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The Real Exchange Rate Always Floats

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Abstract

This paper makes two main points. First, irrespective of nominal exchange rate arrangements, the real exchange rate always floats – if not through nominal exchange rate adjustment, then through price change. Further, because prices and wages tend to be sticky, the adjustment of real exchange rates towards long-run equilibrium takes time, as witnessed by long-lasting currency misalignments around the world. In second place, real exchange rates are rather likely to fluctuate on their way towards long-run equilibrium because of the dynamic interaction between real exchange rates and the current account or, put differently, because the structure of lags with which exchange rates impact the volume of exports and imports may give rise to oscillatory behavior.

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I. Introduction

The exchange rate of a currency is a relative price and, therefore, a real phenomenon. Changes in relative prices affect economic behavior; they have real effects on economic performance, including economic growth over long periods. I am not referring here to the *real* exchange rate. No, I mean the exchange rate – the *nominal* exchange rate, that is.

The exchange rate is the relative price between domestic and foreign moneys. Viewed in this light, the exchange rate is clearly a monetary phenomenon, by definition. But even so, it can have real effects. Inflation, to take a related example, may or may not be a monetary phenomenon; this can vary from case to case and place to place. Because it is, or reflects, a relative price — that between nominal and real assets — the rate of inflation can have real effects, and experience suggests that it does. Recent empirical evidence indicates that inflation in excess of 40 percent per year (Bruno and Easterly, 1998), or even 10 to 15 percent per year (Gylfason and Herbertsson, 2001), goes along with less rapid long-run economic growth across countries. Khan and Senhadji (2001) suggest an even lower threshold beyond which inflation begins to hurt growth, or one to three percent a year for industrial countries compared with 11-12 percent for developing countries. Those who insist that inflation cannot possibly be relevant for growth because inflation is a monetary phenomenon and growth is real (see, for example, Sala-i-Martin, 1991) appear to overlook the fact that inflation is a relative price, as Fischer (1993) has emphasized, among others.

The same applies to the exchange rate. This is why nominal exchange rate regimes make a difference around the world – that is, why it matters whether countries fix the exchange rates of their currencies or allow them to float freely. After all, if nominal exchange rates did not matter, that is, if the fact that they are nominal made them neutral, then how they are set would make no difference for economic performance. But this is clearly not the case: nations do care about the way the nominal exchange rates of their currencies are determined because different exchange rate regimes are correctly perceived to

have different real economic implications. To take but one example, the European Union has recently adopted a common currency, thereby eliminating once and for all internal fluctuations in currency rates within the Union in the hope of encouraging trade and investment within Europe, while at the same time allowing the exchange rate of the euro to float vis-à-vis the U.S. dollar, yen, and other foreign currencies so as to benefit from the flexibility afforded by floating rates. This, of course, is how the United States has arranged its monetary affairs within its borders since independence.

This paper is intended to make two main points about real exchange rates in the long run. First, whether the nominal exchange rate is fixed or floats, the real exchange rate always floats. So if the nominal exchange rate is nailed to the floor, then the price level at home must adjust vis-à-vis prices abroad so as to bring the real exchange rate closer to some sort of equilibrium. In this sense, the real exchange rate of the Hong Kong dollar, for instance, is very much afloat, even if the nominal rate is fixed by means of Hong Kong's currency board. Further, the adjustment of real exchange rates towards long-run equilibrium takes time, as witnessed by long-lasting currency misalignments across the world. For example, persistent overvaluation is a common phenomenon in many countries, especially in Latin America and Africa, sometimes as a result of a conscious government policy aimed at keeping foreign exchange as cheap as possible. The second point is that real exchange rates are rather likely to fluctuate on their way towards long-run equilibrium because of the dynamic interaction between real exchange rates and the current account or, put differently, because the structure of lags with which exchange rates influence the volume of exports and imports may give rise to oscillatory dynamics.

The paper is organized as follows. Section II discusses briefly the relationship between real and nominal exchange rates and then compares and contrasts the chronic overvaluation of many African currencies with that of the Japanese yen. Section III demonstrates how oscillatory real exchange rate movements can arise from a dynamic feedback relationship between real

exchange rates and the current account and discusses the empirical plausibility of oscillations from this source. Section IV offers some concluding remarks.

II. Floating takes time

If nominal exchange rates were neutral, it would make little difference whether they are fixed by fiat or flexible. But exchange rates are not neutral: most often, the reason is that prices are sticky. For this reason, changes in nominal exchange rates are not immediately neutralized through compensating price movements. Therefore, nominal exchange rate changes make the real exchange rate also move. This is why devaluation often works as intended, at least for a while, that is, as long as it takes prices to become unstuck. And this is why nations are right not to be indifferent about the way the exchange rates of their currencies are determined.

