

SOME REAL EXCHANGE RATE ANOMALIES:

How “Sterilization by the People” Helps Explain Them

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This paper is intended to be an exercise in real exchange rate analysis. It begins by considering some very basic issues of concept and measurement. Then it turns to exploring how real exchange rate adjustment normally takes place in countries whose nominal exchange rates are either fixed or nearly fixed. Next, it looks at ways in which a country’s authorities can influence the course of the real exchange rate, principally by the use of different mechanisms of “sterilization”. Attention is then called to another kind of sterilization, which I refer to as “sterilization by the people”, stemming from shifts in the amount of real monetary balances that people are willing to hold. Finally, it is shown how, in some important real-world cases, “sterilization by the people” has greatly influenced the actual path taken by the real exchange rate in the wake of massive inflows of foreign currency, and helps explain what initially amounts to be anomalous observations.

Theoretical Background

In my own graduate studies, some 60 years ago, I cannot remember ever seeing or hearing the term “real exchange rate”. It was there behind the scene, of course, when we discussed the mechanisms by which an economy adjusted to different shocks under fixed and flexible exchange rates, but it was not called the real exchange rate. It was only later, in the late

1960s and early 1970s that real exchange rate economics emerged from its chrysalis and began, as it were, to fly on its own.

Leaders like Salter, Swan, Corden and Dornbusch were the attending physicians at the birth and infancy of this new concept. Theirs was the world of the “small open economy”, defined as an economy for which the world prices of tradable goods were set in the world marketplace. The small open economy was a “price-taker” for these tradables; it followed that any adjustment that it had to make to bring about a new equilibrium in the face of a new disturbance would have to take place, in a broad sense, within that same small open economy.

Perhaps the key distinction between this new approach and the earlier tradition was its focus on the dichotomy of “tradables” versus “nontradables” as it dealt with the links between “this country” and the “rest of the world”, while the older approach linked country A and country B in more-or-less symmetrical terms, with the exports of country A being the imports of country B. In the theoretical models of the small open economy, the key relative price was P_t/P_n , the ratio of the price of tradables to that of nontradables. This price ratio took center stage in the new analysis, reducing P_x/P_m (price level of exports relative to that of imports), and known also as the terms of trade, to a more peripheral role. Note that, with given world prices of both exports and imports, P_x/P_m plays no role in the adjustment process. In the modern vision, changes in tradables prices are treated as exogenous shocks rather than endogenous adjustments.

All this makes a great deal of sense when one recognizes that in the process of international adjustment it is in fact the relative price of tradables to nontradables that does the most work. When a flexible exchange rate moves up and down, it gives an incentive to move resources into or out of the production of both exportables and importables. Similarly, even the very old textbook story of adjustments under the gold standard or other fixed exchange rate

arrangement had the internal price level rising relative to the external price level in response, say, to a capital inflow. This is what makes imports cheaper to buy and exports more expensive to produce.¹

Thus, under both fixed and flexible exchange rate systems, a change in the key relative price P_t/P_n is likely to be required as an economy moves to a new equilibrium in the wake of a change in underlying conditions such as resource supplies, international prices, production technologies, taxes, subsidies, etc. This is the basic role of the real exchange rate -- it is the key equilibrating variable of a country's trade and payments. And in carrying out this role, the principal mechanism of adjustment will entail change in P_t/P_n , the relative price of tradables.

Causes of Real Exchange Rate Adjustment

It is easy enough to create a model with one generalized "tradable" whose price is P_t , and one generalized "nontradable" whose price is P_n . But that is not the world we live in -- in which there are literally thousands of goods and services within each of these aggregates. To think more deeply about this scenario, it is convenient to focus on the adjustment process itself. And within this frame, it is easiest to think of the adjustment being accomplished by changes in the nominal exchange rate E (to be thought of, for a peso country, as the number of pesos one has to pay for a dollar that one is buying). We first think of that market as being initially in equilibrium of supply and demand for foreign currency (expressed in dollars in this case). We then consider how that market reacts to a variety of disturbances.

¹This was an unfortunate (thought not really wrong) description of the process, because the reader's attention was focused on different incentives for imports and exports. Yes, those incentives ended up being different, but behind that difference one had basically the same incentive (increased level of local costs relative to the price of the product) driving resources out of the local production of importables, thus causing an increase in imports; and simultaneously driving resources out of the local production of exportables, thus causing a decrease in exports.

