Explaining long term exchange rate behavior in the United States and Japan

Anwar Shaikh
Professor of Economics
Department of Economics, Graduate Faculty
New School for Social Research
6 E. 16th Street, Room 1124
New York, NY 10003
email: shaikh@newschool.edu
homepage: http://homepage.newschool.edu/~AShaikh/

Rania Antonopoulos
Director of the Gender Equality and the Economy Program
Levy Economics Institute of Bard College
Blithewood
Annandale-on-Hudson NY US 12504-5000
email: rania@levy.org

Abstract
A practical knowledge of exchange rates is of vital importance for economic policy in our increasingly interconnected world. The difficulty is that the current models of the exchange rate perform quite poorly at an empirical level. This makes them an unreliable guide to economic policy. Conversely, in order to have a sound foundation for economic policy, one should operate from a theoretically grounded explanation of exchange rates which works well across a spectrum of developed and developing countries. The present paper extends the theoretical and empirical foundation developed in Shaikh (1980, 1991, 1995), previously applied to Spain, Mexico and Greece (Roman 1997, Ruiz-Napoles 1996, Antonopoulos 1997), to the explanation of the exchange rates of the United States and Japan. Conventional exchange rate models are based on the fundamental hypothesis that, in the long run, real exchange rates will move in such a way as to make countries equally competitive. Thus they assume that in the long run trade between countries will be roughly balanced. In contrast, our framework implies that it is a country's competitive position, as measured by the real unit costs of its tradables, which determines its real exchange rate. This determination of real exchange rates through real unit costs allows one to explain why trade imbalances remain persistent. It also provides one with a policy rule-of-thumb for sustainable exchange rates. The aim is to show that one can construct a theoretically grounded, empirically robust, explanation of real exchange rate movements which can be of practical use to researchers and policy makers.

A practical knowledge of exchange rates is of vital importance for economic policy in our increasingly interconnected world. Expectations about the consequences of NAFTA, the EEC, the causes and cures for trade deficits, the "appropriate" level of exchange rates at which policy should aim, and about the general consequences of macroeconomic policy -- these and many more issues depend heavily on an explanation of exchange rate behavior.

The difficulty is that the current models of the exchange rate perform quite poorly at an empirical level. This makes them an unreliable guide to economic policy. Conversely, in order to have a sound foundation for economic policy, one should operate from a theoretically grounded explanation of exchange rates which works well across a spectrum of developed and developing countries. The present paper applies the theoretical and empirical foundation developed in Shaikh (1980, 1991, 1995) and previously applied to Spain, Mexico and Greece (Roman 1997, Ruiz-Nápoles 1996, Antonopoulos 1997, Martinez-Hernandez 2010), to the explanation of the exchange rates of the United States and Japan[*].

Conventional exchange rate models are based on the fundamental hypothesis that in the long run real exchange rates will move in such a way as to make countries equally competitive. Thus they assume that trade between countries will be roughly balanced in the long run. By contrast, our framework implies that it is a country's competitive position, as measured by the real unit costs of its tradables, which determines its real exchange rate. This determination of real exchange rates through real unit costs allows one to explain why trade imbalances remain persistent. It also provides one with a policy rule-of-thumb for sustainable exchange rates. The aim is to show that one can construct a theoretically grounded, empirically robust, explanation of real exchange rate movements which can be of practical use to researchers and policy makers.

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I. Problems with existing models of the exchange rate

1. The empirical failure of current exchange rate models.

The macroeconomic impact of foreign trade and of international capital flows has always been a matter of considerable importance in policy circles. With the sharp expansion of the global economy in the last two decades, this issue has become even more urgent. And since movements of exchange rates play a critical role in this question, it is not surprising to find that an increasing amount of effort has been devoted to analyzing the determinants of real and nominal exchange rates. In his commentary on the field, Harvey (1996, p. 581) notes that "the literature on exchange rate determination is one of the largest in economics."

What *is* surprising, however, is that in recent years leading economists in this field have conceded that current models of exchange rate movements simply do not work at an empirical level. This applies to a host of models derived from monetary or portfolio balance approaches, as well as models which adhere to Purchasing Power Parity and/or comparative advantage hypotheses (Harvey 1996; Stein 1995; Isard 1995, part II). For instance, in his survey of the field, Stein (1995, p.182) says that the poor empirical performance "of ... contemporary models ... shows why economists have been so disappointed in their ability to explain the determination of exchange rates and capital flows". Harvey's précis (1996, p. 567) is even more succinct: "neoclassical economists have expressed increasing frustration over their failure to explain exchange rate movements ... Despite the fact that this is one of the most well-researched fields in the discipline, not a single model or theory has tested well. The results have been so dismal that mainstream economists readily admit their failure". Yet, it is these very same failed models which "continue to be offered as the dominant explanation of ... exchange rate determination" (Stein, op. cit., p. 185).

2. Long run theories of exchange rates

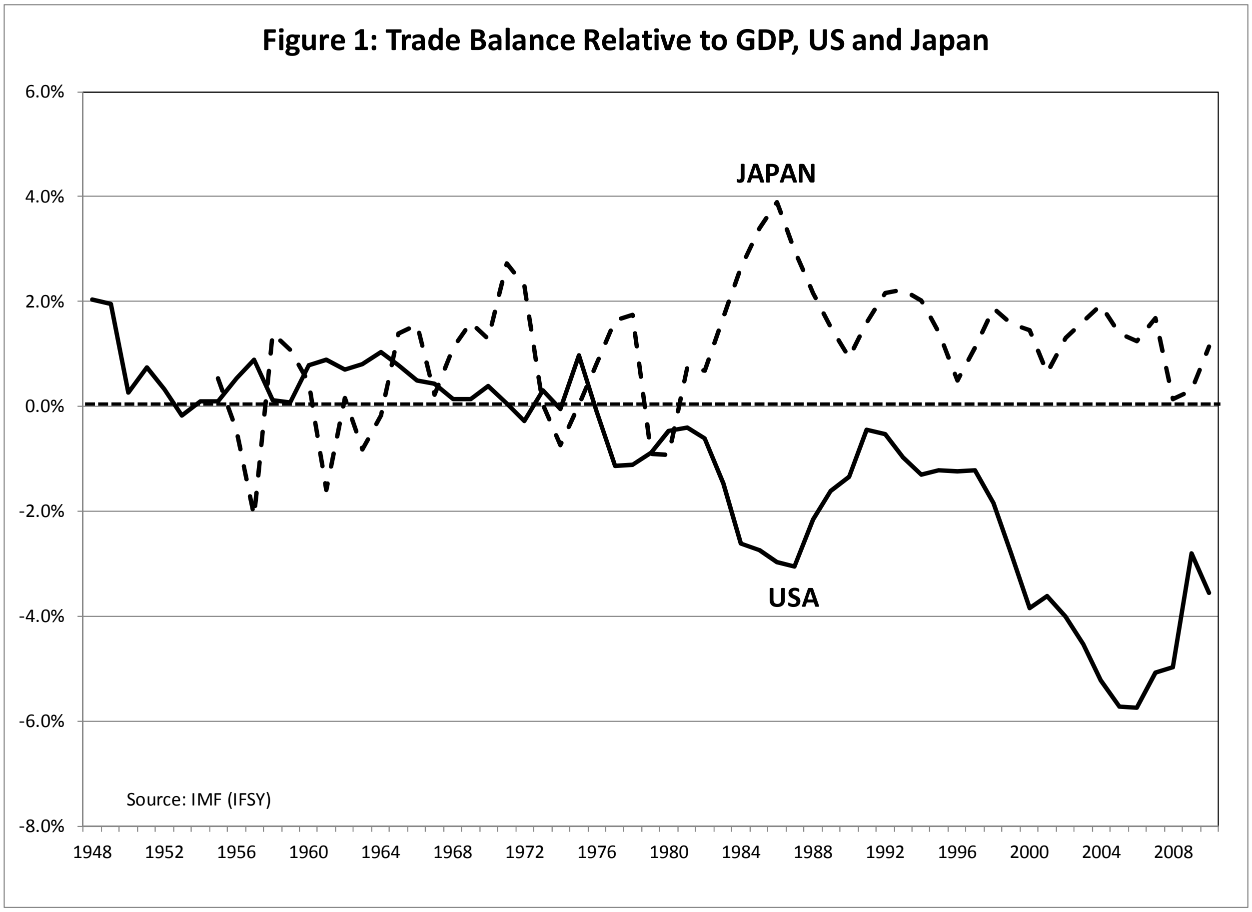
Our own focus is on the long run behavior of the real exchange rate. Here, conventional theory consists of only two basic hypotheses (Isard 1995,p p. 127, 171-2): comparative advantage and

Purchasing Power Parity (PPP). Neither one fares well at an empirical level.