There are two different ways to define the real exchange rate: $R_p = ep/p^*$ and $R_w = ew/w^*$, depending upon deflators. Here R is the real exchange rate, e is the nominal exchange rate (defined as the price of domestic currency in terms of foreign currency, so that a rise in e reflects nominal appreciation), p is a domestic price index, and w is a domestic unit cost index. An asterisk denotes the corresponding price and unit cost indices abroad. It follows from these definitions that real exchange rate movements depend crucially on the behavior of prices and wages at home and abroad.

Even if prices were not sticky, wages often are, especially in countries with centralized wage bargaining in imperfectly competitive labor markets. Such labor market arrangements are common in Europe, Australia, and around the world. Therefore, devaluation can often be relied on to reduce real wages for at least as long as it takes nominal wages to adjust in full to the price increase that follows the devaluation, and thus to increase corporate profits at the expense of labor. Indexation of wages to prices reduces the effectiveness of devaluation, true, but the real exchange rate, defined either way, will still react as long as the indexation is not full and instantaneous (Williamson, 1985). In other words, as long as wages adjust to prices with a lag, the real wage will vary inversely

with the rate of inflation. Therefore, as long as wages adjust to prices with a lag, the reaction of prices to a change in the exchange rate will also take time. This means that the real exchange rate, like the real wage, will react to inflation: the higher the inflation rate, the higher the real exchange rate. Why?

Here is why. Suppose the real exchange rate is 100 at the beginning of the year and inflation is 10 percent per year and none in the rest of the world, so that the real exchange rate rises gradually to $100 \cdot 1.1 = 110$ at the end of the year. Further, suppose the nominal exchange rate adjusts fully to prices with a one-year lag (as might happen with a crawling peg, for example), so that the real exchange rate is restored to 100 at the beginning of next year. Therefore, the average value of the real exchange rate index over the year is $(100 + 110)/2 = 105$. Now suppose inflation goes up to 20 percent per year, so that the real exchange rate increases gradually to $100 \cdot 1.2 = 120$ at year's end. The average value of the real exchange rate index over the year is now $(100 + 120)/2 = 110$. The average real exchange rate is thus directly proportional to the inflation rate as long as the nominal exchange rate does not adjust fully and instantaneously to prices. Hence, inflation has real effects: high inflation biases the real exchange rate upwards – that is, against exports – and thus inhibits economic specialization, efficiency, and growth. Further, if prices *are* sticky, devaluation sways the real exchange rate in favor of export industries as well as those that compete with imports, at the expense of industries that are shielded from foreign competition.

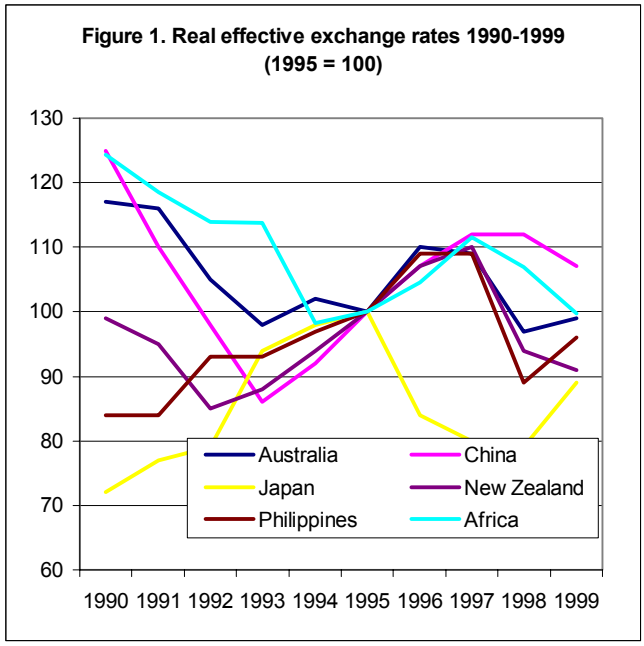
The main point, however, is this. The real exchange rate is a relative price, and reacts to changes in demand and supply in foreign exchange markets as relative prices are supposed to do. The real exchange rate does not have to match supply with demand from year to year, but in the long run it will tend to do so. Put differently, national price levels need not be equal from year to year when expressed in a common currency, but, if left alone, they will gradually gravitate towards equilibrium: in the very long run, presumably, some kind of purchasing power parity will prevail across countries, even if the available empirical evidence on this point is a bit vague (Rogoff, 1996).

Currency misalignments can be viewed as deviations from purchasing power parity. However, due to transactions costs in international arbitrage, it does not always pay currency traders to try to exploit and thereby correct deviations from fundamentals; hence, misalignments can persist. Rogoff (1996) reports that the half-life of deviations from purchasing power parity is about five years. Taylor, Peel, and Sarno (2001) find less persistence, with half-lives of deviations from purchasing power about of two years.