Many types of exogenous disturbances can cause the equilibrium E to change:

- New import restrictions -- curtail the demand for imports and hence for foreign currency. The demand for dollars falls, hence E (the price of the dollar) goes down.
- New export restrictions -- curtail the supply of exports and hence of foreign currency. The supply of dollars falls, hence E (the price of the dollar) rises.
- Capital flows into the country in the form of dollars, and is spent on tradable goods. If spent on imports, it is clear that both the demand and the supply of dollars are augmented by the same amount, so there is no need for E to change. The same happens when the incoming capital is spent on exportables. This operates to reduce the amount available for export, and hence the supply of dollars. But the supply gap created by this reduction in exports is filled by the capital inflow, so the equilibrium of supply and demand for dollars is maintained, and there again is no need for E to change. From these extreme examples it can be inferred that, so long as the capital flow is spent on tradables (either importables or exportables), the equilibrium exchange rate E will remain the same.
- But so long as any part of the capital inflow (coming in as dollars) is spent on nontradables, this will create pressure for E , the peso price of the dollar, to go down. This move will be triggered as the dollars are dumped on the market, to be exchanged for the peso needed to buy the nontradable items. Since virtually all capital inflows are spent partly on tradables and partly on nontradables, the standard result is for E to fall, but the extent of the fall will vary, depending on the fraction of the inflow being spend on tradables.
- What was said above with respect to capital inflows applies without modification to inflows stemming from foreign aid, from emigrant remittances, and from other, similar transfers in the form of foreign currency.

- A rise in the dollar price of an export good in a peso country will unambiguously lead to a fall in the peso price of the dollar, because even if the quantity of exports doesn't increase in response, the supply of dollars will be augmented due to the price rise.
- In contrast, the effect of a rise in the dollar price of a major import good will be ambiguous, depending on the peso country's price-elasticity of demand for imports of that good. The borderline case is unit elasticity, where the total demand for dollars (to buy imports of the affected product) remains unchanged in the face of its price rise. More dollars are demanded (and the peso price of the dollar rises) with inelastic demand, and fewer dollars are required (with a consequent weakening of the price of the dollar) with elastic demand for imports of the affected good.
- Technical advances (also known as real cost reductions and as rises in total factor productivity) also have ambiguous effects on the real exchange rate, depending on whether these advances occur in the tradables or the nontradables sector. When real costs are reduced for an exportable product, the supply of exports increases, making the dollar cheaper. When costs are reduced for an import substitute, the demand for imports falls, and the dollar again becomes cheaper. But when the cost reduction occurs in the nontradables sector, it is the supply of nontradables that is augmented. Real income grows, part of which is spent on tradables, thus raising the real price of foreign currency.

Measures of the Real Exchange Rate -- Not Symmetrical, Not Bilateral

In the previous section, readers were asked to perform mental exercises, thinking of the nominal exchange rate as the active player in the adjustment process. These exercises contemplate a passive role for other variables that might be candidates for active player status. Other key variables would be kept passive if, for example, the Central Bank's monetary policy

(under a flexible exchange rate system), together perhaps with the government's fiscal policy, worked to hold constant the price level of tradables, or almost equivalently, the general price level \bar{p}_D . Our mental exercise, then, can be viewed as contemplating movements in the RER ($= p_t / \bar{p}_D$) being reflected through movements in E alone (\bar{p}^* , the foreign currency price level of tradables being taken as given). Equally, we may consider the case in which E (the nominal exchange rate) is fixed; here, as our gold standard textbooks always told us, the adjustment takes place through movements of the general price level \bar{p}_D .

For all the above analysis to hold, our measure of the RER must work with one foreign price level \bar{p}^* which tries to measure the world price level of tradables, and one domestic price level which conceptually could cover only nontradable items, but which can equally well be a general price index, so long as this general index incorporates the prices of nontradables as well as tradables.²

²Let us start from the textbook definition of the real exchange rate as $RER = (P_t/P_n)$, the price level of tradables divided by the price level of nontradables. One must recognize at the outset that outside of the world of textbooks, it is not at all easy to isolate a group of goods called nontradables. The restaurant meal is an amalgam of tradables (food items, furniture, dinnerware, and cooking utensils) and nontradables (the services of cooks, waiters, managers, etc.) So it is with nearly all goods -- even strict imports, as they are sold to local consumers, incorporate a tradable portion (the CIF price) and a nontradable portion (transport from port to market, plus wholesale and retail margins). Thus, much as we may like P_n for its conceptual clarity, enormous obstacles confront its practical measurement. We are lucky, however, because a general price level \bar{p}_D (like the consumer price index or the GDP deflator) can be conceived of as a weighted average of two components -- $p_t (= E\bar{p}^*)$ built up of the pure tradable "pieces" of each final goods price, and p_n , an index comprising the prices of all the nontradable components. Thus we have $\bar{p}_D = \alpha p_t + (1-\alpha)P_n$, with all indexes having a base-year value of 1. The ratio p_t / \bar{p}_D is then equal to $p_t / [\alpha p_t + (1-\alpha)P_n]$, which in turn equals $1 / [\alpha + (1-\alpha)(P_n/P_t)]$. The ratio p_t / \bar{p}_D thus is a monotonically increasing function of (p_t/p_n) , and is hence equally good at reflecting upward or downward movements of the latter variable.