The most enduring hypothesis about the long run real exchange rate is that it moves to automatically balance the trade of each (freely) trading nation. From the time of Ricardo onward, this principle of comparative advantage has been *the* fundamental hypothesis of orthodox trade theory. And it remains in full force to this very day. For instance, Milberg (1994, p.224) notes that "the notion of comparative advantage continues to dominate thinking among economists". A nice illustration of this is Krugman's (1991) insistence that comparative advantage continues to operate in the modern world, and would automatically lead to balanced trade among nations if only it were given free rein. Even the theorists of the New International Economics School, who emphasize oligopoly, increasing returns to scale, and various strategic behaviors, begin from the premise that comparative advantage would hold in the absence of such "imperfections"(Milberg 1993, p.1).

As is well known, the comparative advantage hypothesis implies that automatic real exchange rate adjustments will ensure that "trade will be balanced so that the value of exports equals the value of imports" (Dernburg 1989, p.3). In contrast to the constant-real-exchange-rate of the PPP hypothesis (which we discuss next), comparative advantage generally implies that the real exchange rate will *vary* so as to ensure that trade remains balanced in the face of changing circumstances. If comparative advantage did indeed regulate international trade, it would make it appear as if nations simply "bartered" exports for imports of equal value (Dornbusch 1988, p.3). Put another way, the theory of comparative advantage claims that real exchange rates will adjust to make all freely trading nations *equally competitive, regardless of the differences in their levels of development or of technology*. This hypothesis that gives rise to the empirical expectation that "[even though] an economy's international competitiveness might rise and fall over medium-term periods ... on average, over a decade or so, ebbs and flows of competitive "advantage" would appear random over time and across economies"(Arndt and Richardson, 1987, p. 12). It is from this perspective that Krugman and Obstfeld (1994, p. 20) inveigh against those who are benighted enough to believe that "free trade is beneficial only if your country is productive enough to stand up to international competition".

The empirical evidence has been quite unsupportive of the comparative advantage hypothesis. Over the postwar period, neither competitive advantages nor trade balances have been the least bit random across space or time. On the contrary, the "appearance of persistent, marked competitive advantage for [countries such as] Japan and marked competitive disadvantage for countries [such as] the United States", coupled with "persistent, marked trade balance surpluses for Japan and deficits for the United States" have characterized much of the postwar period (Arndt and Richardson 1987, p.12). In the end, neither the fixed exchange rate regimes of the Bretton Woods period, nor the flexible and highly volatile exchange rate regime which came into being in 1973, have altered this unpleasant fact. Figure 1 depicts the trade balances, as percentages of GDP, of the U.S. and Japan. The persistent imbalances they display are perfectly general in the capitalist world.



The other traditional explanation of real exchange rates is the Purchasing Power Parity (PPP) hypothesis[1], which claims that international competition will tend to equalize (common-currency) price levels of some major set of commodities across countries. The starting point for this argument is the notion that competitive arbitrage binds the various international prices of a given commodity together, within the limits of transportation costs, tariffs, and taxes. Then if nations have roughly similar output or consumption baskets, the corresponding price indexes will exhibit similar movements when expressed in common currency. Of course, one must then still

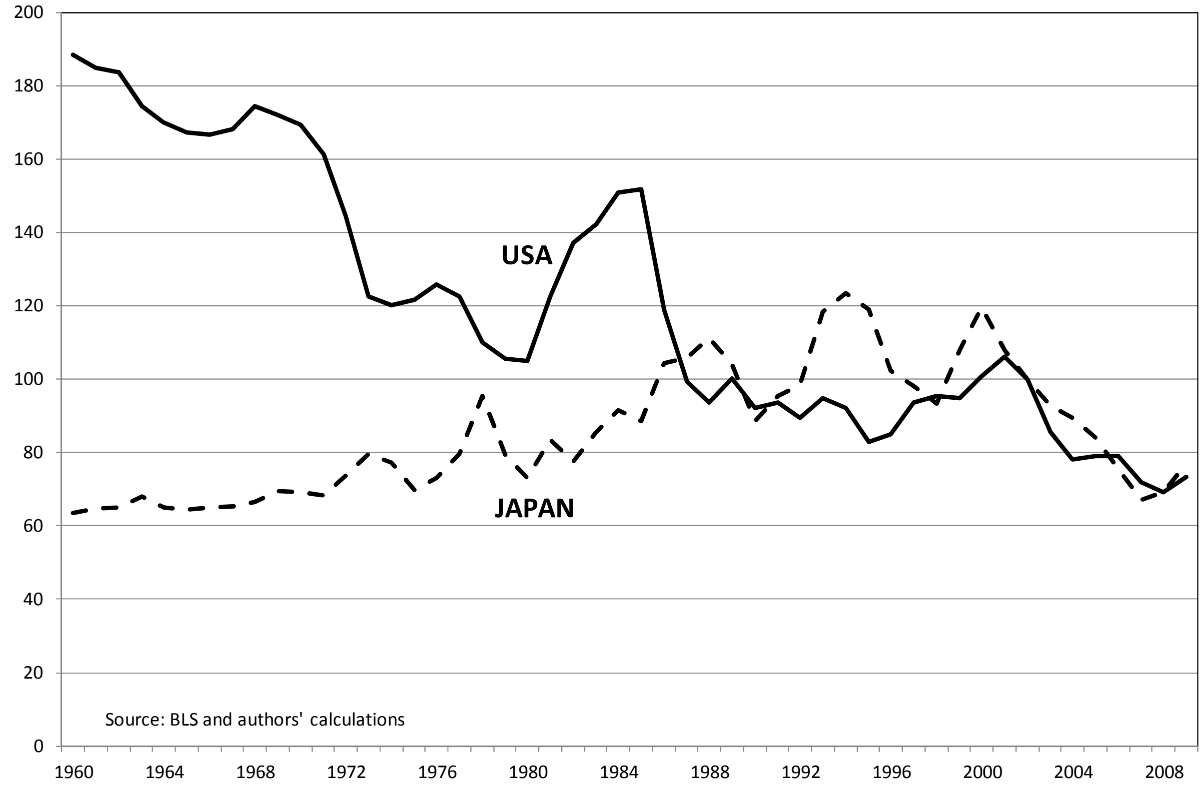
[1]The PPP hypothesis follows from the law of one price, under additional assumptions such as the similarity of aggregate production or consumption bundles between countries. The law of one price is in turn a necessary, but not sufficient, component of the principle of comparative costs in a competitive setting. Thus one could have either PPP or comparative costs without having other, or one could have both.

explain the basis of trade between such nations. One way to do so is to take the PPP hypothesis as a special case of comparative advantage, in which the trade-balancing real exchange rate happens to be roughly constant over time. Alternately, one could argue that competitive processes somehow equalize unit costs across nations (Officer 1976, pp.10-12). In either case, real exchange rates move so as to make nations equally competitive in the long run.

The PPP hypothesis of the equalization of common-currency price levels implies that *real* exchange rates are expected to be stationary over the long run[2]. But this is simply not empirically tenable. For instance, Figure 2 below charts the movements of real effective exchange rates in terms of producer prices for the U.S. and Japan. It is eminently clear that real exchange rates are not stationary in either the short run or the long run. This too is a perfectly general pattern, and we can immediately see why "tests based on aggregate price indexes overwhelmingly reject purchasing power parity as a short-run relationship"(Rogoff 1996, p.647), and why even the 50-year span of the postwar period does not provide much support for the notion that real exchange rates are stationary in some putative long run. This latter difficulty has forced supporters of the PPP hypothesis to argue that any convergence which might exist must be "extremely slow" (Rogoff 1996, p. 647), requiring perhaps 75 or even a 100 years of data in order to become evident (Froot and Rogoff 1995, pp. 1657, 1662).

[2] If p = the domestic price level, p* = the foreign price level, and e = the nominal exchange rate (foreign currency per unit domestic), then the (absolute) PPP hypothesis is that $p \cdot e = p^*$. But this is equivalent to the statement that the real exchange rate ($p \cdot e / p^*$) is constant. Equivalently, it implies that the rate of change of the nominal exchange rate offsets the relative rate of inflation.

