

ELEMENTS OF REAL EXCHANGE RATE ECONOMICS

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Introduction

This paper is being written at the conclusion of my third visit to Moscow in a little less than one calendar year. During these visits I have been able to interact on many occasions with economists from the top level of Russia's economics profession in meetings which have produced many fruitful dialogues. In these conversations my Russian colleagues have taught me a great deal about the nature and structure of the Russian economy, about the difficult problems it faces on the path to a market-oriented equilibrium incorporating rapid economic growth, and about the many complex decisions that its policymakers must confront, now and over an extended future period.

My own role in these conversations with Russian experts has been to try to introduce into their deliberations various aspects of my own experience in dealing with somewhat similar problems in other countries. Perhaps because of the timing of my visits in 2000 and 2001, it turned out that the most important points of contact (between my past experience and Russia's current and future problems and decisions) were concentrated in a relatively new subdiscipline namely, real exchange rate economics. After each of my first two visits I prepared a paper, which was then formally presented at the outset of my next stay in Moscow. These presentations

took place in large conferences, attended by professionals and nonprofessionals, policymakers and nonpolicymakers alike. It thus made great sense that my expositions should be based on the real-world experiences of other countries, rather than on drier, classroom-style expositions of the underlying theory.

The purpose of this paper is to provide that missing link. In it I will try to make the exposition as palatable as possible, but readers should be forewarned that I am aiming this discussion at professional economists rather than at the lay public.

Lying behind all of this is an interpretation of how the Russian economy has evolved and is now in the process of further evolution. We start with the economic system inherited from the old Soviet Union. This was a system with its own pattern of costs and prices, a pattern substantially divorced from system of prices prevailing in the rest of the world economy. With the breakup of the Soviet political system, and with the expressed desire of the Russian authorities to integrate their own economy with that of the rest of the world, a new challenge was defined -- how to move the internal price system to a point of compatibility with the world price system, as quickly and painlessly as possible?

In response to this challenge, various steps were taken, but as of the middle 1990s the adjustment was still far from complete. Many old industries were not viable at world prices, yet continued to produce, given the dependency of thousands of workers and their families, even of whole towns and cities, upon their continued operation. Nonpayment of debts and of wages was a common phenomenon. Barter transactions of all kinds emerged to fill the vacuum created as regular cash payments failed to occur or were somehow suspended.

Then came Russia's financial crisis, culminating in the major devaluation of the ruble, both in nominal and real terms. The increased real price of the dollar, in the wake of this devaluation, provided a healthy stimulus for all sorts of activities whose viability depended on

the real exchange rate. This represented a silver lining to what otherwise was a very unfortunate cloud (the crisis itself). The higher real price of the dollar gave an even-handed stimulus to all “tradable” goods production -- both of export and of import-substitute products. In Russia’s case, import substitutes responded more quickly and strongly than exports -- an experience shared by other countries during episodes of major real devaluations. But one should recognize that the natural economic function of a real devaluation is to stimulate the production of both kinds of tradables, and to do so in a neutral, nondiscriminatory fashion.

Many Russian economists and policymakers perceived the benefit of this market-based stimulus to tradables production, and anticipated a long and sustained economic recovery, based on a high real price of the dollar. If this were to occur, Russia would be following the same type of path as was traced in two earlier, highly successful recoveries -- that of the so-called Brazilian miracle (1968-1979), and that of Chile’s very forceful recovery (1985-1998) from the debt crisis of the early 1980s.

But, in Russia’s case, something intervened to place a similarly long tradables-based recovery in jeopardy. That “something” was the oil-price rise of 1999-2000. The abundance of foreign exchange created by this oil-price boom caused the dollar to become cheaper, in real terms, in the Russian economy. At the same time, the petrodollar boom brought a new source of prosperity to Russia, as some of the petrodollars generated by the boom were converted to rubles and spent (largely) on nontradables like services and house construction.

But just as the black cloud of the financial crisis had its silver lining in a healthy and neutral stimulus to tradables production, so the silver cloud of the petrodollar boom had its black lining in an appreciation of the real exchange rate (reduction of the real price of the dollar) that reversed to a significant degree the previous stimulus to produce tradables (other than petroleum itself). This might be a perfectly reasonable and sensible outcome, if it were thought that the

prevailing high price of oil would continue for a long time. But many wise heads thought that this was unlikely, and that in any event it was prudent to prevent the oil boom from having its full potential effect in lowering the real price of the dollar.

It is at this point that a new aspect of real exchange rate economics comes to the fore. Up to now we were seeing how external economic forces produced their effects on the real exchange rate -- the 1998 crisis producing a rise in the real price of the dollar, and the 1999-2000 petrodollar boom inducing a reduction in the same price. Now the challenge was to find ways in which the instruments of economic policy could be used to change the equilibrium level of the real exchange rate.

The first lesson to be appreciated here is that the most obvious policy reaction is probably the worst of the lot. This most obvious reaction is to move the nominal exchange rate itself, and to think that with such a move the job of maintaining the real exchange rate is done. The problem here is that the key variable that produces equilibrium in a country's trade and payments is the real exchange rate, not the nominal one.

What needs to be true for a nominal devaluation to be a good move is that one should be starting from a point of serious disequilibrium, in which the real price of the dollar is "trying" desperately to rise, but is having a hard time doing so. This situation typically occurs when the equilibrium price of the dollar shifts upward, under a regime of a fixed or quasi-fixed nominal exchange rate. In such a situation the move toward a new equilibrium is reflected in deflationary pressures on prices and wages, and ultimately on reduced levels of output and employment.

Russia is not now in this sort of situation. The real price of the dollar is trying to go down, not up -- and its real value is being eroded by internal prices that are rising, not falling. This fits with the evidence -- an abundance of dollars should make them cheaper in real terms, and that is exactly what has been happening. This is why any effort to raise the real price of the

dollar has to be focused on changing the equilibrium level of the real exchange rate rather than by fiddling with the nominal rate.

There are two basic ways to use policy to influence the equilibrium real exchange rate -- one operating on the current account of the balance of payments, the other on the capital account (plus international reserves). Working on the current account one can think of shifting upward the demand for imports, or on shifting downward the supply of exports. From a middle-to-long run point of view, only the former of these two lines of action makes sense, as it entails reducing import restrictions and further opening the economy (a sensible goal for the long run, especially in the contemporary world of ever-expanding international trade and “globalization”). In contrast, shifting the supply of exports downward entails imposing new restrictions on export trade. Not only does this introduce new trade distortions (rather than reducing them), but it almost by definition works against the goal of an economic recovery led by a booming export sector.

But as one thinks seriously about further import liberalization in Russia, one runs into two snags. First, liberalization gives negative incentives to the production of substitutes for the affected (liberalized) imports, even though through its effect on the real exchange rate it tends to stimulate other import substitutes as well as exports. Second, and perhaps more importantly, Russia has already carried out the biggest steps of liberalization, putting in question how large a shift in the demand for dollars could be accomplished by sensible further reductions in restrictions, prudently spread, say, over a period of five years or so. I conclude that further import liberalization, while desirable and advisable in its own right, should be pursued at a steady, measured pace over the next few years, and not looked upon as a major policy instrument for offsetting the impact of the petrodollar bonanza on the real exchange rate.

This brings us to examine the potential to influence Russia's real exchange rate by operating through the capital account (plus the country's international reserves). The first observation to make here is that capital outflows have already been working as a strong influence to keep the real price of the dollar high. I do not want in any way to give the appearance of endorsing capital flights as bringing an overall long-run benefit to the Russian economy. But one can sound a more hopeful note by viewing these outflows as transitory, with funds going abroad to earn positive real rates of return, in the hope of later "coming home" to Russia to earn even more positive returns, once the internal investment climate has improved sufficiently. In any case, there would be little hope of preventing a major fall in the real price of the dollar if private capital outflows were to be sharply curtailed.