Countries that tend to import more goods and services than they export will see their currencies depreciate in real terms over time, while countries that export more than they import will experience real appreciation. For example, in all but four of the 17 sub-Saharan African countries for which the World Bank publishes real effective exchange rate indices, the real effective exchange rate depreciated in the 1990s. The average rate of real depreciation in these countries was eight percent from 1990 to 1999 (The Democratic Republic of Congo is left out of the arithmetic), and it was 16 percent if we also disregard Equatorial Guinea where recent oil discoveries have boosted gross national product (GNP) per capita by 16 percent per year on average since 1990, a world record. In Japan, by contrast, the yen appreciated by 24 percent in real terms during 1990-1999.[1] This appreciation was far from smooth, however, and this is another important feature of real exchange rates: they not only float but also fluctuate. Figure 1 describes the movements in real effective exchange rates in the group of 15 African countries referred to above[2] as well as in Japan, China, the Philippines, Australia, and New Zealand for comparison. The pattern is the same everywhere: real exchange rates move up and down.

[1] Source: Author's computations based on World Bank, *World Development Indicators* 2001, Washington, D.C.

[2] The countries are Burundi, Cameroon, The Central African Republic, Côte d'Ivoire, Gabon, The Gambia, Ghana, Lesotho, Malawi, Nigeria, Sierra Leone, South, Togo, Uganda, and Zambia.



Exchange rates are, understandably, a sensitive issue. In some languages, even the term used for "exchange rate" is loaded. In Icelandic, the word we use for the exchange rate is synonymous with success or fortune (the Icelandic word is "gengi, " related to "going" in English, as in "How is it going?"). Devaluation and depreciation have a similar connotation in English, of course, suggesting as they do declining fortunes. When the national currency is devalued or when it depreciates, national income measured in foreign currency decreases proportionately. Living standards deteriorate. Governments, therefore, have a vested interest in maintaining high exchange rates that make living standards at home appear to be higher than they really are. High exchange rates sometimes signal that the currency is overvalued, but not always. The explanation may be structural: a chronically high exchange rate – high, for instance, in the sense that export industries languish and foreign debt piles up, as in many parts of Africa, or high in the sense that home-made inefficiency makes prices at home consistently higher than prices of similar goods and services abroad – may thus be an equilibrium outcome that can be sustained over long periods.

Take Africa first. Following independence in the 1960s, many African countries chose to base their economic organization on some form of central planning. This strategy involved, among other things, extensive government interference in price determination. Marketing boards kept export prices to local farmers below world market prices, central banks maintained interest rates below inflation rates, and exchange rates were likewise kept above foreign exchange market equilibrium – that is, currencies were systematically overvalued – in an attempt to secure cheap foreign exchange for importers, especially those who import foreign inputs into production. To be sure, part of the rationale behind this deliberate strategy of overvaluation was no doubt the power that accrued to those who were given the authority to allocate scarce foreign exchange and thus to discriminate among competing customers. It was the same with the state banks: political authorities found it convenient to keep real interest rates negative because of the power it gave them to ration scarce loanable funds. The unintended consequences were not surprising: low saving and investment, sluggish exports, mounting external debts, and slow economic growth, not only because the financial repression and overvaluation punished the export industries and those competing with imports but also, more generally, because government interference in price determination in financial and foreign exchange markets and elsewhere almost invariably breeds inefficiency that impedes economic growth. Overvaluation thus damages economic efficiency and growth in two distinct ways: directly though suppressed exports and imports and indirectly through its frequent association with other market distortions, not least negative real interest rates that suppress saving, investment, and growth. Stein (2002) reaches a similar conclusion by establishing a link between the real exchange rate and investment through Tobin's q-ratio.

The linkage between economic efficiency and growth that I have in mind is the following. Liberalization of prices and trade, in Africa and elsewhere, relaxes the economic distortions that result from excessive interference in free markets and free trade, and thus increases not only economic efficiency but

also economic growth across countries and over time. The same applies to privatization, which eases the distortions associated with excessive state ownership of enterprises; stabilization, which reduces the distortions that stem from excessive inflation; and even education, which aims to diminish the distortions that follow from insufficient investment in human capital. Empirical evidence seems to support these hypotheses. Increased efficiency empowers nations to squeeze more output from given inputs, as if an improvement in technology had taken place. Efficiency gains are thus tantamount to technological improvements, or technological progress in continuous time. Moreover, increased efficiency often encourages technological progress. For instance, increased foreign trade and investment, which generate both static and dynamic efficiency gains, tend to go hand in hand with increased exchange of ideas, know-how, and technology, thus imparting a double boost to economic development over long periods.