Figure 2: Real Effective Exchange Rates (PPI-basis), US and Japan



One can also formulate the PPP hypothesis in terms of the rates of change of the relevant variables, in which case the hypothesis implies that nominal exchange rates will depreciate at the same rate as inflation (so as to maintain a constant real exchange rate). Figure 2 also makes it clear why this (relative) version of PPP is equally unsupportable as a general empirical proposition. However, in the particular case of high inflation, (relative) PPP *does* appear to hold (Froot and Rogoff 1995, p.1651), as illustrated in Table 1 below. This turns out to be an important piece of evidence, because the theoretical structure we develop predicts exactly such a correlation in the case of high relative inflation (Shaikh 1995, p. 73-74.).

Table 1: Changes in Exchange Rates and Relative Price Levels, High Inflation Countries
(Barro 1984, p.542, Table 20.4: relative to the U.S., % change per year over 1955-1980)

	Relative Inflation Rate	% Change in Exchange Rate
Argentina	40.8	39.3
Brazil	26.6	26.4
Chile	47.0	44.1
Colombia	9.7	11.7
Iceland	14.2	13.5
Indonesia (1967-80)	16.4	10.8
Israel	13.2	13.4
Peru (1960-80)	13.1	11.8
South Korea	11.4	10.0
Uruguay	33.3	31.3
Zaire	12.1	16.1

3. The persistence of empirically weak theoretical models as a guide to policy

The travails of orthodox exchange rate theory have led to three types of reactions: some writers reject the very notion that exchange rates are regulated by any underlying economic factors (Harvey 1996, p.581); others, like those in the New International Economics school, retain the principle of comparative advantage but modify its conclusions by introducing "imperfections" such as oligopoly, economies of scale, and strategic factors; and finally, there are those that continue to adhere to PPP and/or comparative advantage doctrines, but are forced to argue that these hypothesized laws operate on a much longer time scale than previously imagined -- perhaps 75 years or longer.

In spite of all these problems, both PPP and comparative advantage hypotheses continue to be widely used in economic models. Stein (1995, p.185) claims that even though "most scholars are aware of the deficiencies of these models, the profession continues to use them wholly or partly because they do not have a logically satisfactory substitute".

More significantly, these same models continue to have a major influence on economic policy. For instance, the PPP hypothesis is frequently used as a policy rule-of-thumb, because when "a country establishes or adjusts an exchange rate peg, it generally relies on some type of quantitative framework, such as the PPP formula, in order to help assess the appropriate level for the new parity" (Isard, 1995, p. 70; see also pp. 59, 72). In a similar vein, the assumption that an unencumbered real exchange rate automatically makes all trading nations equally competitive regardless of their differences in technology or levels of development lies behind many of the modern neoliberal programs of the IMF and the World Bank (Frenkel and Khan, 1993)

The empirical and policy implications outlined above are of considerable importance to us, because the framework we develop leads to very different conclusions. With this in mind, we turn to an outline of this alternate approach to the long run determinants of the real exchange rate, and to its policy implications.

II. An alternate approach to long run exchange rates

1. The basic theory

We have noted that conventional exchange rate models are rooted in the premise that in the long run all countries will be made equally competitive through automatic movements of their real exchange rates. Our framework takes the opposite position: namely, that the international competitive position of a country, as measured by the real unit costs of its tradables, pins its real exchange rate. Such real costs in turn will depend on productivity and real wages. We will show in section 2 below that real exchange rates do indeed move parallel to real unit costs, over the long run.

Two major conclusions follow. First, the real exchange rate of a country will follow the time path of its relative real unit costs. Since these may be rising or falling over time, real exchange rates will generally be nonstationary. This is consistent with the evidence in Figure 1 earlier, which explains why the (absolute) PPP hypothesis does not hold. In addition, because real unit costs of production tend to change relatively slowly over any length of time (about 1% a year over 30 years in Figure 1), the difference between the rate of change of nominal exchange rates and relative national prices must be similarly small. But then if some country has a relatively high rate of inflation in any given year, its *nominal* exchange rate must depreciate at roughly the same rate in order to make the real exchange rate track the trend rate of change in real unit costs. This explains why neither absolute nor relative PPP works when inflation rates are low (as in Figure 2), and also why relative PPP does appear to work when inflation rates are relatively high, as in Table 1 previously.

Secondly, competitively strong countries will tend to have balance of trade surpluses, because their relatively cheap products will enhance exports and discourage imports. Conversely, competitively weak countries will tend to run balance of trade deficits. But since the real exchange rate is pinned by real unit costs, it is not free to adjust to eliminate such imbalances, which will therefore be *persistent*. Any equilibrium in foreign trade will therefore come through the balance of payments, not through the balance of trade.

In order to grasp the logic behind this argument, it is useful contrast it with that of conventional economic theory. The two critical differences have to do with the meaning of the term competition, and with the consequences of competition in the international arena.

On the first point, by competition we mean real competition, in the sense of business competition, not "perfect" competition. Firms utilize strategy and tactics to gain and hold market share, and price cutting and cost reductions are major features in this constant struggle (Shaikh 1980). The second point has to do with the international implications of competition. Here, it is useful to note that conventional economic theory is marked by a striking disjuncture between its treatment of competition *within* a country, and that of competition *between* countries. As far as internal competition is concerned, virtually all theories agree that competition within a given country is driven by the law of *absolute costs*, that is to say, firms with lower unit costs of production enjoy an absolute competitive advantage. From this point of view, within any one country, high-cost regions would suffer from a competitive disadvantage. If unprotected from competition, firms in such a region would tend to have declining shares in the national market. Their higher costs would make it difficult for them to sell outside the region ("exports") and would leave their markets vulnerable to products originating in lower-cost regions ("imports"). In other words, in free *intra*-national trade, regions with higher costs would tend to have "balance of trade" deficits. This in turn implies that if such regions entered into trade with other more competitive ones within the same country, they would tend to suffer job loss and real wage declines --- at least until they caught up and/or their labor migrated elsewhere.

The curious thing is that when orthodox economics turns to the question of *external* competition, i.e. between nations, it stands its previously sensible description of competition on its head. Now, it is argued that trade between different countries is not ruled by absolute costs, but rather by comparative ones. The argument is well known, and need only be outlined here. In effect, it is assumed that if two initially unequally competitive countries were to open trade with one another, any initial disadvantage in the form of a trade deficit suffered by the higher cost country would be eventually overcome by the fact that its real exchange rate would continue to depreciate until its trade was balanced. This is because the assumed depreciation of the real exchange rate would cheapen the international prices of the country's own products and make more expensive the prices of the products of its trading partners, thereby enhancing its exports and restricting its imports. As long as a trade imbalance remained, this process is assumed to continue, so that in the end trade would be balanced. For a country with an initial competitive advantage and corresponding initial trade surplus, this same mechanism would erode its surplus until it too arrived at balanced trade. Thus the humble would be raised high, and the mighty brought down, all through the automatic operations of the invisible hand. In the end, all nations would end up equally competitive. As noted earlier, the resulting equilibrium real exchange rate would generally vary over time, though it might be stationary (i.e. might look like PPP) if both countries had similar commodity baskets.

The central point about the orthodox theory of international trade is that it abandons the absolute cost principle which regulates competition within a country, substituting in its place the principle of comparative costs. By way of contrast, Shaikh (1980, 1995) argues that the same general principle of absolute cost advantage regulates both competition within a country and competition between countries. Recall that in a competitive environment within any one country, high-cost regions would suffer from a competitive disadvantage which would make it more difficult for them to sell outside the region and more likely to import products from lower-cost regions, thus leading them to display structural "balance of trade" deficits -- at least until they managed to reduce their relative costs. Such deficits would of course have to be financed, either by running down some monetary stocks, or by attracting other funds from outside the region to cover its net import needs.