We proceed, therefore, on the hypothesis that capital outflows will be sustained at something like their current rate during the period while the "petrodollar" problem persists, though one should hope that conditions in the Russian economy will lead to their abatement and ultimate reversal over a longer period. Against this backdrop, the principal instruments by which policymakers can influence the real exchange rate are: 1) accumulation of additional foreign reserves by the Central Bank, and 2) payments of interest and amortization on the Russian government's external debt. These are the elements which have actually been employed in the effort to keep the real price of the dollar from falling "too much" or "too rapidly". For example, the Central Bank's foreign exchange reserves (including gold) stood at around U.S.\$10 billion in March of 1999, just before the petrodollar boom began, and rose to around U.S.\$25 billion by September of 2000. Similarly, the Russian government increased its foreign indebtedness during the first half of 1999, but has been reducing it since then.

The Concept of “Net Resource Transfer” (NRT)

For the purposes of real exchange rate analysis, the concept of net resource transfer is quite central. It incorporates all the ways an economy can either “produce more than it uses” or “use more than it produces”. When a country produces more than it uses, the difference is represented by an accumulation of foreign assets (including the international reserves of the Central Bank), or by a reduction of foreign liabilities (including paying down government and private debt), or by the payment of interest owed on foreign debt plus the dividends and profit remittances on foreign equity holdings in the country.

When a country produces more than it uses, aggregate supply Y^s exceeds aggregate demand Y^d , and at the same time total exports X exceed total imports M by the same amount, and the country’s geographic savings S exceed its geographic investment I , also by the same amount. Yet another addition to this litany states that total supply (T^s) of tradable goods and services will exceed total demand (T^d) for them, also by the same amount.

To elucidate these “magical” coincidences we turn to some simple exercises in national accounting. Using the subscript h to indicate “produced at home”, we note that total home production (value added) must be either consumed at home (C_h), invested at home (I_h) or exported (X_h). Thus,

$$(1) \quad Y^s = C_h + I_h + X_h$$

To bring imports into the picture, we define C_m as imports of final consumer goods plus inputs that combine with domestic value added C_h to make final consumer products. Thus we have

$$(2) \quad C_h = C - C_m, \text{ and similarly}$$

$$I_h = I - I_m, \text{ and}$$

$$X_h = X - X_m.$$

Now we note that total imports M are equal to $C_m + I_m + X_m$, and we substitute (2) into (1) to

obtain the familiar

$$(3) \quad Y^s = C + I + X - M$$

Now, setting $Y^s - C = S$, gross domestic savings, we end up with the equally familiar

$$(4) \quad I - S = M - X$$

At another level, we define $Y^d = C + I$, and obtain, from (3)

$$(5) \quad Y^d - Y^s = M - X$$

Finally, we divide the demand for tradables (T^d) into the demand for exportables (E^d) plus that for importables (R^d), and similarly set $T^s = E^s + R^s$. Then we set

$$(6) \quad \begin{aligned} T^d - T^s &= (E^d + R^d) - (E^s + R^s) \\ &= (R^d - R^s) - (E^s - E^d) \\ &= M - X \end{aligned}$$

So we have five different representations or “guises” for the net resource transfer:

- (7) a) $NRT = (M - X)$, the import surplus
 b) $NRT = (T^d - T^s)$, the excess demand for tradables
 c) $NRT = (Y^d - Y^s)$, the excess of aggregate demand over aggregate supply
 d) $NRT = (I - S)$, the excess of domestic investment over domestic saving
 e) $NRT =$ net flow of money from abroad = net transfers received plus capital inflow
 minus accumulation of international reserves minus net payments of
 interest, dividends, profit remittances, etc.

Note that definition e) is based on flows of funds, not on changes in foreign assets and liabilities. Thus a rise or fall in the stock market value of Russian accounts in London or Zurich or New York would not contribute to the net resources transfer into or out of Russia, but a movement of funds from Russia to these accounts, or vice versa, would be part of the NRT.

Net Resource Transfers and the Real Exchange Rate

The preceding introduction opens the door to a graphical representation of how net resource transfers operate to affect the real exchange rate. The curve connecting T^* and H^* in Figure 1 is the production possibility frontier between tradables (T) and nontradables (H).¹

Consider an economy that is initially in equilibrium at point A. Let that economy receive a net resource transfer equal to NRT. Figure 1 shows two alternative possibilities: a) one in which the NRT is spent fully on tradables and b) one in which it is spent at least partly on nontradables. In case a), the equilibrium production stays at A, while the equilibrium of demand shifts to A'. In case b), the economy has to end up with higher production and demand for nontradables, for which equilibrium requires $H^s = H^d$. The new production point must therefore be to the right of A, at a place like B. At this point only part of the net resource transfer (NRT_t) is spent on tradables. The rest (NRT_h) is used to exchange for nontradables. The added demand for nontradables alters their relative price P_h/P_t , and produces a situation in which the equilibrium demand point (D) for the country's own income earners is different from their production point (B).

Figure 2 tells the same story in a much simpler way. Here the key elements are the demand and supply of foreign exchange as a function of the real exchange rate (P_t/P_h). The

¹This curve, for a nondistorted economy, represents the maximum of T^s that the economy can, with a given stock of resources, produce, for each given amount of H^s that it produces. T^* is the amount of T that can be produced with all the available resources of the economy. H^* is the output that results when all the economy's resources are allocated to nontradables production. Distortions, particularly ones that distort the prices of productive factors, can produce a locus which is inefficient, the sense that it does not give the maximum of T^s for each given value of H^s . This is the way "real-world" production possibility curves should be conceptualized. Corresponding to each equilibrium price ratio there will be a production point (T^s, H^s); the "real-world" production possibility frontier is the locus of such points, taking as given the set of distortions present in the economy.

basic supply of foreign exchange is conceived as coming from the supply of exports, while the basic demand is derived from the demand for imports. The world prices of exports and imports are taken as given, and unchanging throughout the exercise. The net resource transfer (NRT) is considered as an additional source of supply. The top panel of Figure 2 illustrates the case of a net resource transfer fully and completely spent on imports. The net resource transfer NRT adds to the supply of foreign exchange, but the spending of that NRT adds an equal amount to the demand, so the equilibrium (P_t/P_h) does not change. (If the net resource transfer were spent on exportables, it would reduce the supply of exports by NRT, but the NRT itself would add an equal amount to the supply of foreign exchange, so the country's supply curve of foreign exchange would remain unchanged as would its demand for foreign exchange, so again the equilibrium P_t/P_h would remain constant.)

The bottom panel of Figure 2 shows the case of a net resource transfer spent exclusively on nontradables. Here the supply curve of foreign exchange shifts to the right by the amount of the transfer, but the demand function (for imports) does not shift. Hence the equilibrium level of (P_t/P_h) falls.

Figure 3 illustrates the general (and most typical) case, in which the net resource transfer is spent partly on imports, partly on exportables, and partly on nontradables. The part spent on imports (NRT_m) shifts the demand curve for foreign exchange to the right; the part spent on exportables (NRT_e) shifts the supply curve of exports to the left, and the part spent on nontradables introduces a wedge (NRT_h) between the original import demand $[M^d(0)]$ and export supply $[X^s(0)]$ curves.

It can easily be seen from Figure 3 that if NRT_h is zero, the equilibrium real exchange rate should not change. And equally clear is the fact that the change in the equilibrium RER will depend, not on the overall net resource transfer but on that part of it (NRT_h) that ends up being

spent on nontradables. This is why we should be somewhat tentative in empirical exercises in which we try to establish a functional relationship between the net resource transfer and the real exchange rate. Actually, in cases of major movements of the NRT, such empirical relationships turn out to be quite good, but I am always surprised by their goodness of fit, and I always take pains, as I am doing here, to point out that there is no deep theoretical basis to expect a close empirical fit between these two variables (NRT and RER). The genuine functional relationship is that between NRT_h and RER.