A convenient way to visualize the concept of the ideal exchange rate as $E\bar{p}^*/\bar{p}_D$ is to think of the baskets of goods and services that each of the two price indexes represents. When we do this, we can express the RER as answering the question, “How many domestic (consumer or producer) baskets are needed in order to buy one international tradables basket?” In order for this question to be answered well, the international price level must be focused on tradables, while the domestic price level must incorporate nontradables prices, not necessarily exclusively, but certainly with due weight. This harks back to the origins of real exchange rate analysis and its focus on tradables and nontradables. There is no way that an RER measure can properly perform its equilibrating role if both the numerator and the denominator indexes refer to tradables prices, nor can it do so if both indexes refer to nontradables prices. This is why we have so firmly asserted that a proper measure of the RER cannot be symmetrical.

To see why such a measure should not be thought of as bilateral, one need only consider the origins of real exchange rate economics in the study of the so-called small open economy. It is there made perfectly clear that real exchange rate adjustment contemplates the movement of the real exchange rate in response to a whole host of different types of disturbances (see bullet points above). These adjustments take place for given values of a whole set of determining variables in world markets as the small open economy experiences an internal shock (changes in taxes or tariffs, in factor supplies, or in total factor productivity in any subset of activities) or a shock stemming from abroad (change in flows of capital, foreign aid, emigrant remittances, or in international prices or demand conditions).

An added point -- our discussion so far has treated a country as a pure price-taker facing given international prices for all tradables. This assumption can be modified to take account of situations in which, say, the world demand curve for a country's exports slopes downward (as a

function of its world price). In such cases, we replace the idea of a fixed world price with the alternative assumption that the world demand function for that good remains unchanged. And instead of defining a positive disturbance (for Brazil) as an upward shift in the world price of coffee, we would instead introduce the idea of an upward shift in the world demand curve for Brazilian coffee (as a function of its international price).³

The Adjustment Process Under Fixed Exchange Rates

It should already be clear to readers that, once one has a fixed nominal exchange rate, any shift of a country's equilibrium real exchange rate will have to take place through movements in that country's internal price level \bar{p}_d , which in turn (for given levels of world price \bar{p}^*) will arise out of changes in the nontradable components of \bar{p}_d .

I want to call attention at this point to a very common misconception -- a confusion between what should be thought of as a "real exchange rate adjustment" on the one hand, and what should be considered a "standard inflation" on the other. In trying to put the distinction in capsule form, I have described a standard inflation process as being typically characterized by large budget deficits, by a tendency to lose international reserves, by a tendency of the exchange rate to (want to) depreciate, and by people betting on a future depreciation. In contrast, in most situations of a price level rise that reflects a real exchange rate adjustment in process, one sees a tendency for international reserves to accumulate, a tendency of the exchange rate to (want to) appreciate, and one observes people betting on a future appreciation of the local currency. This is certainly a notable difference, and only reflects that the two phenomena have very different causes and present policymakers with very different sets of plausible policy alternatives.

We will argue here that the most “natural” denouement for a massive shift in a country’s supply of dollars is for the Central Bank to do nothing (or very little) if it has a fixed exchange rate setup. The “rules of the fixed exchange rate game” call for the Central Bank to keep buying the newly-supplied dollars at the stipulated exchange rate. This, for a large inflow of dollars, will cause an important expansion in the supply of base money, M_0 , which in turn will lead, through the money multiplier, to a significant expansion of M_2 (or other relevant aggregate of “broad money”).⁴

In the “natural” scenario of response to a positive shock to the supply of M_2 the public finds its actual holdings of real monetary balances (M_2^S / \bar{p}_d) are larger than its desired holdings (M_2 / \bar{p}_d) of same, so it ends up spending some of the excess. A fraction a_t the newly induced spending will fall on tradables, and another fraction a_n will fall on nontradables. These fractions will not sum to one, except in the rare case where all of the excess monetary holdings (M_2^S / \bar{p}_d) - (M_2 / \bar{p}_d)^d gets to be spent within one period. (Note that the excess holding is a stock variable, while a_t or a_n times that excess represents a flow.)