What is the empirical evidence concerning overvaluation and economic growth? Overvaluation is hard to gauge precisely, but let us for the sake of the argument use the average current account deficit relative to gross domestic product (GDP) from 1990 to 1999 as a rough guide to the extent of overvaluation: the more overvalued the currency, the larger the deficit, other things being the same. The average current account deficit in sub-Saharan Africa in the 1990s was seven percent of GDP compared with four percent outside Africa. So, we should not be surprised to find out that the average ratio of exports to GDP, a rough measure of openness to trade, was 30 percent in Africa over the same period compared with 40 percent outside Africa. Economic growth, needless to say, was less rapid in Africa than in the rest of the world: the average rate of growth of GNP per capita in the 1990s was 0.2 percent in Africa compared with 1.3 percent in the rest of the world (and 1.0 percent in the world as a whole).[3]

In retrospect, floating exchange rates would probably have served Africa better. The real exchange rate always floats, of course, but sometimes too

[3] Source: World Bank, *World Development Indicators* 2001.

slowly: greater flexibility in African exchange rates would have resulted in more rapid adjustment, less persistent overvaluation, more exports (and imports!), and more rapid economic growth. It does not seem likely that greater exchange rate flexibility *per se* would have ignited extra inflation on a continent where inflation has remained high in many countries mainly because of insufficient financial depth and not enough discipline either in monetary and fiscal affairs.

The choice of an exchange rate regime, however, should never be made once for all; rather, the choice should be dictated by time and circumstance (Frankel, 1999). When inefficiency stands in the way of economic growth, as it does in Africa and many other places, increased exchange rate flexibility can sometimes play an important role in uprooting the inefficiency and laying a foundation for more rapid growth. This was, for example, an integral element of the quite successful though far from complete liberalization of the Icelandic economy in the 1960s (Gylfason, 2001). When, on the other hand, inflation constitutes a serious impediment to economic growth, fixing the exchange rate for a while can be a good idea, perhaps even indispensable. When both inefficiency and inflation are serious problems, however, as is quite common in Africa, the choice is not so clear: then an intermediate solution of some sort may be called for (Williamson, 2000; Corden, 2002).

Now take Japan. The yen has been overvalued, or at least high, for a long time. How do we know this? Not by looking at Japanese monetary or balance of payments statistics. No, we know this because Japan's per capita GDP seems to be overvalued at the current market exchange rate of the yen. Japan's purchasing-power-parity adjusted GDP per capita is much (specifically, almost a fourth) lower and more accurately reflects the living standards of the Japanese compared with other nations. Viewed this way, the real exchange rate is simply the ratio of officially registered GDP to purchasing-power-parity adjusted GDP, and is thus clearly a real phenomenon. Even if Japan's current account has consistently been in surplus for many years (the surplus averaged 2.4 percent of GDP per year in the 1990s), the overvaluation, or high exchange

rate, of the yen has stunted export growth and probably economic growth as well. Japan remains a remarkably closed economy: its exports amounted to 10 percent of GDP on average in the 1990s. This is one of the lowest export ratios on record. Only six countries exported less than Japan in the 1990s relative to GDP: Myanmar (one percent), French Polynesia (three percent), Rwanda (six percent), Brazil (nine percent), Argentina (nine percent), and Burundi (nine percent). At ten percent, Japan's export ratio was tied with those of Haiti, Uganda, and Bangladesh. All other countries export more than this relative to GDP. Also, Japan's per capita economic growth was remarkably sluggish in the 1990s, or 1.1 percent per year on average, very close to the world average.

How does Japan's overvaluation differ from that in Africa? Here the plot thickens a bit. Africa's overvaluation is the result of fixed exchange rates that were kept deliberately above market-clearing levels and of lax fiscal and monetary policies and immature financial markets that fuelled inflation, further contributing to the overvaluation in real terms. Japan's situation is completely different: the yen is afloat and monetary and fiscal policies have been sufficiently restrained – some say far too restrained! – to keep inflation at 0.1 percent per year on average in the 1990s. So where does Japan's overvaluation come from? It appears to come from the deeply ingrained inefficiency in domestic production and distribution that has kept Japanese prices and costs in many areas far above those abroad. Japan's restrictive farm policy regime is a case in point. Persistently high prices and costs and the protectionist policy stance that keeps them high tend to perpetuate the overvaluation. In such a situation, however, as indicated before, it is a matter of taste and terminology whether the currency should be described as overvalued or simply strong, or, put differently, whether the exchange rate is "too high" or just "high."

The natural real exchange rate (NATREX) model sheds light on this problem (see, for example, Stein, 2002). This model is, in essence, economic in contradistinction to the econometric behavioral equilibrium exchange rate (BEER) model that lets the data dictate the modeling and economic theory take

the back seat. Two of the main implications of the natural real exchange rate model are that (a) increased productivity leads to real appreciation of the currency in the long run and (b) increased expenditure ("social consumption") leads to real depreciation in the long run. Hence, high-productivity, low-expenditure countries should have strong currencies and low-productivity, high-expenditure countries should have weak currencies. Japan is probably best described as a (yet not very) low-productivity, low-expenditure country, and thus does not fit neatly into either category. Many African countries, on the other hand, are clear cases of low productivity and high expenditure and, accordingly, have weak currencies that their governments try their best to keep artificially high to the detriment of their economic development. When exchange rates are high because the fundamentals are weak, high exchange rates and low incomes usually go hand in hand.