Within a nation, the relative prices of products are driven by the *best-practice producers*, the regulating producers. And as with all competition, the prices in question can be linked to unit costs, particularly to total (i.e. vertically integrated) unit labor costs. As a matter of accounting, we can decompose any unit price into its unit labor costs, its unit gross profits, and its unit materials costs. But the unit materials cost is itself simply the price of some bundle of commodities, and can itself be similarly decomposed, as can the materials costs of the materials costs, and so on. The upshot is that the price of the regulating producers can be decomposed into direct and indirect unit (vertically integrated) labor costs times an average gross profit margin over the various linked stages of production. The relative price of any two commodities therefore depends on the ratios of these same two terms. But precisely because each stage-averaged (i.e. vertically integrated) profit margin is an average of the regulating producer's own profit margin *and* of all profit margins in the industries directly or indirectly connected to its input requirements, each industry's vertically integrated profit margin picks up the profit margins of many other industries. Given the highly connected inter-industrial structure of modern economies, it is not surprising to find that the dispersion of their relative vertically integrated profit margins is quite small. Thus it turns out that the relative vertically integrated unit labor costs of the regulating producers provide an excellent approximation to relative prices (Shaikh

1984; Ochoa 1988; Bienenfeld 1988; Milberg and Elmlie 1992)[3]. Appendix A provides a more formal treatment.

If we let p denote unit price, and **v** denote the unit vertically integrated labor cost of the *regulating* producer, then for any two industries within a nation we may write

$$1.\quad \left(\frac{p_i}{p_j}\right) \approx \left(\frac{v_i}{v_j}\right)$$

The same principle may be applied an international scale, modified only to take into account the distinction between national currencies. Hence the relative *common-currency* prices of any two goods in the world market will be regulated by the total real unit labor costs of the best-practice producers of these products. Let e be the nominal exchange rate (foreign currency/domestic currency), p and p* the prices of domestic and foreign tradable goods, respectively. Then p·e/p* is the common-currency relative price of these two sets of tradables. Corresponding to this will be **v**, **v***, the best-practice vertically integrated unit labor costs of these same bundles of tradables, respectively, expressed in common-currency. Since the best-practice producers of the tradables of a given country may be spread out over several countries, many exchange rates may be implicit in the common-currency measures of these costs. International competition will then imply that the real exchange rate e_r is

$$2.\quad e_r = \left(\frac{pe}{p^*}\right) \approx \left(\frac{v}{v^*}\right)$$

Now suppose that there was some bundle of tradable consumer goods whose effective prices p_{cT}, p^*_{cT} (adjusted for transportation costs, etc.) are equalized across the two countries. Then

[3] National studies based on input-output analysis can only estimate the costs of the average producer, because of the nature of the data available.

3. $p_{cT}e \approx p^*_{cT}$

Let p_c, p_c^* be the prices of consumer goods in the two countries, comprising both tradables and nontradables. Then if we write *real* best-practice vertically unit labor costs as $v_r \equiv \frac{v}{p_c}$ and let $\tau = \frac{p_c}{p_{cT}}$, we may combine equations 2 and 3 to yield the basic proposition (Shaikh 1991, 1995)

4. $e_r \equiv \left(\frac{pe}{p^*}\right) \approx \left(\frac{v_r}{v_r^*}\right)\left(\frac{\tau}{\tau^*}\right)$ (over the long run)

The preceding result implies that the relative common-currency prices of the two countries -- *which is the real exchange rate between them* -- will be regulated by the real labor costs of the regulating capitals of those commodity bundles, adjusted for the tradable/nontradable content (the openness) of the consumption bundle (see Appendices A-B for further details). From this, it is only a short step to explain movements of the real exchange rate in terms of other price indexes such as CPI's or GDP price deflators.

2. Implications of the alternate approach to long run exchange rates

Several practical implications can be derived from equation 4.

-- First, it allows us to derive a practical policy rule-of-thumb for the movements of the (real and nominal) exchange rate: the sustainable real exchange rate is that which corresponds to the relative competitive position of a nation, as measured by its relative real unit labor costs.

-- Second, it tells us that since the real exchange rate is pinned (through competition) by real unit costs and other factors, it is not free to adjust in such a way as to eliminate trade imbalances. Indeed, such imbalances will be persistent, and will have to be covered by corresponding direct payments and/or capital inflows. It follows that currency devaluation will not, in itself, eliminate trade deficits. Rather, it would be successful only to the extent that it affects the real unit costs (via the real wage) and/or the tradables/nontradables price ratio of consumer goods (Shaikh 1995, p.72). And that depends on the ability of workers and consumers to resist such effects.

-- Third, it tells us that the real exchange rate of a country is likely to *depreciate* when a country's relative competitive position *improves*, other things being equal. Just as in the case of competition within a country, in which an industry with relatively falling costs will be able to lower prices, so too in international competition will a country's export prices fall relatively, in common-currency, when the corresponding relative real costs of production fall. It should be added that just as a cost-based decline in a commodity price is very different from the fall in its price due to distress in the industry, so too is the competitive depreciation of a currency quite distinct from its depreciation due to a crisis.

-- Fourth, it tells that the real exchange rate between two countries will be stationary only when their relative competitive positions and relative degrees of openness remain unchanged over the interval examined. In the absence of these special conditions, the real exchange rate will be nonstationary, which implies that in general PPP will not hold (Figure 1).

-- Fifth, because relative real unit labor costs can only change modestly in a given year, the same is likely to apply to the long run trend of real exchange rates (shorter run factors are discussed later). For example, if relative real unit labor costs of a country happened to rise by 3% over some interval, then a relative inflation rate of 40% would imply a nominal depreciation of about 37%. In this way, (relative) PPP would appear to be a good approximation in the particular case of high inflation countries (Table 1).

-- Sixth, that free trade is beneficial to a country only when it is strong enough to stand up to international competition. This is precisely the proposition that Krugman and Obstfeld (1994, p. 20) dismiss as a "myth".

-- Finally, of great practical importance to policy, it allows us to distinguish between two basic routes to increasingly a country's international competitiveness. The *high road* operates by continuously improving productivity. On the other hand, the *low road* which seeks to depress real wages and shift the burden of adjustment onto the backs of workers, which is ultimately culminates in a dead end when these processes reach their political and social limits.

The preceding discussion has focused on the central tendencies of the real exchange rate, as expressed in equation 4. This is sufficient for a direct comparison of the real exchange rate with its hypothesized center of gravity, as in Figures 3-4 in the next section. On the econometric side, we show that the two variables are cointegrated, with speeds of adjustment shown in tables 2 and 3. Both speeds of adjustment are significant and of the correct sign, suggesting that the long-run variations of the real exchange rate are regulated by real unit labor costs.

The deviations of the real exchange rate from its fundamentals depend on conjunctural factors within a country or outside of it. These include policy changes and market factors. Since trade imbalances will tend to be persistent (unless the real underlying factors are changed), exchange rate equilibrium requires a zero *ex ante* balance of payments. Autonomous foreign capital flows can then change the balance of payments and change nominal and real exchange rates, as well as nominal and real interest rates. Alternately, an autonomous change in the real interest rate can induce foreign capital inflows and lower the interest rate. Thus high real interest rates in the US in the early 1980s attracted a large capital inflow, which appreciated the exchange rate while reducing the interest rate. More recently, the crisis in Europe has precipitated a capital flight from Southern Europe into Germany, driving up the interest rates in the former and driving them down in the latter (Castle, 2011, p. B4). But since Germany is now within the EU, internal flows such as this have no direct impact on the Euro. These examples make it clear that at best, only a portion of the deviation of the real exchange rate from its fundamentals is likely to be correlated with interest rate differences. Nonetheless, in the absence of a more fully developed model of the factors involved, we include the real interest rate interest rate differential (i - i*) between the domestic real interest rate and a trade-weighted average of foreign rates, as a potential explanatory variable of short run deviation..

3. Empirical Evidence

Our basic long term hypothesis of equation 4 says that relative common-currency prices (the real exchange rate) $e_r \equiv \left(\frac{pe}{p^*}\right)$ will be regulated by its center of gravity $\left(\frac{v_r}{v_r^*}\right)\left(\frac{\tau}{\tau^*}\right)$ which is the corresponding best-practice vertically integrated unit labor costs adjusted for tradable/nontradable goods effects. We have chosen to measure all country variables relative to a bundle of major trading countries (excluding themselves) because in international competition countries compete against all others in the same league, so to speak. It is also empirically appropriate for the consideration of international capital flows, since capital flows out to many locations, and flows in from many others. For this reason, any conclusions about the *bilateral* relation between the U.S. and Japan would have to be drawn from their separate *multilateral* relations with their competitors and trading partners.

The central difficulty in constructing empirical measures of the necessary variables arises from estimating best-practice vertically integrated unit labor costs. First of all, since the commodities which comprise the tradables of a given country may have corresponding best-practice techniques in some other countries, one might use the unit labor costs of these other countries to construct the overall average best-practice cost of the tradables bundle in question. Alternately, one might assume that any given country is one of the best-practice producers of its own exports, so that if we pose our question in terms of common-currency export prices (export-price deflated real exchange rates), the problem reduces one of estimating the unit labor costs of a given country's export sector.