Figure 4 illustrates this for the case where the entire net resource transfer is spent on home goods, i.e., $NRT_h = NRT$.

If parts of the NRT are spent on importables and exportables, the curves in Figure 4 have to be reinterpreted, following Figure 3. X^s in Figure 4 would become $X^s(0)$ from Figure 3, M^d in Figure 4 would become $T^d(0)$ from Figure 3. Correspondingly T^d in Figure 4 would become $T^d(0)$, while the actual T^d would shift according to $T^d = T^d(0) + NRT_e + NRT_m$.

I am warning readers that it takes some effort to work through these relationships to draw out their full implications. For example the functional relationship between RER and NRT_h can be thought of as applying when NRT changes reflect only changes in NRT_h , i.e., with NRT equal to a variable NRT_h plus fixed amounts (denoted by the superscript *) for NRT_e and NRT_m . In this case the shifted curves of Figure 3 would simply be $M^d(0) + NRT_m^*$ and $X^s(0) - NRT_e^*$, and correspondingly we would have $T^d = T^d(0) + NRT_m^* + NRT_e^*$. This makes for a simple graphical representation.

But one could also think of a graph like Figure 3 being generated from a varying net resource transfer in which $NRT_h = \alpha_h NRT$, $NRT_m = \alpha_m NRT$ and $NRT_e = \alpha_e NRT$. In this case the dotted curves of Figure 3 would not be parallel to the original ones, but would cross at the initial equilibrium point, as shown in Figure 5.

The important lesson here is that Figure 4 can be derived from Figure 3 or from Figure 5. In fact it can be built up from any specified functional relation giving NRT_h as a function of NRT. Dotted curves like those in figures 3 and 5 can be derived taking $M^d(0)$ plus NRT_m (as a function of NRT) and $X^s(0)$ minus NRT_e (also as a function of NRT).

The main point is that Figure 4 stays unchanged under all these permutations. This can also be seen by going back to Figure 1. The equilibrium of production at B and of domestic demand (not including the specific use of the transfer) at D stays the same as we increase the net resource transfer by extending the line BB' farther up the page -- just so long as NRT_h is not changed.

What's Wrong With (P_t/P_h) ? -- The P_t Side

As previously indicated, the conception of the real exchange rate being measured by a price ratio (P_t/P_h) had its origin in relatively simple theorizing (a la Figure 1) in which production and demand in the economy were neatly divided into two "goods" -- tradables and nontradables. So far we have obtained very straightforward results using these two categories. But so far we have only considered cases in which the exogenous force operating to change an initial equilibrium was represented by a change in the net resource transfer. We have seen that it is NRT_h , not the total NRT, which operates to influence (P_t/P_h) .

The trouble is that there are many other forces that operate to change the real exchange rate, the way most of us think of it. Yet if we use the ultrabasic (P_t/P_h) as the measure of the real exchange rate it does not behave reliably, in the ways that we expect, in response to many of these other forces. Here let me juxtapose to P_t/P_h an alternative, simplified definition of the real exchange rate -- one with which most people are familiar. This is simply E/\bar{p}_d , where E is the nominal exchange rate (e.g., ruble price of the dollar), and \bar{p}_d is a general price index. We will consider in turn a series of different potential disturbances displacing a pre-existing equilibrium.

a) A Petrodollar Boom for an oil-exporting country. This could in principle come from a rise in the world price of oil, or alternatively from the opening of new fields causing a rapid expansion of the quantity exported at somewhere near the old price. The important thing here is the number of dollars earned from oil exports. It is to be presumed that a petroleum boom would cause the total dollar value of oil exports (for an oil-exporting country) to rise significantly, and that the real price of the dollar would therefore fall, bringing on an episode of the so-called "Dutch disease".

With such a disturbance, there are two forces working on the ratio (P_t/P_m) . The rise in the world price of oil itself will cause P_t to rise, but the consequent drop in E will cause it to fall. So we really don't know what will happen to (P_t/P_h) .

The definition E/\bar{p}_d fares much better, with the clear tendency being for the real price of the dollar to fall, as dollars suddenly become a lot more plentiful.

b) A Major Reduction of Import Restrictions. Here we again encounter ambiguity with the (P_t/P_h) definition. The perception is that a major reduction in import restrictions will cause the curve $M^d(0)$ to shift to the right causing a rise in the real price of the dollar. The internal prices of all exports, and of all imports other than the liberalized ones, should rise, because (E/\bar{p}_d) should go up as a consequence of the greater demand for foreign currency. But the internal prices of the liberalized imports will tend to fall, producing an ambiguous final effect on the average price of tradables, P_t . Not so for the real exchange rate defined as E/\bar{p}_d , which should unambiguously rise for any major liberalization of imports.

c) A Major Increase of Export Taxes Here the "natural" effect is to reduce the available supply of dollars and to make the dollar more expensive in real terms. E/\bar{p}_d should unambiguously rise. But P_t/P_h remains ambiguous. The rise in E should cause the internal prices of "other" exports and all imports to rise. But the effect of new export taxes will be to

cause the internal prices of the affected exports to fall, so the net effect on the average internal price of all tradables will again be uncertain.

To keep the balance straight, we should also note those cases in which both measures -- (P_t/P_h) and (E/\bar{p}_d) come to the same answer. These include:

d) Net Resource Transfers, the case already treated in earlier sections. Here both measures would indicate no effect on the real exchange rate if the net resource transfer is spent fully on tradables, and a negative effect so long as any relevant part of it is spent on nontradables.

e) Technical Advance in the Production of Tradables Here the effect of technical advance is to reduce the real cost of the affected tradables, hence also, presumably their internal prices. Thus (P_t/P_h) should go down. As for our alternative measure, a reduction in the real cost of producing exportables should lead to a rightward shift of export supply, while a reduction in the real cost of producing importables should lead to a leftward shift of import demand -- in either case causing the equilibrium level of E/\bar{p}_d to fall.

f) Technical Advance in the Production of Nontradables The effect of this disturbance on (P_t/P_h) is clear, since the disturbance itself operates to reduce P_h . To establish the direction of its effect on (E/\bar{p}_d) , we resort to an indirect demonstration. First, a general reduction of real costs by λ percent is obviously equivalent to an increase of this percentage in the real income and product of the economy. Neither theory nor evidence suggests that an increase in income and product by themselves has a substantial effect on the equilibrium real exchange rate. Put simply -- both the demand and supply of tradables shift to the right, with no presumption concerning which shift will dominate. If the RER is neutral with respect to general increases in income and output, then necessarily a reduction of the real cost of nontradables by λ percent has to have exactly the opposite effect of a similar general cost reduction in the production of

tradables. Even if there is not full neutrality of the RER, the strong presumption is that technical advance in nontradables production works in the opposite direction for technical advance in tradables production.

g) A Rise in the International Price of an Importable Good Here the (P_t/P_h) measure should presumably rise, while the effect on (E/\bar{p}_d) is ambiguous. The reason is that such a price rise can have the result of shifting the demand for foreign currency either to the right or the left. If the particular product or products whose price rises have demands that are inelastic with respect to relative price, then more foreign currency will be demanded as a consequence of the price rise. But, on the other hand, if the affected products have an elastic import demand, then the demand for foreign currency will shift to the left as a consequence of the rise on the world prices of these imports.

Thus, the signals (given by the two definitions of the RER) are different in this case; the question is which signals are right. We will show in later sections that the (E/\bar{p}_d) definition leads to the more correct answer in this case.

My conclusion from this section is that the (P_t/P_h) measure of the real exchange rate gives the “wrong” answer about half the time. It gives the right answer when the disturbances are net resource transfers or technical advances (in tradables or nontradables). It gives “wrong” answers when the disturbances are changes in the international prices of exportable or importable goods, and when they are changes in import tariffs or export taxes or subsidies. In contrast, the (E/\bar{p}_d) measure gives the correct answer under all of these types of disturbances.