Hong Kong, Korea, Singapore, and Taiwan are equally clear cases of high productivity and low expenditure and, therefore, have had strong currencies, the financial crash of 1997-1998 notwithstanding. In Hong Kong, a strong currency with a firmly fixed exchange rate has necessitated real exchange rate adjustment through inflation that, at five percent per year on average in the 1990s, has been consistently higher than among Hong Kong's main trading partners. Without the inflation, Hong Kong's strong fundamentals would have driven the real exchange rate of the Hong Kong dollar to unacceptable and unsustainable heights.

The Hong Kong story is a healthy reminder that a currency board is no panacea against inflation. On the contrary, in a high-productivity, low-consumption country like Hong Kong, an immutably fixed exchange rate can be a prescription for moderate inflation that is nevertheless rapid enough to keep the real exchange rate close to long-run equilibrium. But such inflation – inflation that results from efficient economic organization and rapid growth – is essentially harmless unless perhaps it skews the distribution of income and wealth, and this does not seem to have happened to any major extent in Hong Kong or elsewhere in East Asia for that matter. In most cases, the main reason

why inflation is undesirable is that it inhibits economic efficiency and growth. In countries such as Hong Kong where the inflation is a consequence of strong fundamentals that fuel rapid economic growth this reasoning does not apply. When exchange rates are high because the fundamentals are strong, as in Hong Kong, high exchange rates and high incomes are likely to go hand in hand.

Singapore, where the fundamentals seem no less strong than in Hong Kong despite many differences in economic organization and strategy, provides a telling contrast: the Singapore dollar has been allowed to float, within limits, and there has for that reason been no need for domestic inflation to keep the real exchange rate at manageable levels. The average inflation rate in Singapore in the 1990s was 1.6 percent per year. And economic growth has been strong: 4.7 percent per year on average from 1990 to 1999, as in Korea, compared with 1.9 percent in Hong Kong. For more on Hong Kong and Singapore, see Rajan and Siregar (2002).

III. Fluctuations

The experience with floating exchange rates around the world since the end of the Bretton Woods era has shown that they have a tendency to fluctuate, in the short run as well as over extended periods (recall Figure 1). Many explanations of exchange rate fluctuations in the short run have been suggested in the literature, involving the volatility of financial asset flows, random shocks, overshooting, speculation, expectations, and so on. This type of short-run exchange rate variability is well documented; for an early survey, see Schadler (1978). Almost from the outset of the great debate of the benefits and costs of fixed versus floating exchange rates, and in spite of Friedman's (1953) view of stabilizing speculation, the lack of a stable anchor of monetary policy and the attendant exchange rate instability were identified as a major potential drawback of flexible exchange rates (as opposed to inflation targeting), even if it was recognized that a flexible exchange rate regime could eliminate balance

of payments problems once and for all and thereby help sharpen the focus of monetary policy on maintaining low inflation at home.

Here, however, I want to take the cue from Stein and Allen (1995) and discuss briefly why long swings in real exchange rates are also to be expected in view of the time it may take exchange rate changes to have their full effects on exports and imports. This explanation involves a simple dynamic extension of the time-honored elasticities approach to the current account of the balance of payments and to exchange rate determination. The approach taken below is in the old tradition of flow equilibrium, and bypasses the complications that can arise as real exchange rates gravitate towards stock equilibrium. Herein lies a dilemma: the real exchange rate is a relative price that, under ideal conditions, should be expected to find its way simultaneously to both flow equilibrium and stock equilibrium in today's world with liberalized capital movements that dominate real exchange rate fluctuations in the short to medium term. This dilemma can be a recipe for disequilibrium some of the time in at least one of the two markets, that is, the flow market.

First, let me set the stage by showing how real exchange rate oscillations can be generated in continuous time in the simplest possible way.[4] Let the change in the real exchange rate dR/dt vary directly with the trade balance B:

$$(1) \qquad \frac{dR}{dt} = B$$

A rise in R reflects real appreciation. Both R and B can be logarithms. Equation (1) tells us that an export boom makes the currency appreciate in real terms, while a surge in imports makes the currency depreciate in real terms. Let the change in the trade balance dB/dt vary inversely with the real exchange rate R:

$$(2) \qquad \frac{dB}{dt} = -R$$

Equation (2) tells us that real depreciation improves the trade balance, so that the Marshall-Lerner condition is satisfied.

[4] I am indebted to Jerome Stein for the trigonometric formulation in the text.

The solution to equations (1) and (2) is given by equations (3) and (4):

(3) $B(t) = \cos(t)$

(4) $R(t) = \sin(t)$

Both variables oscillate steadily. Equation (4) replicates real exchange rate oscillations around purchasing power parity because the real exchange rate revolves around a constant zero mean. My main point in this section – that market-clearing real exchange rates tend to fluctuate – thus having been made, I could stop here, but let me still develop the argument a little further.