Unfortunately, neither approach is easily implemented at the present time, due to a lack of appropriate data. For the present study, therefore, we have chosen to use producer price indexes as the proxy for tradable prices, and use the manufacturing sector as the base for the corresponding unit labor costs, since these variables are available for all of the major OECD countries over a sufficiently long time span. We need a broad sample of countries, because for each country we construct trade-weighted effective exchange rates and corresponding relative real unit labor costs, etc.

A second difficulty arises from the fact that the theory requires vertically integrated unit labor costs, and time-series data is only readily available for direct unit labor costs -- which is what we utilize. In order to estimate vertically integrated costs, one would need input-output tables for all of the countries involved, over a sufficient time span to permit the creation of an adequate time series. This too is beyond the scope of this study. Further details are in Appendix B.

In spite of these empirical limitations, the results we get are quite strong. Figure 3-4 show that the real effective exchange rates of the U.S. and Japan's do indeed gravitate around the corresponding real unit labor costs (adjusted for tradable/nontradable effects), both variables being defined relative to the trading partners of the country in question. Given that we are working with index numbers whose scale is arbitrarily defined by the chosen base year (2002=100), for purposes of visual comparison we rescale the real unit labor cost variable to have the same period average as the real exchange rate variable. This has no effect on the econometric tests, of course.

Deviations of the real exchange rate from slowly changing real unit labor costs can be linked to sharp changes in relative export prices and in nominal exchange rates. In the case of relative export prices, the two oil shocks in 1973 and 1979 are obvious candidates for explanatory factors, since they have a greater effect on the costs of countries that rely more heavily on energy imports. In the case of the nominal exchange rate, short run intervention in the nominal exchange rate4 and changes in capital inflows are likely candidates. In the US, the major deviations of the real exchange rate from its theoretical center of gravity are in the 1980-87 and 1997-2003 periods, in which the former at first deviates sharply from the latter but then returns towards it. The first period has been widely discussed in the literature, and there is considerable debate over its underlying causes. One prominent explanation has been that it arises from the large run-up in the interest rate differential between the U.S. and its trading partners, leading to large short-term

4 Since we are concerned with short run interventions, we exclude the Bretton Woods era of fixed exchange rates in which most nations intervened to maintain fixed exchange rates.

capital inflows which in turn slowed down as the interest rate differential was extinguished (B. Friedman 1991). The second period is coincident associated with the equity price bubble from the late 1990s to the early 2000s. Here the relevant variable might be the differential in equity market rates of return, rather than the interest rate differential. We will nonetheless utilize the latter as a proxy for the former, given the lack of consistent data on OECD equity market rates of return. In the case of Japan, the matter is complicated by several well known short term interventions in the exchange rate market. The most significant of these are deemed to have been in 1976-1978, 1985-1988 (Plaza Accord), 1992-1996, and 1998-2004 (Nanto, 2007, p. CRS-4). In this light, we test whether interest rate differentials remain influential in explaining the deviations of the Japanese real exchange rate from its fundamentals.

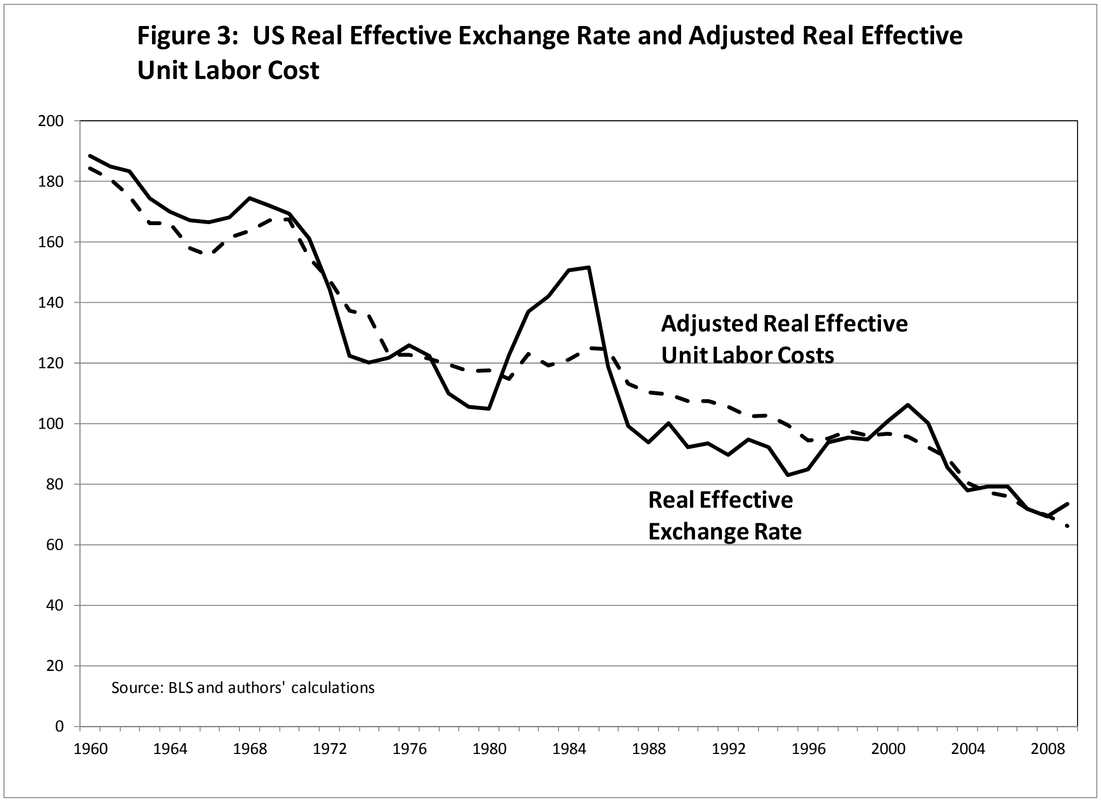


Figure 3: US Real Effective Exchange Rate and Adjusted Real Effective Unit Labor Cost
200
180
160
140
120
100
80
60
40
20
0
Adjusted Real Effective Unit Labor Costs
Real Effective Exchange Rate
Source: BLS and authors' calculations
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008