But readers should not pause here. There are more arguments to come on this subject.

What’s Wrong With (P_t/P_h) ? -- The P_h Side

This side of the question is relatively easy to deal with, because it is basically concerned with the simple issue of finding relevant data. My basic theme is “the nontradable good is to

economics what the black hole and the quark are to modern physics -- things whose existence is based on theory and evidence, but which are not themselves directly seen.”

The definition of a tradable good is quite straightforward -- it is a good whose world price p_j^* is determined in the world market, and whose internal price Ep_j^* is also fundamentally world-market-determined. Transport costs t_j and tariffs τ_j may insert additional wedges between p_j^* and p_j (the internal price) so that we have $p_j = Ep_j^*(1+t_j)(1+\tau_j)$, but this does not alter the fundamental link between p_j^* and p_j . That link does, however, become fundamentally changed in cases where the combination of tariffs and transport costs becomes prohibitive. For when the protection thus given becomes prohibitive of imports, the good in question effectively passes from the tradable to the nontradable category -- its price is now determined by domestic supply and demand, not by p_j^* .

But while a final good that is tradable has its price determined fundamentally by p_j^* , basically free of influence from domestic forces (other than tariffs and transport costs), we cannot make a comparable statement saying that the prices of nontradables are free from world market influences. The problem here stems from the presence of tradable inputs in the cost structure of nontradable goods and services.

The price of any final good can be expressed as a sum of the prices of its inputs (including the economic rents accruing to capital and other possibly fixed factors). Thus we have

$$(8) \quad P_f = \sum_i a_{if} p_i + \sum_j a_{jf} p_j,$$

where the p_i are the local prices of nontradable imports and the p_j are those of tradable imports. If good f is itself tradable, its price will be linked to the world market price by

$$(9) \quad P_f = E p_f^* (1 + t_f)(1 + \tau_f),$$

so a rise in the exchange rate will directly affect it -- perhaps adding to the economic rents accruing to capital and other factors. But when good f is nontradable we have

$$(10) \quad P_f = \sum_i a_{if} p_i + \sum_j a_{jf} E p_j^* (1 + t_j)(1 + \tau_j),$$

so it is not divorced from movements of world prices p_j^* or of the exchange rate E . In short, good f , even though its final product price is determined by domestic supply and demand, is in effect a compound² good consisting of nontradable and tradable components.

We can never hope to find an index of the prices of nontradables that fully captures just the nontradable parts of such compound goods as restaurant meals (nontradable services plus tradable food), taxi rides (nontradable drivers' time plus tradable cars and gasoline) or construction (nontradable labor time plus tradable materials). The best we can do is work with a general index like the Consumer Price Index (CPI) or the GDP deflator. Both these indexes are general averages containing both tradable and nontradable goods. They are well-defined in the sense that the CPI aims at being a general index of consumer prices (of final goods and services), while the GDP deflator aims at being a general index of producer prices of such goods and services.

Thus such a general index of final product prices can be expressed as

$$(11a) \quad \bar{p}_d = \sum_t f_t p_t + \sum_h f_h \left[\sum_i a_{ih} p_i + \sum_j a_{jh} p_j \right]$$

²I use the term compound good here in order to distinguish this concept from that of a composite good. The elements of a compound good are linked by an input-output relationship. The elements of a composite good can be all final products, all inputs, or a combination of both of these. What defines a composite good is the idea of the component prices moving up and down in the same proportion.

$$(11b) \quad \bar{p}_d = \frac{[\sum_t f_t p_t + \sum_h f_h \sum_j a_{jh} p_j]}{\text{Tradables Component}} + \frac{[\sum_h f_h \sum_i a_{ih} p_i]}{\text{Nontradables Component}}$$

$$(11c) \quad \bar{p}_d = \lambda \bar{p}_t + (1 - \lambda) \bar{p}_h$$

Note that $\sum_t f_t + \sum_h f_h = 1$, and $\sum_t a_{ih} + \sum_j a_{jh} = 1$. Here we see how a general index like the

CPI or the GDP deflator can, at least conceptually, be decomposed into a weighted average of a general index of tradables “prices and components” and of nontradables elements.

Happily, we do not need to have an observable index for \bar{p}_h , for the ratio \bar{p}_t / \bar{p}_d will move up and down in sympathy with the unobservable ratio (\bar{p}_t / \bar{p}_h) . Thus

$$(12) \quad \frac{\bar{p}_t}{\bar{p}_d} = \frac{\bar{p}_t}{\lambda \bar{p}_t + (1 - \lambda) \bar{p}_h} = \frac{1}{\lambda + (1 - \lambda)(\bar{p}_h / \bar{p}_t)}$$

The Best Concept of the Real Exchange Rate ($E\bar{p}^*/\bar{p}_d$)

Introducing \bar{p}_d into the denominator of the expression for the real exchange rate does more than just insert a measurable proxy in place of the unobservable \bar{p}_h . Expressing things in terms of consumer (CPI) baskets or producer (GDP) baskets carries us into the realm of what I call “standard” numeraire for economic analysis generally. We often see, in general equilibrium theory, expressions like

$$(13) \quad Q_j^d = F(p_1, p_2, p_3, \dots, p_n)$$

where quantities demanded (in this case) are made to depend on the whole gamut of individual prices. But since, in the framework of this theory, it is only relative prices that count, one is left free to choose any one of the n goods and services as the numeraire, thus having demand depend on $(n-1)$ price ratios.

The general equilibrium texts tell us we can pick any one of the n prices as the numeraire, but no practitioner of empirical economics would make such a statement. It makes no sense whatsoever to express real GDP in terms of kilos of sugar, or real monetary balances in terms of barrels of petroleum, or the price of beer in terms of grams of copper or lead. The most important function of a deflating numeraire, in the working economist's framework, is to correct for movements in the general level of prices -- and for this, one necessarily wants a general price index. We use such an index to convert nominal GDP to real GDP, or to convert nominal monetary balances into real ones. We also typically deflate all relevant prices by a general index, when we fit empirical demand and supply functions for goods and services.

So having \bar{p}_d in the denominator of our expression for the real exchange rate puts us on the main highway of empirical economic analysis -- sound theory requires us to have a numeraire, sound empirical work asks for that numeraire to be a general index, rather than a particular price (like that of sugar, or petroleum, or copper) that is subject to lots of idiosyncratic movements.

The very special requirements that enters with respect to the denominator of the expression for RER is that it simply must give adequate weight to the prices of nontradables for only then can it reflect movements in (\bar{p}_t / \bar{p}_h) as shown in equation (12). Put another way, if one chooses a \bar{p}_d which reflects only tradables prices, it is like setting $\lambda = 1$ in equation (12), resulting in a price ratio that is identically equal to one.

Choosing an Index \bar{p}^* of the World Price Level of Tradables

In our preceding section on “the p_t side” it was shown that defining p_t to include the specific tradables of the country, weighted by their importance in the country's own trade, led to ambiguous results in cases of changes in the world prices p_j^* of those specific tradables, or in

the cases of changes of tariffs or other policy-imposed distortions affecting them. We say, too, that in the analysis of different types of disturbances, the simple measure E/\bar{p}_d was more satisfactory than a hypothetical measure of p_t/p_h . Yet when we identified what we felt was the best measure of the real exchange rate, it was not E/\bar{p}_d , but rather $E\bar{p}^*/\bar{p}_d$.

Why did we here introduce \bar{p}^* ? Before answering this question let me go back to E/\bar{p}_d and ask, why does it typically function well as a concept and a measure of the real exchange rate? The answer is it works well in a conceptual analysis of real exchange rate adjustment, because in such an analysis the world price level is typically taken as given -- indeed the world prices of individual tradable goods are nearly always taken as given, or at least beyond the control of the country whose real exchange rate we are studying.