³Needless to say, we are in this case analyzing the effects on the RER stemming from, say, a shift in the rest of the world’s demand for Brazilian coffee, now no longer thought of as homogeneous with other coffee.

⁴As with national income, output, investment and other magnitudes there is no single, precisely defined monetary aggregate that exactly captures the concept of “broad money”. As in the other cases, some sort of convention is called for, so that professionals can communicate easily and clearly. I believe that the basic concept of broad money is that it represents the principal financial liability of a consolidated banking or financial system whose main assets are “net foreign assets” and “domestic credit”. It is the most meaningful aggregate in terms of which to define the money multiplier, which is the ratio of broad money to base money or the incremental money multiplier which is the ratio of the (actual or expected) increment of broad

We can now consider two “natural” scenarios -- one in which the initial shock is transitory (lasting, say, for one period) and the other in which that shock is more long-lasting. In the first case (a transitory shock), there is only one period of extra purchases of foreign exchange by the Central Bank. Thus there is only one induced expansion of M_0 , and only one resulting jump in M_2 . This leaves people with a certain amount of excess real monetary balances as a result of the shock. But this excess declines over time as people spend, during each successive period, a part ($a_t + a_n$) of these excess holdings. The fraction a_t times the excess holding turns into a loss of international reserves from the Central Bank. Thus M_0 moves back toward its initial level. So long as any of the “excess M_2 ” generated by the initial shock remains in the system, there will be further induced spending out of this excess. In the end M_0 and M_2 will both have been restored to their initial levels, and the ending equilibrium will be the same as the initial (pre-shock) one.

The second “natural” scenario postulates not a one-shot increase in the supply of foreign exchange, but rather a rise in the annual rate of flow of foreign exchange into the country. Now we have a series of sequential purchases of newly-generated foreign currency by the Central Bank, with a new increment to M_0 being generated by each successive transaction.

Corresponding to each ΔM_0 there will be some ΔM_2 , reflecting the workings of the incremental money multiplier. In this case we do not have a restoration of the initial equilibrium, but an approach to a new one reflecting an appreciated equilibrium RER. With a fixed exchange rate, the general price level will rise in successive steps, reflecting successive increases in its nontradable components. Each successive step will cause an increase in the demand for

money to the (actual or expected) increment of base money corresponding to a given (or

importables and hence in the demand for imports. Likewise each successive step will cause an increase in the demand for exportables, leading to a reduction in the amounts available for export.⁵ The end result is a reduction in exports and an increase in imports, leading the Central Bank to sell off some of the extra international reserves it has just bought. In the new equilibrium, the country will be receiving the new long-lasting inflow ΔF of foreign exchange each period, but this inflow will be offset by an induced outflow of equal size, generated by an induced fall in exports and an induced rise in imports.⁶

Whether the exogenous shock is transitory or permanent, the adjustment process entails:

- a) The purchase of dollars by the Central Bank,
- b) The expansion of M_0 and, via the money multiplier, of M_2 ,
- c) Generation thereby of excess monetary balances $[(M_2^s / \bar{p}_d) - (M_2 / \bar{p}_d)^d]$ in the hands of the public,
- d) The resulting spending (not all at once) of these excess balances, finally working the excess down to zero,
- e) A resulting induced new demand for dollars as part of this induced spending goes for tradable goods,

expected future) period.

⁵Similar shifts on the supply side only work to reinforce these effects. Rising costs successively reduce the amount of both exportables and import substitutes that will be supplied at the old price.

⁶Where the exogenous shock ΔF comes from an export expansion (say an oil-price rise for an all-exporting country), the response can be thought of as being concentrated on the country's other exports. Even oil exports in this case will be subject to a rising real price of foreign currency, but this endogenous feedback effect will only be a small fraction of the

- f) A tendency, in this adjustment process for the price level of nontradables p_n and hence of the general price level \bar{p}_D to rise as part of the drawdown of excess monetary balances is spent on nontradables.

The above listing describes what I have called a “natural” process of adjustment to an exogenous increment ΔF in the inflow of foreign currency into a fixed-exchange-rate country. The process we have described is what we would get by dynamizing a simple comparative static model with given factor supplies, given production and demand functions and full employment of resources. This is probably the most direct way of expounding the adjustment process to a new audience. It covers the full process, and (hopefully) touches all the bases.

Yet one must be careful about assuming that this process flows smoothly, from a) all the way to f), in real-world situations involving big increases in F , the inflow of foreign exchange into a country’s economy. We have already seen how the real exchange rate responds to a wide variety of forces, so we must be prepared to find pressures from one or more other forces to be at work at the same time as we observe a big ΔF coming from a particular source.