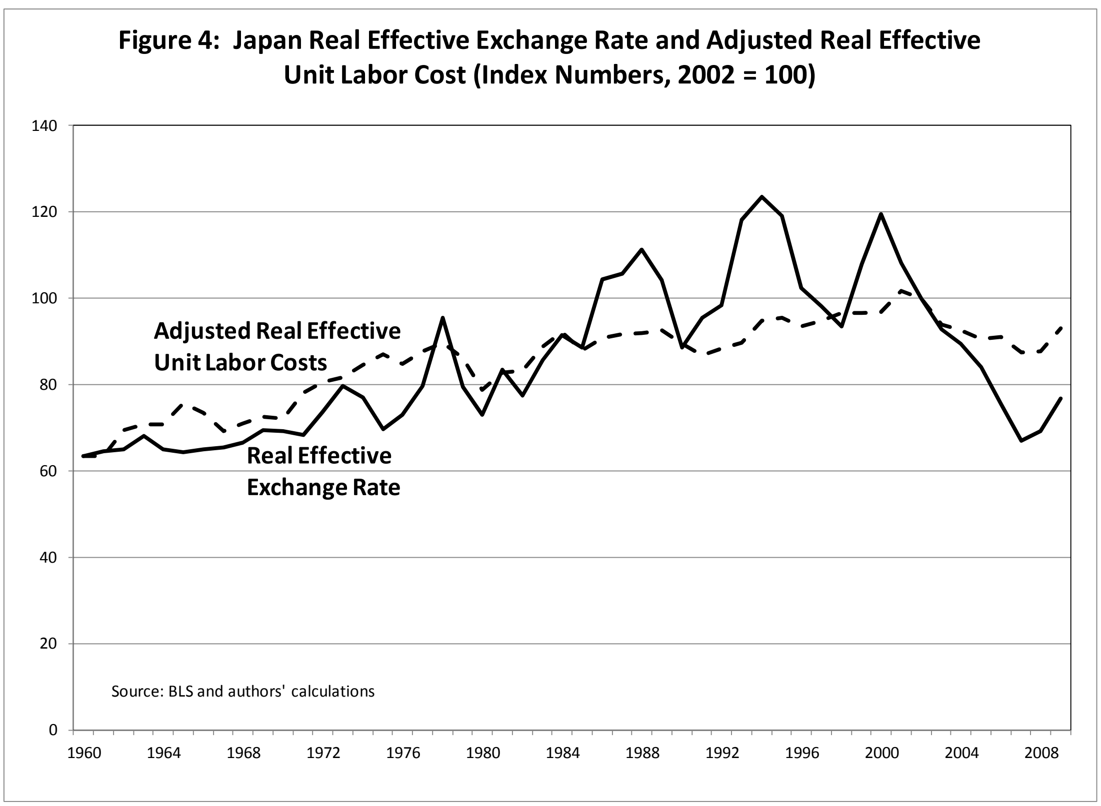
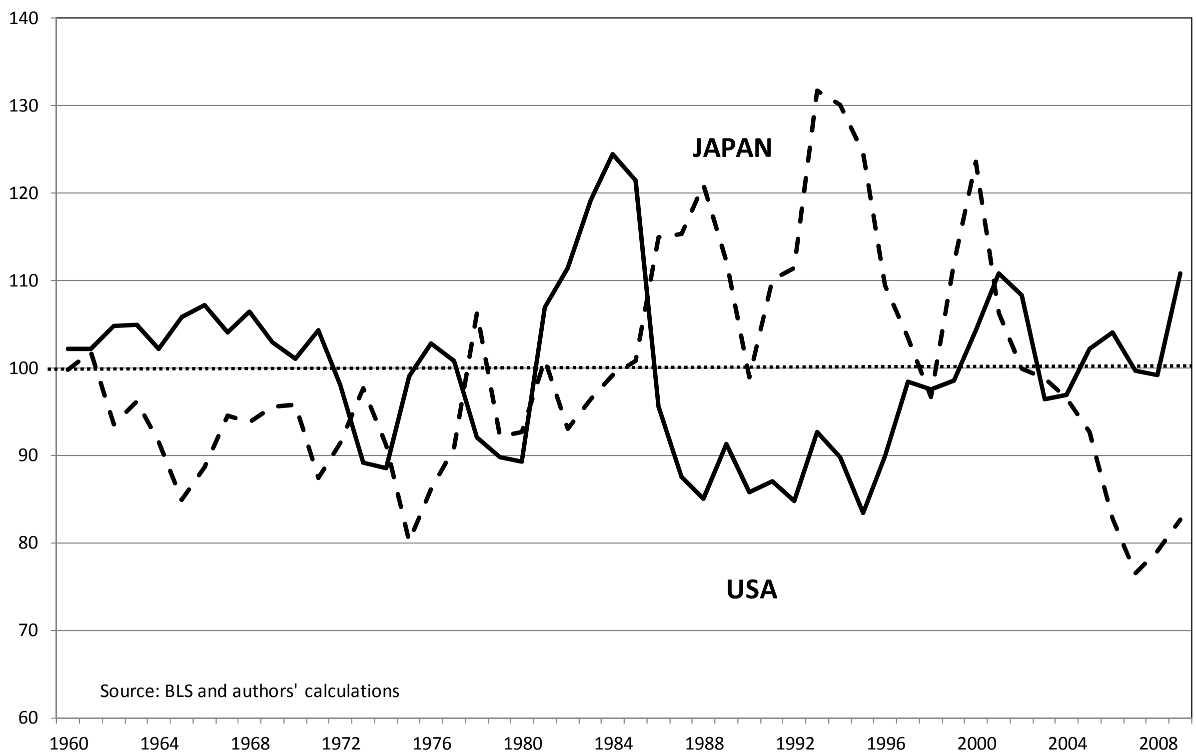


Figure 4: Japan Real Effective Exchange Rate and Adjusted Real Effective Unit Labor Cost (Index Numbers, 2002 = 100)
140
120
100
80
60
40
20
0
Adjusted Real Effective Unit Labor Costs
Real Effective Exchange Rate
Source: BLS and authors' calculations
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008

An alternate manner of formulating the hypothesis examined in Figures 3-4 is to take the ratio of each country's real exchange rate to its adjusted real unit labor costs, which would then given us an indication of the extent to which the former reflects the trend of the latter. Figure 5 depicts this ratio for both the U.S. and Japan. Given the data limitations discussed earlier, and the large impact of the anomalous 1980-87 period, it is remarkable how stable this ratio is over the long run. This provides us with a robust policy rule-of -thumb on the sustainable level of the real exchange rate, one which is far superior to the empirically unreliable yet widely used PPP hypothesis (recall Figure 2).

Figure 5: Real Effective Exchange Rate/Adjusted Real Unit Labor Costs, US and Japan (Indexes, 2002 = 100)



It now remains to provide an econometric test of our general hypothesis that the real exchange rate is determined in the long run real unit labor costs, with the real interest rate differential as a possible explanatory variable of short run deviations. In order to test for the existence of a long-run relationship between the real exchange rate and relative unit labor costs we deployed the ARDL method (Pesaran, Shin, and Smith 2001) using Microfit 5.0 (Pesaran and Pesaran 2009). The main advantage of this *bounds test* method is that no prior unit root testing is required. There are two steps in the ARDL method. In the first step an F-test is used to investigate the possibility of a long-run relationship between the variables in an error correction model (ECM). The computed F statistic for both countries indicates the existence of a long-run relationship, with the causation running from real unit labor costs to the real exchange rate. Once a long-run relationship has been established, we estimate the long-run coefficients from the underlying ARDL relationship along with the error correction coefficient from the associated error correction mechanism. The appropriate lag length of this ARDL is chosen by using the Akaike Information Criterion (AIC). The final results indicate a strong stable long run relation running from real unit labor costs to the real exchange rate, with moderate speeds of adjustment. The dependent variable in each case is the log of the real exchange rate, and the independent variable the log of the (direct) real unit labor costs adjusted for tradable/nontradable goods. The real interest rate differential was tested as a determinant of short run fluctuations in the real exchange rate, and was statistically significant in the US but not in Japan. Further details are in Appendix C.

Table 2: ECM results for Japan: 1962-2008			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Constant	-1.5581	0.98941	-1.5748[.124]
LRULCJP	1.3533	0.22179	6.1017[.000]
Speed of Adjustment	-0.45378	0.11674	-3.8872[.000]

Table 3: ECM results for US: 1962-2008			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Constant	0.36445	0.43908	0.83005[.411]
LRULCJP	0.91982	0.093053	9.8850[.000]
Speed of Adjustment	-0.33641	0.085373	-3.9405[.000]

III. Summary and conclusions

This paper has set out to test whether the framework developed in Shaikh (1980,1991,1995) can explain the long run movements of the real exchange rates of the United States and Japan. This framework extends the basic results of competition within a country to competition between countries. In this respect, it rejects the traditional hypothesis that competition between countries is characterized by comparative advantage, in favor of the hypothesis that it characterized (like competition within any one nation) by real costs

The real costs thesis implies that the long run real exchange rate of countries reflects their respective international competitive positions, as measured by their relative real unit labor costs. This implies that trade imbalances will tend to be persistent or slowly changing, that hypotheses such as PPP will not hold in general, and that only large and relatively persistent capital inflows will have significant additional effects on the real exchange rate. One important practical implication of our results is that we can formulate a simple policy rule-of-thumb for judging the appropriate level of the real exchange rate: it is the level which is in line with the international competitive position of the country, as measured by its relative real unit labor costs.

Appendix A: Relative prices and relative vertical unit labor costs

Let p, u, π, and m be the per unit price, labor costs, gross profits, and materials costs, respectively, of some given commodity. Then by definition we may write $p = u + \pi + m$. However, the materials costs are simply the price of some bundle of materials, which in turn may be decomposed into unit labor costs, profits, and their own materials costs one (conceptual) stage back. This decomposition can be repeated on the material costs of the materials bundle itself, and so on, so that without any loss of generality we can always write (Shaikh 1984)

$$p = u + \pi + m = u + \pi + u^{(1)} + \pi^{(1)} + m^{(1)} = u + \pi + u^{(1)} + \pi^{(1)} + m^{(1)} + u^{(2)} + \pi^{(2)} + m^{(2)} + \ldots$$

Denote the sum of all the direct and indirect unit labor costs by $v = u + u^{(1)} + u^{(2)} + u^{(3)} + \ldots$ and that of all the direct and indirect unit gross profits by $\pi^T = \pi + \pi^{(1)} + \pi^{(2)} + \pi^{(3)} + \ldots$ Then

$$p = v + \pi^T = v(1 + \rho)$$

where $\rho = \pi^T / v$ = the average direct and indirect (i.e. the vertically integrated) profit-wage ratio. Note that this applies to any price whatsoever, since it follows from an accounting identity.