I first want to show that the Marshall-Lerner condition for static stability in the foreign exchange market is necessary and sufficient for exchange rate fluctuations to occur when exchange rate changes influence the volume of exports and imports immediately as well as with a one-period lag. A brief review of empirical estimates of price elasticities in world trade suggests that they are generally large enough for the necessary and sufficient conditions for stable exchange rate fluctuations to be satisfied. While the algebraic exercises to follow are inevitably quite mechanical, they, like the trigonometric example above, may perhaps offer a partial explanation for the persistent gyrations that continue to characterize foreign exchange markets around the world.

A change in the real exchange rate e is assumed to influence this and next period's exports X and imports M and the income and price elasticities are taken to be constant:

(5) $X_t = a_0 Y_t^{*a_1} e_t^{a_2} e_{t-1}^{a_3}$

(6) $M_t = b_0 Y_t^{b_1} e_t^{-b_2} e_{t-1}^{-b_3}$

Here Y^* and Y are foreign and domestic income and all the parameters are positive. The subscript t denotes time. Further, let us abstract from capital movements and impose the long-run condition that the exchange rate moves so as to keep the current account of the balance of payments in equilibrium:

(7) $B_t = X_t - e_t M_t = 0$

Now, the exchange rate is determined by current exports and imports, which in their turn depend on last period's exchange rate, among other things. Therefore, a shock to the system (for example, a change in income at home or abroad) affects the exchange rate not only in the current period but in all future periods as well.

The behavior of the exchange rate over time can now be studied by substituting equations (5) and (6) into equation (7), arranging terms and taking logarithms in order to obtain a first-order difference equation:

$$(8) \qquad \ln(e_t) = -\left[\frac{a_3 + b_3}{a_2 + b_2 - 1}\right]\ln(e_{t-1}) + c$$

Here $c = \ln(b_0) + b_1 \ln(Y_t) - \ln(a_0) - a_1 \ln(Y_t^*)$.

If the simple Marshall-Lerner condition is satisfied in the current period (that is, if $a_2 + b_2 > 1$), the coefficient on $\ln(e_{t-1})$ in equation (8) is negative, implying oscillations in the real exchange rate over time. These oscillations are stable or, more precisely, damped as long as this coefficient is less than one in absolute value, that is, as long as

$$(9) \qquad a_2 + b_2 > 1 + a_3 + b_3$$

This condition is clearly stronger than the simple Marshall-Lerner condition. The larger the lagged effect relative to the immediate effect, the smaller is the likelihood of stable oscillations.

The reasoning behind these results is really quite simple. If depreciation of the currency improves the current account of the balance of payments in the current period, that improvement causes appreciation in the next period, which in turn weakens the current account so that the currency depreciates again in the period thereafter and so forth. The oscillations are automatic: the real exchange rate goes up one period and down the next, and the process repeats itself with unrelenting regularity, a rather implausible pattern of real exchange rate movements in real life. If, on the other hand, depreciation happens to weaken the current account in the current period because the price

elasticities are small, the deterioration leads to further depreciation in the next period and so on. In this case, the adjustment is monotonic.

To enrich the lag structure a bit to see what happens, the export and import equations (5) and (6) can now be rewritten as

(10) $X_t = a_0 Y_t^{*a_1} e_t^{a_2} e_{t-1}^{a_3} e_{t-2}^{a_4}$

(11) $M_t = b_0 Y_t^{b_1} e_t^{-b_2} e_{t-1}^{-b_3} e_{t-2}^{-b_4}$

Substituting equations (10) and (11) into equation (7) as before now yields a second-order difference equation:

(12) $$\ln(e_t) = -\left[\frac{a_3 + b_3}{a_2 + b_2 - 1}\right]\ln(e_{t-1}) - \left[\frac{a_4 + b_4}{a_2 + b_2 - 1}\right]\ln(e_{t-2}) + c$$

In this case, oscillations will occur if

(13) $$\left[\frac{a_3 + b_3}{a_2 + b_2 - 1}\right]^2 - 4\left[\frac{a_4 + b_4}{a_2 + b_2 - 1}\right] < 0$$

Therefore, the simple Marshall-Lerner condition, $a_2 + b_2 > 1$, is still necessary but no longer enough to generate oscillations in the adjustment path of the exchange rate. The lag structure in equations (10), (11), and (12) produces longer swings in the real exchange rate than the simpler structure in equations (5), (6), and (8) – that is, swings that can now, somewhat more plausibly, extend over several periods. Longer lags that result in third-order linear difference equations for the equilibrium real exchange rate, or higher, would produce more complicated albeit just as mechanical patterns but they would also render the algebraic analysis intractable. Like before, stability requires that the coefficient on $\ln(e_{t-2})$ in equation (12) be smaller than one in absolute value, that is, that $a_2 + b_2 > 1 + a_4 + b_4$ if the simple Marshall-Lerner condition is satisfied in the current period.