\bar{p}^* comes into play, however, in empirical analyses of time series, for the world price level, whether expressed in dollars, Deutschmarks, Euros, pounds or Yen, has experienced significant variations over time, and quite specifically over the last several decades. The dollar of 2000 has less than a quarter of the purchasing power of a 1970 dollar!! My standard litany here is that E is the nominal price of the nominal dollar, E/\bar{p}_d is the real price of the nominal dollar, and $E\bar{p}^*/\bar{p}_d$ is equal to the real price of the real dollar. E/\bar{p}_d works, as a concept of the real exchange rate

- (a) When we are dealing with theoretical problems, hence holding \bar{p}^* constant by assumption, and
- (b) When we are dealing with empirical problems during short periods when the movements in \bar{p}^* are small enough to be neglected.

Once one has decided, for the reasons given earlier, that \bar{p}^* should not be an index of the prices of the specific basket of tradables of the country in question, one sees that its

fundamental role is that of correcting for world inflation of the prices of tradable goods. The best way to think of \bar{p}^* then, is as a world tradables numeraire.

The ideal world tradables numeraire would be an index that was explicitly constructed to serve that purpose. And the natural entity to construct such an index is obviously the International Monetary Fund, acting either on its own or possibly, in collaboration with the World Bank. Until this is actually done, however, we must improvise.

My preferred index for \bar{p}^* is what I call the SDR-WPI. This index considers the wholesale price indexes of different countries to be separate estimates of the world price level of tradable goods -- this because most wholesale price indexes have the great bulk of their weight concentrated on tradables -- i.e., manufactured, mineral, agricultural and forestry products. I call this index the SDR-WPI because it weights the separate wholesale (or producers) price indexes of U.S., Germany, France, the U.K., and Japan, using the same weights as the International Monetary Fund uses in defining its own monetary unit -- the SDR. In our own work we have usually taken those SDR weights for a given year, and used them to construct a Laspeyres-type fixed-weight price index for the period of our study. For the long run, it is probably best to build a single index with weights that follow the IMF's changing properties, but which attempt to achieve a smooth splicing at each point where changes (in weights) occur.

Other studies have used trade-weighted indices of wholesale prices, with the weights extending over all trading partners of the country in question. I find little to recommend in this procedure, for I do not think that the wholesale price indexes of minor countries are of very high quality, even less that they are to be thought of as independent estimates of the world price level of tradables. Moreover, it is typically true of that several of these minor trading partners are at any given time in the throes of an inflationary episode, an exchange rate crisis, or banking crisis or some other type of turmoil. In such cases, it seems to me that including these countries would

only introduce more noise into a weighted average estimate of \bar{p}^* .

When one thinks of \bar{p}^* as an index of the world price level of tradables, we know exactly the question that is answered by $E\bar{p}^*/\bar{p}_d$. That question is “How many baskets of world tradables can be bought with one Russian production basket (if \bar{p}_d is Russia’s GDP deflator) or with one Russian consumption basket (if \bar{p}_d is Russia’s consumer price index)?³

The Real Exchange Rate $E\bar{p}^*/\bar{p}_d$ Is Invariant With Respect to the Foreign Currency of Reference, when the SDR-WPI Is Used to Represent \bar{p}^*

A great amount of confusion has been caused by approaching the question of the real exchange rate starting from a concept of purchasing power parity. Purchasing power parity is essentially a bilateral concept, which had its greatest usefulness in periods where one country had undergone serious inflation, and was choosing a new exchange rate as part of a stabilization plan. Purchasing power parity would say that this new rate should reflect changes in relative price levels. Thus if country A’s price level had multiplied by 10, while country B’s had multiplied by only 2, then the exchange rate E_{ab} should (to maintain “purchasing power parity”) have multiplied by five.

This is not the place to enter into an extended treatment of purchasing power parity. Suffice it to say that the theory was developed in the context of major (mainly post World War I) inflations, that it was developed in principle as a bilateral concept, and that it has unquestioned theoretical validity in cases where the only major changes (in the two countries concerned) are

³I have given considerable thought to the question of what index I would recommend to researchers who were not content to use a world tradables numeraire as their index for \bar{p}^* . My considered conclusion is that the best alternative would be \bar{p}_{mj}^* , an index of the world prices of country j’s imports. In this case $E\bar{p}_{mj}^*/\bar{p}_{dj}$ tells us how many baskets of Russia’s imports can be bought with one Russian production (or consumption) basket.

strictly monetary in nature.

The real exchange rate, in contrast, is concerned fundamentally with real (i.e., nonmonetary) issues, and is distinctly non-bilateral. I purposely use the word non-bilateral rather than multilateral, because the RER reflects adjustment mechanisms that take place within a single country. When a disequilibrium appears between the flow supply and the flow demand for foreign currency in Russia, the adjustment of $E\bar{p}^*/\bar{p}_D$ is essentially a Russian phenomenon. The instruments at Russia's disposal to solve this problem are the nominal exchange rate E on the one hand and movement of the internal general price level \bar{p}_D on the other. If the world price level \bar{p}^* moves in a given period, that may help, in the sense of reducing the gap between the prevailing real exchange rate and its new equilibrium level, or may hurt, in the sense of making that gap even bigger. But whatever happens to \bar{p}^* lies beyond the control of the Russian authorities and of the Russian economy in general.

This leads us directly to think of the RER as the principal equilibrating variable for disequilibria between the demand and supply of foreign currency, whatever may be the source of those disequilibria. Import restrictions curtail demand, creating a situation of excess supply at the old real exchange rate; so, to equilibrate the market, the real price of the dollar must fall. With export restrictions it must rise, with capital inflows it will fall, to the extent they are spent on nontradables. With real cost reductions in the production of tradables, an excess supply of dollars (at the old RER) is created, so to reach the new equilibrium the real price of the dollar must fall. In responding to all disturbances that alter the supply and demand relationship at the old RER, a change in the real price of the dollar is the way the economy reaches (or tries to reach) a new equilibrium.

All of the above is aimed at convincing readers that the real exchange rate is a variable that moves as the economy tries to find its way to a new equilibrium after any sort of shock that

disturbs the old equilibrium of supply and demand for foreign exchange. This being the case, it should not be a matter of importance whether one works with U.S. dollars, or with British pounds or with Deutschmarks, or with Yen, in defining the real exchange rate. And this is in fact the case. One can measure the RER working with any given currency, and the end result is the same exact number, down to the last decimal place.

Let E_{r1} be the price of the dollar in terms of rubles, E_{r2} the price of the DM, E_{r3} the price of the franc, and E_{r4} the price of the pound and E_{r5} the price of the Yen. Similarly E_{12} , E_{13} , E_{14} and E_{15} give the prices, in U.S. dollars, of the DM, the franc, the pound and the Yen.

If we start from E_{r1} , the ruble price of the dollar, as the nominal exchange rate, we will have

$$(14) \quad \begin{aligned} \text{RER} = (E_{r1} / \bar{p}_d) [& f_1 \text{WPI}_1 + f_2 E_{12} \text{WPI}_2 \\ & + f_3 E_{13} \text{WPI}_3 \\ & + f_4 E_{14} \text{WPI}_4 \\ & + f_5 E_{15} \text{WPI}_5] \end{aligned}$$

But if we start from E_{r2} , the price of the DM, we get:

$$(15) \quad \begin{aligned} \text{RER} = (E_{r2} / \bar{p}_d) [& f_1 E_{21} \text{WPI}_1 \\ & + f_2 \text{WPI}_2 \\ & + f_3 E_{23} \text{WPI}_3 \\ & + f_4 E_{24} \text{WPI}_4 \\ & + f_5 E_{25} \text{WPI}_5 \end{aligned}$$

But (15) yields exactly the same number for the RER as does (14). To see this, note that $E_{12} = E_{21} \times E_{11}$, i.e., the ruble price of the DM equals the ruble price of the dollar times the dollar price of the DM. Note also that the expressions in square brackets $\sum_j f_j E_{ij} \text{WPI}_j$ are equal to \bar{p}_i^* , the SDR-WPI world price index of tradables, expressed in currency i . Thus to move from (14) to (15), we multiply the first term by E_{12} , and the second term by E_{21} . But the end result of this is no change in the value of RER because $E_{12}E_{21} \equiv 1$, i.e., the dollar price of the DM is the reciprocal of the DM price of the dollar.