It follows that any two relative prices can always be written as

$$p_i / p_j = (v_i / v_j) \cdot (z_{ij})$$

where $z_{ij} = (1 + \rho_i)/(1 + \rho_j)$ = the ratio of the vertically integrated profit-wage ratios. Thus the relative price of any two commodities therefore depends on two terms: their relative vertically integrated unit labor costs, and their relative vertically integrated gross profit margins. But it is important to note that each industry's vertically integrated profit margin is an average of its own profit margin and of all those industries which are directly or indirectly connected to it by its input requirements. If all industries were directly or indirectly connected, then each industry's vertically integrated profit margin would be an average (a convex combination) of the same set of direct profit margins, with only the weights being different. Vertically integrated profit margins would therefore be much more similar than direct ones, i.e. their dispersion would be relatively small (Shaikh 1984). From this point of view, one may view the term z_{ij} is as a "disturbance" term around the relative vertically integrated unit labor cost ratio (v_i / v_j).

Given the highly connected interindustrial structure of modern economies, it is not surprising to find that this is indeed true. Thus it turns out that the relative vertically integrated unit labor costs provide an excellent approximation, on the order of 90%, to relative prices (Shaikh 1984; Ochoa 1988; Bienenfeld 1988; Milberg and Elmlie 1992; Chilcote 1997). In national studies based on input-output data we cannot empirically distinguish between average and regulating producers. But for theoretical reasons, it is important to do so. And in the international arena, one may plausibly argue each country is the regulating producer for its own exports. For these reasons, we maintain the distinction between average (v) and regulating (**v**) vertically integrated unit labor costs, and write

$$p_i / p_j \approx \mathbf{v}_i / \mathbf{v}_j$$

Appendix B: Calculation procedures

1. *Coverage*: 1960-2009, all index numbers 2002 = 100, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, K(Republic of) Korea, Netherlands, Norway, Spain, Sweden, UK, and US.

2. *Raw Data*: CPI, ULC, pmfg, PPI, e, X+M, and IntRate

CPI: U.S. Bureau of Labor Statistics (BLS), Division of International Labor Comparisons, August 18, 2011, CPI derived as the ratio of unit labor costs real unit labor costs in local currency from Tables 7 and 13, respectively. Missing values for Australia 1960-1989, Spain 1960-78 and Korea for 1970-1984 were taken from BLS Supplementary Table 1, Consumer

Price Indexes (CPI), 16 countries, 1950-2009, 1982-84 = 100, rebased to 2002=100; Korea from 1960-1969 was set equal to the 1970 value.

ULC = Unit Labor Cost in manufacturing is from BLS, International comparisons of Manufacturing, Table 9: Unit labor costs in Manufacturing, National Currency Basis, 19 countries or areas, 1950-2009. Missing data for Korea 1960-1969 were set equal to the 1970 value. For Spain, 1960-1963 was set equal to the 1964 value, and 1964-1978 were taken from Roman (1997). Data for Australia was also missing for 1960-1989, but since this is used to estimate real unit labor costs, the problem was circumvented by estimating the latter directly for these years (see below).

pmf = manufacturing price index, derived as the ratio of current-cost to constant-cost manufacturing value added, from BLS International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends, Underlying Data Tables, Dec 21 2010. Missing values for Australia 1960-1969 were estimated as ppi in those years (see below) times the ratio of pmfg/ppi in 1970 (the latter ratio remains close to 1 from 1970-1989); Belgium 1960 was set equal to the 1961 value: Korea 1960-1969 was estimated as the ratio of nominal to real value added in manufacturing from the 10-Sector Database Korea from Groningen Growth and Development Centre 10-sector database, June 2007, http://www.ggdc.net/, created by de Vries and Timmer (2007); and Spain 1960-1963 was set equal to the 1964 value.

PPI = Producer Price Index, from the World Bank, World Development Indicators 2010. Missing values for Australia 1960-1989 were estimated by multiplying the corresponding cpi by the average ratio of ppi/cpi from 1990-2009, and for Korea 1960-1969 values were set equal to the 1970 one.

e =Index of the nominal exchange rate (Foreign currency/Dollar) taken from BLS International comparisons of Manufacturing**,** Table 11: Exchange rates (value of foreign currency relative to U.S. dollar), 19 countries or areas, 1950-2009, (2002=100).

X+M = sum of Exports and Imports, from the International Monetary Fund (IMF), International Financial Statistics (IFS), exports and imports in US dollars. Missing values for Belgium for 1960-1992 were taken from AMECO Database, http://ec.europa.eu/economy_finance/ameco/, imports (UMGS) and exports (UXGS) in current prices and units Mrd ECU/EUR, which were then converted to US-dollars using the exchange rate (XNE) in terms of US dollars per ECU/EUR.

w = the trade weight of the i^{th} country in a given year = $\frac{w_i}{\sum_{j \neq i} w_j}$.

IntRate = nominal interest rate, 3-mo Treasury Bills, compiled from the IMF, IFSY, Statistical office Publications and Central Bank Bulletins for 1960-1967, and from the OECD, 1968-2009.

3. Calculations

The object is to calculate for the US and Japan in a given year the variables in equation 4 of the text: $pmfg \cdot e / pmfg^*$ where pmfg = the manufacturing price index of a country, pmf* = the manufacturing price index of its trading partners, and e = the exchange rate of the country vis-à-vis its trading partners; and $(\mathbf{vr} / \mathbf{vr}^*) \cdot (\tau / \tau^*)$, where vr, vr* are proxies for the vertically integrated real unit labor costs of a country and its trading partners (we use direct real unit labor costs RULC and RULC* due to lack of data on vertically integrated costs), and τ, τ^* are adjustments to account for the difference between tradable and nontradable goods. In all cases, trading partner variables such as pmf*, etc. are calculated as geometric averages of individual pmf_j for all countries $j \neq i$: in effect, each country is compared to the average of all the others in the sample. This same procedure was also applied to interest rates in order to calculate the nominal and real interest rate differentials (using percentage changes in ppi) for each country: nominal interest rate differential = domestic nominal interest rate – foreign nominal interest rate and real interest rate differential (RIDIF) = domestic real interest rate – foreign real interest rate.

Appendix C: Econometric Procedures[5]

In order to test for the existence of a long-run relationship between the real exchange rate and relative unit labor costs we deployed the *bounds test* ARDL approach (Pesaran, Shin, and Smith 2001) using Microfit 5.0 (Pesaran and Pesaran 2009). The main advantage of this method is that is does not require prior unit root testing. There are two steps in the ARDL method. In the first step an F-test is used to investigate the possibility of a long-run relationship between the variables in an error correction model (ECM). Consider the following ECM for a bivariate system involving two variables Y and X. Then if y = lnY and x = lnX the ECM is:

$$Dy_t = a_0 + b.Dx_t + \sum_{i=1}^{n} c_i Dy_{t-i} + \sum_{i=1}^{n} d_i Dx_{t-i} + \beta_1 y_{t-1} + \beta_2 x_{t-1} + v_t$$

This ECM should be free of serial correlation. The framework tests the null hypothesis H_0: $\beta_1 = \beta_2 = 0$ which is the "non-existence of a long-run relationship" between the variables, against the alternative hypothesis H_A: $\beta_1 \neq \beta_2 \neq 0$. A significant F-statistic for the joint significance of β_1 and β_2 permits us to reject the null hypothesis and conclude that there is a long-run relationship. Pesaran et al have computed approximated critical values of the F statistic.

There are two sets of critical values, of which one set assumes that all the variables are I(1) while the other one assumes that all the variables are I(0). If the computed F statistic falls outside this band a definite conclusion can be reached regarding the existence or non-existence of a long-run relationship. If the F statistic is greater than the upper bound, at some level of significance, then we can reject the null of the non-existence of a long-run relationship between y and x. In addition, as Pesaran, Shin, and Smith (2001) and Pesaran and Pesaran (2009) argue, a significant F statistic also shows the existence of "long-run forcing" relationship which identifies which variable explains variations of the other one. Consequently, in the tests below we carry out the F-test by making first the real exchange rate and then relative unit labor costs the dependent variable.

