontraded goods. The argument is as follows. Denote by q the domestic price of the home goods. I have shown earlier that the devaluation causes an upward jump in a and E/p. This implies that the relative price of traded goods in terms of the nontraded goods faced by the domestic consumers equals p/q, while that faced by the domestic producers equals $p(1+s)/q$, where the second term in the bracket is the export subsidy. Since the export subsidy is equivalent to a tax on the

production of home goods, there is a decrease in the supplied quantity of the home goods at any level of q/p. This combined with a positive income effect caused by an output boom in the traded goods sector imply an instantenous increase in q/p (a drop in p/q). Recalling the positive relationship between the real exchange rate and the export subsidy, it is clear that over time p/q gradually increases thus returning to its long run level. Incidentally, evidence in Kiguel and Liviatan (1990) shows that ERBS's were, essentially always, accompanied by a real appreciation. In particular, this was true in the Brazilian stabilization in 1964 and the Uruguayan in 1968.

Similarly, in the case of a revaluation an import subsidy to the consumption of traded goods decreases the quantity of the nontraded goods demanded at any level of q/p. Consequently, q/p goes down on impact and increases during the transition.

As one can see, the finding that a devaluation (revaluation) leads to a combination of a trade surplus (deficit) and a decrease (increase) in the relative price of the traded goods in terms of the nontraded goods is critically dependent on the presence and convexity of the arbitrage costs. It is clear that if PPP holds at all times, then a devaluation (revaluation) must cause an increase (decrease) in p/q. This is because of either the negative (positive) "real balance effect" (see Dornbusch (1973)), or the short run price stickiness in the home goods sector (see Jones and Corden (1976)).

However striking, the preceding argument about the negative comovement of E/p and p/q cannot be dismissed by the available empirical evidence. Several empirical studies have found that, historically, the nominal devaluations most often led to the real devaluations (see e.g.,

Krueger (1974) and Edwards (1989)). These studies derive their findings by looking on the pre- and post-devaluation behavior of the real exchange rate. The latter is computed by multiplying the nominal exchange rate by the ratio of the foreign price level to the domestic price level. Suppose that the domestic CPI can be written in the usual Cobb-Douglas form, $p^{1-\alpha}q^{\alpha}$, where α is a number between zero and one. Then the index of the real exchange rate equals the foreign price level times $(E/p)(p/q)^{\alpha}$. It is clear that in the absence of PPP an increase in this index following a nominal devaluation does not say anything about the behavior of p/q.

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Table 1

The Effects of a Devaluation and a Revaluation

variable	Devaluation		Revaluation	
	Impact Effect	Transition	Impact Effect	Transition
h	+	−	?	?
c	+	−	+	−
n	+	−	?	?
E/p	+	−	−	+
w/p	+	−	0	0
M/p	−	+	+	?*
i	+	−	−	?*
ρ	−	+	0	0

Note: * As explained in the text, the real balances (the nominal interest rate) may be initially increasing (decreasing) during the transition. However, this is reversed when e becomes relatively small.
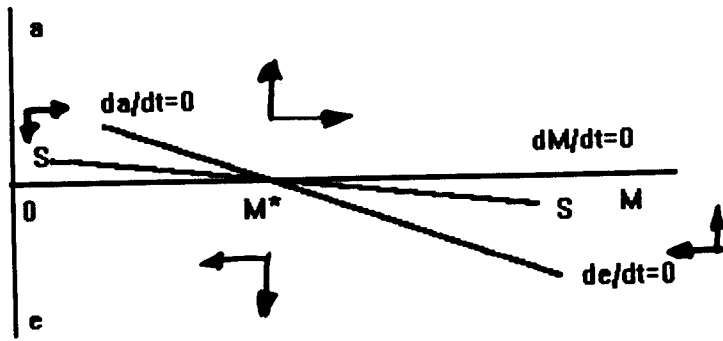
Figure 1

Dynamics of a, e, and M