Thus, the real exchange rate, as we measure it, is not modified as one changes from one reference country to another. And it would not change either, if we took as a reference country one (like, say, Sweden or Switzerland) that was not represented in the calculation of the SDR-WPI. But of course we would in that case not be using information from the wholesale price index of Sweden or Switzerland in the calculation of the real exchange rate. We would still be basing our calculation on the weighted average of the wholesale price basket of those countries included in the IMF's definition of the composition of the SDR.

The Quantity Axis -- In Units of "Real Dollars' Worth"

In this and the next subsection we explore alternative measures of the real exchange rate in terms of what they imply about how we should measure the "quantities" of tradables.

We start with the measure of quantity that is implied by our preferred definition -- $\text{RER} = E\bar{p}^* / \bar{p}_d$. In order to focus the discussion on a concrete problem, we take a rise in the world price of a major export commodity (e.g., petroleum in the case of Russia) as the disturbance whose consequences we want to trace. Figure 6 presents a graphical representation of this problem.

The initial equilibrium (before the oil-price rise) is at point N_0 . This is the intersection of the demand curve for imports, $[M^d(y_0, p_p^{*0})]$ and the supply curve of exports $[X^s(y_0, p_p^{*0})]$ that correspond to the initial level (y_0) of GDP, and the initial world price (p_p^{*0}) of petroleum.

The change in petroleum price causes the equilibrium level of real GDP to rise, hence we expect the demand curve for imports to be displaced to the right. The supply curve of exports also shifts to the right, as the oil price rise leads to a greater generation of “export dollars” at each possible level of the RER. The new equilibrium is at point N_1 . This is drawn so as to produce the expected (Dutch disease) result, of a fall in the equilibrium real price of the dollar.

What can we say about the units of measurement along the quantity axis in this case? Actually we can say a great deal, because the answer is directly implied by what we have on the vertical axis. The vertical axis in this case is $(E\bar{p}^*/\bar{p}_d)$ -- “the real price of the real dollar”. Hence we must be measuring quantity, along the quantity axis, in units of real dollars. The proper measure of the quantity of imports V_m is $(\sum_i M_i p_i^*)/\bar{p}^*$, and that for the quantity of exports V_x is $(\sum_j X_j p_j^*)/\bar{p}^*$. With these measures of quantity, we have $V_m^0 = V_x^0 = V^0$ in the initial equilibrium, and $V_m^1 = V_x^1 = V^1$ in the new equilibrium.

If we call the initial real exchange rate R^0 and the new one R^1 , we can also determine that

$$V^0 R^0 = \frac{E \sum_j X_j P_j^{*0}}{\bar{p}_d^0} = \frac{E \sum_i M_i P_i^{*0}}{\bar{p}_d^0}$$

and

$$V'R' = \frac{E\Sigma X_j P_j^{*1}}{\bar{p}_d^1} = \frac{E\Sigma M_i P_i^{*1}}{\bar{p}_d^1}$$

Thus, in each equilibrium we have equality between the nominal dollar values of imports and exports; $(\Sigma X_j P_j^* = \Sigma M_i P_i^*)$, between the real dollar values of imports and exports

$$(\Sigma X_j P_j^* / \bar{p}^* = \Sigma M_i P_i^* / \bar{p}^*),$$

and between the real ruble counterparts of these values:

$$(E\Sigma X_j P_j^* / \bar{p}_d = E\Sigma M_i P_i^* / \bar{p}_d).$$

In short, when we measure the quantity axis in units of real dollars, as indicated, everything works as it should. No contradictions or special complications emerge.

What Happens When We Try to Put Quantum Units on the Quantity Axis?

In this section we look at exactly the same case -- a rise in the world price of a major export product. But this time we will do so using quantum indexes of imports and exports as the variables appearing on the horizontal axis.

For our quantity units of imports and exports we take the simplest possible measures

$Q_m = \Sigma M_i P_i^{*0}$ = each period's imports measured at base year international prices.

$Q_x = \Sigma X_j P_j^{*0}$ = each period's exports measured at base year international prices.

The condition we want to impose is that the corresponding price indexes, \bar{p}_m and \bar{p}_x should meet the condition that price times quantity equals total expenditures (for imports) and total receipts (for exports). And for comparability with the analysis of Figure 6, we want these total receipts and total expenditures to be expressed in units of real rubles (i.e., nominal rubles divided by \bar{p}_d). Thus,

$$\bar{P}_m Q_m = E(\sum_i M_i P_i^*) / \bar{p}_d$$

$$\bar{P}_x Q_x = E(\sum_j X_j P_j^*) / \bar{p}_d$$

Dividing by the corresponding expressions for Q_m and Q_x , we easily derive

$$\bar{P}_m = \frac{E}{\bar{p}_d} \left\{ \frac{\sum_i M_i P_i^*}{\sum_i M_i P_i^{*o}} \right\} = \frac{E \bar{P}_m^*}{\bar{p}_d}$$

$$\bar{P}_x = \frac{E}{\bar{p}_d} \left\{ \frac{\sum_j X_j P_j^*}{\sum_j X_j P_j^{*o}} \right\} = \frac{E \bar{P}_x^*}{\bar{p}_d}$$

It can readily be seen that the terms in brackets are Paasche (i.e., current-quantity weighted) indexes of the world prices of imports and exports respectively. We can call these indexes \bar{p}_m^* and \bar{p}_x^* . Since these are indexes of nominal dollar prices, they have to be converted into rubles and expressed in real terms to produce \bar{p}_m and \bar{p}_x , as measured on the vertical axis of Figure 7.⁴

⁴It is a well known property of Laspeyres (base-year weighted) and Paasche (current-year weighted) indexes that one must have asymmetric price and quantity indexes in order that their product accurately reflect what is happening to the monetary value of the aggregate they represent. This old "rule" is reflected in the calculation of Q_m and \bar{p}_m^* and of Q_x and \bar{p}_x^* . For those who may not be aware of the old rule, the demonstration goes as follows:

$$Q_L = \sum_i p_i^o q_i^t / \sum_i p_i^o q_i^o$$

$$P_P = \sum_i p_i^t q_i^t / \sum_i p_i^o q_i^t$$

$$Q_P = \sum_i p_i^t q_i^t / \sum_i p_i^t q_i^o$$

$$P_L = \sum_i p_i^t q_i^o / \sum_i p_i^o q_i^o$$

Obviously $Q_L P_P = Q_P P_L = \sum_i p_i^t q_i^t / \sum_i p_i^o q_i^o$.

Analysis of Figure 7

Figure 7 is so constructed that the initial Q_m^d and Q_x^s curves, are identical with those in Figure 6. So, too, then, are the initial points on the quantity and price axes. Thus, taking the initial \bar{p}^* to be equal to unity, we have $V^o = \sum X_j^o P_j^{*o} = Q_x^o$ and $V^o = \sum M_i^o P_i^{*o} = Q_m^o$.

And taking the initial indexes \bar{p}_m^{*o} and \bar{p}_x^{*o} to be equal to unity we have

$$E^o \bar{p}^{*o} / \bar{p}_d^o = E^o \bar{p}_m^{*o} / \bar{p}_d^o = E^o \bar{p}_x^{*o} / \bar{p}_d^o.$$

That is, $R_o = \bar{p}_m^o = \bar{p}_x^o$.