A full set of necessary and sufficient conditions for stability in equation (12) can be shown to be as follows: $a_2 + b_2 + a_3 + b_3 + a_4 + b_4 > 1$,

$a_2 + b_2 > 1 + a_4 + b_4$, $a_2 + b_2 + a_4 + b_4 > 1 + a_3 + b_3$; see, for example, Gandolfo (1971, 56).

In sum, the behavior of floating exchange rates over time can be affected by the lag structure of the effects of real exchange rate changes on the current account. Whether this is likely to occur in practice or not is an empirical question to which we now turn.

Quantitative estimates of price elasticities in world trade are plentiful in the literature. By and large, these estimates suggest that the price elasticities of exports and imports are large enough for depreciation to improve the current account as intended within a fairly short time. However, these estimates are typically static, not dynamic: they mostly refer to long-run effects without an attempt having been made to estimate the lag structures involved. Even so, it seems reasonable to suppose that the effects of real exchange rate changes on the volume of trade take time to materialize in full. This conjecture appears consistent with what little evidence there is of lags: Gylfason's (1978) average estimate of the sum of the price elasticities of exports and imports in nine industrial countries based on monthly data from 1971-1977 is 1.66, and is lower than Goldstein and Khan's (1976, 1978) sum of estimates, 2.32, based on quarterly data from the same countries in 1955-1973, and is also lower than Stern's *et al*. (1976) sum of "best" estimates of long-run elasticities, 2.18, based on the approximate median of several estimates. The empirical literature on price and income elasticities in world trade is large, and is neatly summarized by Goldstein and Khan (1985), but it went out of fashion when the monetary approach to the balance of payments became popular in the 1980s.

Table 1 provides a summary of empirical estimates of the long-run price elasticities of exports and imports in 15 industrial countries and nine developing countries. These estimates suggest that the simple Marshall-Lerner condition is easily satisfied in all the countries represented in the table as is required to generate real exchange rate fluctuations, see equation (8). On average, the estimates of the sum of the elasticities lie between 1.5 and 2.5 in the industrial countries and between 1.5 and 4.1 in the developing countries.

The difference is perhaps not surprising: poor countries have a stronger incentive than rich countries to adjust to currency depreciation by curtailing imports and increasing exports. Rich countries can perhaps afford not to economize on the use of foreign exchange when its price rises; poor countries cannot, at least not to the same extent. Thus, for example, developing countries are likely to do more than industrial countries to reduce their dependence on imported oil when its price rises in world markets.

Table 1. Elasticity of demand for exports and imports of 15 industrial countries and nine developing countries

	Elasticity of demand for exports	Elasticity of demand for imports
Industrial countries		
Austria	1.02	1.23
Belgium	1.12	1.27
Canada	0.68	1.28
Denmark	1.04	0.91
France	1.28	0.93
Germany	1.02	0.79
Iceland	0.83	0.87
Italy	1.26	0.78
Japan	1.40	0.95
Netherlands	1.46	0.74
Norway	0.92	1.19
Sweden	1.58	0.88
Switzerland	1.03	1.13
United Kingdom	0.86	0.65
United States	1.19	1.24
Average	1.11	0.99
Developing countries		
Argentina	0.6	0.9
Brazil	0.4	1.7
India	0.5	2.2
Kenya	1.0	0.8
Korea	2.5	0.8
Morocco	0.7	1.0
Pakistan	1.8	0.8
Philippines	0.9	2.7
Turkey	1.4	2.7
Average	1.1	1.5

Source: Reproduced from Gylfason (1987).

What do the data say about the lag structures involved? Not much. Deppler and Ripley (1977) and Goldstein and Khan (1978) report that the long-run effects of price changes on imports and exports are about 1.8 times the short-run effects. Their studies are based on samples of 14 and eight industrial countries, respectively. Moreover, the two studies suggest that the price effects are felt quite quickly. Deppler and Ripley (1977) find that 50 percent of the long-run price effects materialize within a year, while Goldstein and Khan (1978) report that it takes only a quarter for a half of the long-run effects to materialize. In the above model, this means that the implicit estimates of the sum $a_3 + b_3$ are generally smaller than those of $a_2 + b_2$ as is necessary, but not enough, for the real exchange rate fluctuations to be stable, see equation (8).

In conclusion, the empirical evidence reviewed above seems consistent with the hypothesis that real exchange rate fluctuations can in practice as well as in principle stem from a dynamic feedback relationship between exchange rates and the current account. If so, such fluctuations may or may not be stable. Even so, the above argument must not be taken literally because in practice real exchange rates do respond to a variety of economic forces other than their own historical path.

IV. Conclusion

The real exchange rate always floats, and it fluctuates as well. Sometimes, nominal exchange rate movements dominate these fluctuations, as Stein (2002) has shown to be the case with the real exchange rate of the euro. More often, however, movements in real exchange rates reflect changes in relative prices and costs at home and abroad as well as in nominal exchange rates. When the nominal exchange rate is held fixed, as in Hong Kong, for example, relative price changes – in Hong Kong's case, through domestic inflation that is higher than inflation abroad – play a key role in keeping the real exchange rate in the neighborhood of long-run equilibrium. In this sense, the real exchange rate of the Hong Kong dollar is flexible, even if the nominal rate is firmly fixed through a currency board.