5 We are very grateful to Jamee Moudud for his help with the econometrics in this Appendix.

Once a long-run relationship has been shown to exist, the next step is to estimate the long-run coefficients from the underlying ARDL relationship along with the error correction coefficient from the associated error correction mechanism. The appropriate lag length of this ARDL is chosen by using the Akaike Information Criterion (AIC). As Pesaran and Pesaran (2009, pp. 463-465) show an error correction equation of an ARDL equation has embedded it an error correction mechanism (ECM) that relates the dependent variable to all the predetermined variables. From this ECM one can read off the coefficients that pertain to the hypothesized co-integrating relationship, i.e. the real exchange rate and relative unit labor costs. It will be recalled that the F test was carried out on the non-existence of a long-run relationship involving these two variables only.

VARIABLES

LRXR1JP and LRULCJP, the natural logs of real exchange rate and relative unit labor cost for Japan, respectively; LRXR1US and LRULCUS, the natural logs of real exchange rate and relative unit labor cost for US, respectively; RIDIFJP and RIDIFUS, the real interest rate differentials for Japan and US respectively, and INPT, the regression intercept. "D" next to a variable signifies its first difference.

JAPAN

We estimated a conditional ECM with DLRXR1JP as the dependent variable (see table below) using dummies d79, d93, and d06070809, for 1979, 1993, 2006-09, respectively. In the interest of parsimony we used a lag length of 1 on the conditional ECM. There was no serial correlation in the conditional ECM: the Lagrange Multiplier statistic CHSQ(1)= .017532[.895] and the F statistic F(1, 37) = .013807[.907].

The first step of the test yielded an F statistic of 8.1644 which exceeded the critical bounds values of (7.057-7.815) at the 99% level (for k = 1)6. In the conditional ECM if DLRULCJP is

6 All critical values for the F statistic are from Table B.1, p. 544, of *Time Series Econometrics: Using Microfit 5.0* (Pesaran and Pesaran 2009). Note that while in Pesaran, Shin, and Smith (2001) the authors make use of both an F

made the dependent variable the F statistic is 5.5, which puts it in the indeterminate range at the 95% when the bounds are (4.934-5.764). This provided the strong conclusion that not only is there a long-run relationship between the two variables but also that relative unit labor costs act as the *long-run forcing variable* (Pesaran and Pesaran 2009, p. 310) that drives the real exchange rate. The Microfit 5.0 tables on this step are omitted to save space.

Error Correction Representation for the Selected ARDL Model
ARDL(2,2) selected based on Akaike Information Criterion
****
Dependent variable is DLRXR1JP
47 observations used for estimation from 1962 to 2008
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DLRXR1JP1	.33345	.14931	2.2333[.032]
DLRULCJP	.82239	.31190	2.6367[.012]
DLRULCJP1	-.51765	.29077	-1.7803[.083]
DRIDIFJP	-.0038079	.0037806	-1.0072[.320]
Dd79	-.20663	.078179	-2.6430[.012]
Dd93	.21398	.067272	3.1807[.003]
Dd99	.13858	.069068	2.0064[.052]
Dd06070809	-.12749	.046261	-2.7559[.009]
ecm(-1)	-.45378	.11674	-3.8872[.000]

****
*
ecm = LRXR1JP -1.3533*LRULCJP + 1.5581*INPT + .0083915*RIDIFJP + .45534*
d79 -.47154*d93 -.30538*d99 + .28096*d06070809
****
*

R-Squared	.57872	R-Bar-Squared	.46170
S.E. of Regression	.065667	F-Stat. F(9,37)	5.4950[.000]
Mean of Dependent Var.	.0014992	S.D. of Dependent Variable	.089503
Residual Sum of Squares	.15524	Equation Log-likelihood	67.5638
Akaike Info. Criterion	56.5638	Schwarz Bayesian Criterion	46.3880
DW-statistic	2.2013		

Testing for existence of a level relationship among the variables in the ARDL model
****

---

and a t statistic to investigate the long-run properties, in Pesaran and Pesaran (2009) use is just made of the F statistic. In a personal communication to Moudud Bahram Pesaran pointed out that only the F statistic is used in the 2009 manual because it is more robust than the t test.

F-statistic	*95% Lower Bound*	*95% Upper Bound*	*90% Lower Bound*	*90% Upper Bound*
8.1644	5.4923	6.3202	4.4076	5.1510
W-statistic	*95% Lower Bound*	*95% Upper Bound*	*90% Lower Bound*	*90% Upper Bound*
16.3287	10.9845	12.6404	8.8153	10.3020

The ARDL equation to which the above error correction equation corresponds satisfies all the goodness-of-fit criteria:

```
                   Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *          F Version          *
*******************************************************************************
* A:Serial Correlation*CHSQ(1)  =   1.5160[.218]*F(1,35)     =   1.1666[.287]*
* B:Functional Form   *CHSQ(1)  =   .79812[.372]*F(1,35)     =   .60461[.442]*
* C:Normality         *CHSQ(2)  =   .61857[.734]*      Not applicable        *
* D:Heteroscedasticity*CHSQ(1)  =   1.2455[.264]*F(1,45)     =   1.2249[.274]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

N.B. These tests are based on the nulls of no residual serial correlation, no functional form misspecification, normal errors, and homoscedasticity. When the p-values given in [.] exceed 0.05 these nulls cannot be rejected (Pesaran, Shin, and Smith 2001).

<u>US</u>

Step 1 yielded an F statistic of 6.7245 when DLRXR1US was made the dependent variable in the conditional ECM, with the dummy d86 for 1986. The critical values at the 95% level are (4.934-5.764), thereby clearly suggesting a long-run relationship. In fact when DLRULCUS is made the dependent variable in the conditional ECM the F statistic is 0.21903 which is lower than the bounds at the 90% level which are (4.042-4.788). Hence, LRULCUS is unambiguously the forcing variable regulating the long-run movement of LRXR1US. There was no serial correlation in the conditional ECM: the Lagrange Multiplier Statistic CHSQ(1)= .13349[.715] and the F Statistic F(1,41)= .11434[.737].

Error Correction Representation for the Selected ARDL Model

ARDL(2,0) selected based on Akaike Information Criterion

****

Dependent variable is DLRXR1US
48 observations used for estimation from 1962 to 2009

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DLRXR1US1	.23666	.11598	2.0405[.048]
DLRULCUS	.30944	.094108	3.2881[.002]
DRIDIFUS	.015073	.0035866	4.2027[.000]
dD86	-.16912	.052330	-3.2318[.002]
ecm(-1)	-.33641	.085373	-3.9405[.000]

ecm = LRXR1US -.91982*LRULCUS -.36445*INPT -.044807*RIDIFUS + .50272*d86

****

R-Squared	.63237	R-Bar-Squared	.58860
S.E. of Regression	.049334	F-Stat. F(5,42)	14.4488[.000]
Mean of Dependent Variable	-.019270	S.D. of Dependent Variable	.076915
Residual Sum of Squares	.10222	Equation Log-likelihood	79.5346
Akaike Info. Criterion	73.5346	Schwarz Bayesian Criterion	67.9210
DW-statistic	1.9336		

Testing for existence of a level relationship among the variables in the ARDL model

****

F-statistic	*95% Lower Bound*	*95% Upper Bound*	*90% Lower Bound*	*90% Upper Bound*
7.1240	5.2762	6.1342	4.2112	5.0254

W-statistic	*95% Lower Bound*	*95% Upper Bound*	*90% Lower Bound*	*90% Upper Bound*
14.2481	10.5524	12.2685	8.4224	10.0508

****

The ARDL equation to which the above error correction equation corresponds satisfies all the goodness-of-fit criteria:

Diagnostic Tests

```
*******************************************************************************
*
*    Test Statistics  *        LM Version        *          F Version          *
*******************************************************************************
*
* A:Serial Correlation*CHSQ(1)  =  .073634[.786]*F(1,41)     =  .062993[.803]*
* B:Functional Form   *CHSQ(1)  =   2.3891[.122]*F(1,41)     =   2.1476[.150]*
* C:Normality         *CHSQ(2)  =   .57908[.749]*      Not applicable        *
* D:Heteroscedasticity*CHSQ(1)  =   1.8919[.169]*F(1,46)     =   1.8875[.176]*
*******************************************************************************
*
```

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values

C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

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