Readers will surely find something unusual about the “new” equilibrium in Figure 7 -- it is characterized by two points -- N_1^m and N_1^x . This is very strange, but it is not wrong, for both Figure 6 and Figure 7 are dealing with the same event. The difference is that in Figure 6, both exports and imports are being measured in dollars' worth, so the condition of balanced trade in the new equilibrium gives us the same amount on the horizontal axis.

In Figure 7, the horizontal axis measures quanta, not dollars' worth. Obviously, if the price of petroleum has risen, while other tradables prices have stayed the same, the Paasche export price index \bar{p}_x^* must have gone up, while the corresponding import price index \bar{p}_m^* remains the same. This automatically guarantees that N_1^x and N_1^m will have different ordinates $(\bar{p}_x^1 = E\bar{p}_x^{*1} / \bar{p}_d)$ and $(\bar{p}_m^1 = E\bar{p}_m^{*1} / \bar{p}_d)$. But now the condition of balanced trade requires that they have different abscissae also.

This is the way Figure 7 is drawn. N_1^x and N_1^m represent two points at which the value of imports equals the value of exports. And because relative prices have changed from the

initial equilibrium at N_o , these equal-value points will be composed of different price-quantity combinations. As shown in the diagram, their equal-value attribute means that the same rectangular hyperbola will pass through both points.

As shown in the graph, the quantum of exports actually declines between N_o and N_1^x . This is a clear possibility but it need not be the case. We can be sure, however, that the quantum of non-oil exports will decline, because: a) their internal price has fallen along with the real exchange rate, leading to a reduced quantity supplied, and b) the rise in GDP occasioned by the oil-price boom would normally cause an increase in the quantity of exportables that is demanded by the internal market.

I will not try here to elaborate any further on Figure 7. My purpose was simply to show how complicated and awkward it is to pursue real exchange rate analysis while measuring exports and imports in quanta instead of in “real dollars’ worth”. Figure 6 is much simpler and more straightforward than Figure 7.

In real world applications the case for measuring tradables in real dollars’ worth is even stronger. For in real-world situations the world prices of most items (both import and export goods) are changing from period to period. This presents no problem in quantifying exports and imports in real dollars’ worth, for their dollar values are regularly published in International Financial Statistics as well as in most countries’ own official bulletins. It presents a huge problem, however, if we want to measure them as quanta. (Existing price and quantity indexes for imports and exports typically cover only limited lists of products, and many countries have no such indexes at all.)

The Supply and Demand for “Dollars’ Worth”

Having, I hope, convinced my readers of the wisdom and convenience of carrying out real exchange rate analysis using the “real dollars’ worth” as the basic quantity unit, my next task is to show how this concept relates to ordinary supply and demand curves.

Figure 8 takes a hypothetical supply curve of exports of petroleum. Consider the following data.

The basic export supply curve, within Russia, says that at a price of 150 rubles per barrel, 6.67 million barrels will be exported. Total ruble receipts will be 1000 million. If the exchange rate is 10 rubles to the dollar, this point on the standard export supply curve will be reflected in dollar receipts equal to 100 million dollars. This corresponds to a world price p_p^* equal to \$15 per barrel. Point A in Figure 8 represents this point. Russian suppliers are supplying 6.67 million barrels at a price of 150 rubles per barrel (not shown on graph). The total receipts of 1000 million rubles correspond to 100 million dollars at an exchange rate of 10 rubles = \$1 dollar.

Suppose now that we consider what would happen if the world price of oil were \$30 instead of \$15. The first point to note is that the situation inside of Russia would not be different, if Russian producers continued to get 150 rubles per barrel. They would still produce 6.67 million barrels, generating total receipts of 1000 million rubles. But now 6.67 million barrels will be producing \$200 million of receipts. What is required to make 200 million of dollar receipts equal to 1000 million of ruble receipts is an exchange rate of 5 rubles per dollar, as at A'. Thus A and A' represent exactly the same supply situation within Russia -- exports of 6.67 million barrels, a price of 150 rubles per barrel, and total receipts of 1000 million rubles. The only difference is that at point A this 1000 of receipts comes from a world price of \$15 per barrel yielding \$100 million to be converted at an exchange rate of 10 rubles per dollar, while at

point A' this same 1000 of receipts comes from a world price of \$30 per barrel yielding \$200 million to be converted at an exchange rate of 5 rubles per dollar. To move from A to A' we simply cut the rubles per dollar in half, and double the quantity of dollars.

Point B in Figure 8 reflects a different point on the underlying supply curve. Here the internal price of oil is 300 rubles per barrel, and the quantity of oil exports is 13.33 million barrels. Total receipts are now 4000 million rubles. This internal equilibrium position will have different representations on the supply function of dollars, stemming from petroleum exports, depending on the world price of oil. If the world price of oil is \$15, 13.33 million barrels will sell for \$200 million, which in turn will generate the 4000 million of ruble receipts only when the price of the dollar is 20 rubles. This gives us point B in Figure 8.

If now the world price of oil gets to \$30, one would get to the same equilibrium point only if the ruble price of the dollar were 10 rubles. This is shown as point B' in Figure 8.

Points A and A' both represent total receipts of 1000 million rubles. Points B and B' both represent total receipts of 4000 million rubles. If we connect A and B we get a supply curve of dollars stemming from exports of petroleum, given a world price of \$15. Similarly, if we connect A' and B' we get the corresponding supply curve that applies when the world price of oil is \$30.

Figure 8 thus shows us exactly what is involved when the world price of an export product changes. Each point on the "old" supply curve of dollars is mapped into a new point (i.e., A is mapped into A' and B into B'). This remapping takes place through a rectangular hyperbola. If the world price doubles, each old point is mapped with a new point where the ordinate is cut in half and the abscissa is doubled. If the world price increases by 50%, each ordinate would be multiplied by $2/3$ and each abscissa by $3/2$. This is the general rule that tells

us how any curve representing the supply of dollars from any given export good would be modified if the world price of that good were to change.

If one thinks about it hard enough, one begins to feel very comfortable with the idea that a change in the world price level of a tradable good will generate a rectangular hyperbolic remapping of any basic curve whose ordinate is “rubles per dollar” and whose quantity axis is measured in dollars. (Of course, as shown earlier, we can, at will, use DM or Yen or Pounds or any other foreign currency in place of dollars.)

This is a convenient point to shift the discussion to the demand curve for imports. Here it is conceivable (though of course unlikely) that the relevant “demand for imports” curve could itself have a unitary elasticity over the relevant range. Applying a rectangular hyperbolic remapping to such a curve would “map it into itself” ;-- i.e., a point like A’ would be at a different place on the same curve as point A. And similarly points like B and B’ would lie on the same curve.

Though interesting, the case of a unit elastic demand curve for any particular import good is not something we are likely to encounter very often in the real world. The importance of this example lies instead with the idea of a unit elastic curve as a boundary line. For it is easy to see that if the world price rises for a good with an own-price import demand elasticity of less than one, total demand for dollars will increase, while if the good whose price has risen has an import demand elasticity greater than one, the total demand for dollars will fall. This leads to an important generalization for the analysis of changes in the world prices of particular tradable goods. If the world price of any export good X_j rises, the supply of dollars as a function of the real exchange rate always shifts to the right. But if the world price of an import good M_i should rise, the consequent shift in the country’s demand for dollars’ worth of imports as a

function of the real exchange rate can be either to the left or to the right, depending on whether the underlying demand for imports of M_i is elastic (left) or inelastic (right).