The fluctuations observed in real exchange rates on their way towards long-run equilibrium have been traced to several sources that have been clearly laid out in the literature: random shocks, shifts in expectations, policy changes, external developments, and so forth. Another possible explanation proposed here involves dynamic interaction between real exchange rates and trade flows or, equivalently, the structure of lags with which real exchange rates may influence foreign trade. It was demonstrated how this interplay in continuous time and lagged effects of real exchange rates on trade flows in discrete time can result in oscillatory exchange rate dynamics.

References

Bruno, Michael, and William Easterly (1998), Inflation Crises and Long-Run Growth, *Journal of Monetary Economics*, 41, February, 3-26.

Corden, W. Max (2002), *Too Sensational: On the Choice of Exchange Rate Regimes*, MIT Press, Cambridge, Massachusetts.

Deppler, Michael C., and Duncan M. Ripley (1978), The World Trade Model: Merchandise Trade, International Monetary Fund *Staff Papers*, 25, July, 147-206.

Fischer, Stanley (1993), The Role of Macroeconomic Factors in Growth, *Journal of Monetary Economics*, 32, December, 485-512.

Frankel, Jeffrey A. (1999), *No Single Currency Regime Is Right for All Countries or at All Times*, Essays in International Finance No. 215, August, Princeton University Press.

Friedman, Milton (1953), The Case for Flexible Exchange Rates, in *Essays in Positive Economics*, University of Chicago Press, Chicago, 157-203.

Gandolfo, Giancarlo (1971), *Mathematical Methods and Models in Economic Dynamics*, North-Holland, Amsterdam.

Goldstein, Morris, and Mohsin S. Khan (1976), Large Versus Small Price Changes and the Demand for Imports, International Monetary Fund *Staff Papers*, 23, March, 200-225.

___ (1978), The Supply and Demand for Exports: A Simultaneous Approach," *Review of Economics and Statistics*, 60, 275-286.

___ (1985), Income and Price Effects in Foreign Trade," in Ronald Jones and Peter B. Kenen (eds.), *Handbook of International Economics* II, North-Holland, Amsterdam, Ch. 20, 1041-1105.

Gylfason, Thorvaldur (1978), The Effect of Exchange Rates on the Balance of Trade in Ten Industrial Countries, International Monetary Fund, Departmental Memorandum, DM/78/90.

___ (1987), Does Exchange Rate Policy Matter?, *European Economic Review*, 31, February/March, 375-381.

___ (2000), Fix or Flex? Alternative Exchange Rate Regimes in an Era of Global Capital Mobility, *North American Journal of Economics and Finance*, 11, December, 173-189.

___, and Tryggvi Thor Herbertsson (2001), Does Inflation Matter for Growth?, *Japan and the World Economy*, 13, December, 405-428.

Khan, Mohsin S., and Abdelhak S. Senhadji (2001), Threshold Effects in the Relationship Between Inflation and Growth, International Monetary Fund *Staff Papers*, 48, No. 1, 1-21.

Rajan, Ramkishen S., and Reza Siregar (2002), Choice of Exchange Rate Regime: Currency Board (Hong Kong) or Monitoring Band (Singapore)?, *Australian Economic Papers*, this issue.

Rogoff, Kenneth (1996), The Purchasing Power Parity Puzzle, *Journal of Economic Literature*, 34, 647-668.

Sala-i-Martin, Xavier, Growth, Macroeconomics, and Development: Discussion, *Macroeconomics Annual* 1991, 368-378.

Schadler, Susan (1977), Sources of Exchange Rate Variability: Theory and Empirical Evidence, International Monetary Fund *Staff Papers*, 24, July, 253-296.

Stein, Jerome L. (2002), The Repercussions of EU-Enlargement for the Equilibrium Value of the Euro, *Australian Economic Papers*, this issue.

___, and Polly Reynolds Allen (1995), *Fundamental Determinants of Exchange Rates*, Oxford University Press, Oxford and New York.

Stern, Robert M., J. Francis and B. Schumacher (1976), *Price Elasticities in International Trade*, Trade Policy Research Center, Macmillan Press.

Taylor, Mark P., David A. Peel, and Lucio Sarno (2001), Nonlinear Mean-Reversion in Real Exchange Rates: Toward a Solution to the Purchasing Power Parity Puzzles, *International Economic Review*, 42, November, 1015-1042.

Williamson, John (1985), ed., *Inflation and Indexation: Argentina, Brazil, and Israel*, Institute for International Economics, Washington, D.C.

___ (2000), *Exchange Rate Regimes for Emerging Markets: Reviving the Intermediate Option*, Institute for International Economics, Washington, D.C.

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