The Real Exchange Rate as the Fundamental Equilibrating Variable of a Country's International Trade and Payments

In this section I attempt to summarize, and also draw what I believe to be a few of the main lessons of real exchange rate analysis. The short message is this -- there are many different types of disturbances that can create a need for adjustment, but there is only one principal and natural equilibrating variable if a country's international trade and payments, and that is that country's real exchange rate. This variable is not a bilateral variable, vis-a-vis one or another country, but is instead a variable internal and specific to the country in question. We saw how, regardless of whether we do the measurement of tradables demand and supply in terms of dollars, DM, Yen or Pounds, the underlying analysis is the same. The quantity axis, whether we label it real dollars' worth, real DM worth, or real Yen worth, is in the final analysis expressed in some standard basket of tradables, and the price axis, measured as $E\bar{p}^* / \bar{p}_d$ measures how many standard baskets of tradables can be bought with one standard Russian basket as defined by Russia's CPI or GDP deflator. Thus, while it is very helpful to think in terms of dollars' worth on the horizontal axis and the real price of the real dollar on the vertical axis, it is very important to realize that the actual supply and demand curves we work with would be identical if we chose to do our labeling in terms of real DM or real pounds, and to consider the RER to be the real price of the real DM or of the real pound. The reason for this is that as we shift our unit of expression from one currency to the other, E and \bar{p}^* change in precisely inverse proportions, so that their product stays exactly the same. And on the horizontal axis a variable like $\sum M_i P_i^* / \bar{p}^*$ or $\sum X_j P_j^* / \bar{p}^*$ will also remain unchanged. If one dollar equals two DM,

then when we change our “foreign currency of choice” from dollars to DM, we simply double every individual p_j^* , and at the same time double \bar{p}^* . So nothing really changes when we make this currency switch.

So what we are talking about is internal adjustment to disequilibria coming from a whole array of possible sources -- changing tariffs or other import restrictions; modifying subsidies, taxes, or other policies affecting exports; changing world price of importable or exportable goods; technical advances in the local production of either importables or exportables or nontradables; capital movements spent in different proportions on importables, exportables, and nontradables. All these disturbances lead to different sorts of shifts in the demand and supply curves for dollars' worth of imports, exports, and tradables taken as an aggregate

But the above list covers only trade-oriented distortions. The demand and supply curves we have been talking about will also shift as a consequence of a major tax reform, or a new highway program or a big increase in educational outlays, or a sharp cutback in military spending. So the idea to keep in one's mind is that the conditions generating trade equilibrium are always in a state of flux, and the equilibrium real exchange rate is always changing. Happily, most movements of this ever-shifting equilibrium are spread over substantial periods of time, and adjustment takes place gradually, working through E and through \bar{p}_D in relation to \bar{p}^* .

Even when adjustment is gradual, taking the form of almost imperceptible steps per month or per quarter, we as analysts should be aware of what is going on -- we should understand the process that is taking place. But it is even more important for us to understand what is going on when a big RER adjustment is called for. A major change in the world price of oil, a big shift in the rate of capital outflow or inflow, a significant fiscal reform, either on the tax or expenditure side -- these are disturbances that are likely to cause important disequilibria in

international trade -- disequilibria that will have to be equilibrated by a significant RER adjustment.

Understanding basic real exchange rate economics will help one to be able to diagnose these situations when they happen. When the real price of the dollar is trying to rise, this can come about either through an increase in E or a fall in \bar{p}_d . Typically, if the nominal exchange rate is being held within some band by the Central Bank, this type of disequilibrium will be reflected in downward pressure on the general price level (working mainly, of course, on its nontradable components). When we see this sort of downward pressure we should ask ourselves whether we are in a situation of RER disequilibrium, and if so whether the most prudent course would not be to allow the nominal exchange rate to rise, rather than suffer the pangs of an internal deflation.

Similarly, when the disequilibrium is in the other direction and the real price of the dollar is trying to fall, the country can benefit greatly if the authorities recognize the nature of the scenario they are in. If the nominal exchange rate is being held fixed or within a narrow band, the price level will have to rise in order to reach equilibrium at a lower real exchange rate. The public usually perceives this sort of price level rise as representing inflation. But if so they should be made aware that it arises out of natural economic forces, not out of fiscal or monetary indiscipline. In that sense, one can say it is not really inflation, but only a very important adjustment of relative prices, making nontradables more expensive relative to tradables.

From the analytical side, the important point to remember is that disturbances cause shifts of the demand and supply curves we are talking about and that equilibrating adjustments take place along the curves, working to eliminate an excess demand or excess supply of real dollars. And in conceptualizing the adjustment process, we view it as a parallel movement of the prices of all tradable goods -- i.e., a movement of the price of tradables as a composite commodity.

This leads to my final point, which is that the demand and supply curves that we have drawn in this paper are not what many people think. The demand curves for imports in our diagrams do not represent how demand changes when only import prices rise, nor do the supply curves of exports represent how supply changes when only export prices rise. Rather, they represent how first, import demand and second, export supply respond (respectively) when the prices of both imports and exports, and, in fact, of all tradable goods taken as a group, move up and down together. This is the machinery by which the equilibrating adjustments take place.

As a corollary of the same point, it is to be expected that these curves will be much less elastic than the individual demand curves for particular imports and the individual supply curves of particular exports. This is because, when all tradables prices move up and down in lockstep, no substitution is generated among them. A good guess at the elasticity of demand for total Tradables (T^d) is -0.25. The elasticity of supply of total tradables might be as low as +0.25 for a country like Russia, where primary products account for a large share of total tradables. This elasticity gets higher as the share of manufactures in total tradables production gets larger, for total manufacturing production responds more readily to price stimuli than total primary production.

The elasticities of import demand and export supply are somewhat more difficult to characterize, because by their nature they are, in principle at least, excess supply and excess demand curves. An excess demand curve draws its elasticity not only from the underlying demand function for the good or goods in question, but also from the underlying supply function.

And similarly, an excess supply curve draws its elasticity not just from the underlying supply function but also from the corresponding demand function.⁵

Figure 9 is drawn to reflect this type of difference in elasticities. That is, the import demand (M^d) and export supply (X^s) curves are more elastic than the demand and supply curves (T^d and T^s) for total tradables. It is along these curves, which are shifted by a given disturbance, that RER adjustment takes place as one reaches a new equilibrium.

⁵Letting T_i^d and T_i^s represent total Russian demand and total Russian supply of the importable good i , we have

$$\begin{aligned}
 M_i &\equiv T_i^d - T_i^s \\
 \partial M_i / \partial E &= \partial T_i^d / \partial E - \partial T_i^s / \partial E \\
 (E/M_i)(\partial M_i / \partial E) &= (T_i^d / M_i)(E/T_i^d)(\partial T_i^d / \partial E) - (T_i^s / M_i)(E/T_i^s)(\partial T_i^s / \partial E) \\
 \eta_{mi} &= (T_i^d / M_i)\eta_{ti} - (T_i^s / M_i)\epsilon_{ti} \\
 X_j &\equiv T_j^s - T_j^d \\
 (\partial X_j / \partial E) &= (\partial T_j^s / \partial E) - (\partial T_j^d / \partial E) \\
 (E/X_j)(\partial X_j / \partial E) &= (T_j^s / X_j)(E/T_j^s)(\partial T_j^s / \partial E) \\
 &\quad - (T_j^d / X_j)(E/T_j^d)(\partial T_j^d / \partial E) \\
 \epsilon_{xj} &= (T_j^s / X_j)\epsilon_{tj} - (T_j^d / X_j)\eta_{tj}
 \end{aligned}$$

The relative elasticities are those corresponding to goods i and j as components of the composite good consisting of all tradables, so let us take $\eta_{ti} = \eta_{tj} = -0.25$ and $\epsilon_{ti} = \epsilon_{tj} = +0.25$. If, then, for commodity i , imports (M_i) represent one third of total demand then

$$\eta_{mi} = 3(-0.25) - 2(0.25) = -1.25$$

and if for commodity j exports represent one half of total supply, we have

$$\epsilon_{xj} = 2(0.25) - 1(-0.25) = 0.75.$$