I do not want, however, to produce an encyclopedic catalogue of all the “other things” that might interfere with the adjustment process we have described. Rather, I plan here to focus on just one important phenomenon -- an increase in the public’s demand for real monetary balances $(M/\bar{p}_D)^d$. this may stem from the general forces of growth in the economy, or from changes in institutions or in the tastes of the people. But, whatever its sources, it can seriously short-circuit the adjustment process as described. For ease of communication, I use the term

exogenous increase ΔF in the inflow of foreign currency (here assumed to stem from an increase in the price of oil).

“sterilization by the people” to describe the consequence of an increased demand for real monetary balances in the face of an increased inflow ΔF of foreign exchange.

Why employ the term “sterilization” in this instance? The answer lies in steps b) and c) above. When Central Banks find themselves expanding base money (and consequently broad money) to a degree that causes them to worry about the consequences, they very often take steps to offset those increases. These steps may include open market operations in which they sell bonds or other financial assets in order to reduce the amount of base money outstanding. They may also include increases in the amount of M_0 that commercial banks are required to hold as a reserve against their deposits (or sometimes loans), thus reducing the money multiplier and hence limiting the expansionary effect of the initial increment of M_0 . At times the central government will help in the sterilization process by transferring some of its deposits from the commercial banks to the Central Bank, thus immobilizing that portion of M_0 .⁷

Obviously, another way to short-circuit the expansionary effect of an increase in M_0 is for people to willingly hold a significant portion of the resulting expansion of M_2 . This can happen as a consequence of a rising real GDP, no matter whether its source is linked or not to the increase ΔF in foreign exchange receipts, or it can happen because of some other source of shift in the demand for real monetary balances (institutional changes, monetization of a backward economy, reduced inflationary expectations, an improved political environment, etc.)

⁷The components of M_0 include both currency and the deposit liabilities of the Central Bank. These deposits in turn can be held by the commercial banks themselves (typically as reserves against their deposits) or by the government (or occasionally by private sector entities). Typically, when the government shifts a deposit from commercial banks to the Central Bank this transaction results in a reduction of the amount of currency plus bank reserves, which is the simplest textbook example of the monetary base.

Going back to our textbook examples, a one-time increase of ΔF in the inflow of foreign exchange in a fixed-exchange-rate economy will normally have an initial impact of $\mu\Delta F$ on the broad money supply. This would be worked off through a bulge in the internal price level, \bar{p}_d inducing a series of balance-of-payments deficits, causing successive drops in the levels of international reserves, of base money M_0 , and consequently of broad money M_2 . But this entire adjustment process would be averted if for whatever reason the demand function for real cash balances $(M_2 / \bar{p}_d)^d$ were to shift upward by the amount $\mu\Delta F$, thus turning this amount into a desired (rather than an unwanted) increase in the supply of money.

Turning to the case of a long-lasting increment ΔF in the flow supply of foreign exchange, suppose ΔF to be equal, say, to 10% of each period's GDP. This would lead to the supply of M_2 increasing in each period by the amount $.1\mu y$ where μ the money multiplier is and y is GDP. This increase in the supply of M_2 would be automatically offset with GDP growth at the rate γ , an income elasticity of demand for real monetary balances of σ , and $\sigma\gamma M_2 = .1\mu y$.

All the forces described above for the adjustment of the real exchange rate would still be present in latent form, but they would not be triggered into action, because the gap between (M_2^s / p) and $(M_2 / p)^d$ (a critical step for setting in motion the adjustment process previously described) would never be opened.

Obviously, there is no significant chance that real-world cases would be characterized by such a neat offsetting of opposing forces. There are certainly no endogenous economic pressures that would work to produce this kind of full offsetting in some automatic way. In short, full offsetting, if it were to occur, would be a random event, not a natural equilibrium phenomenon.

But while full offsetting must be regarded as an accident of history, some degree of offsetting must be thought of as being quite likely. Thus, in an empirical analysis of a country's real exchange rate history, one should be careful not to simply treat a big oil-price rise or a major export boom or a new wave of large capital inflows and/or emigrant remittances as the main disturbances, leaving everything else locked up in the pound of ceteris paribus. No, one must diligently look for signs of other forces that are simultaneously at work. And of these forces, particular attention should be paid to those influencing the time path of $(M_2/p)^d$ -- desired real monetary balances. In the remainder of this paper we attempt to show how important it can be to follow this advice.

The Case of China, 1996-2003

This paper focuses specifically on the case of China because of its apparently anomalous behavior. Across the world, business writers and the news media generally have noted how stable has been the exchange rate between the yuan and the U.S. dollar. At the same time these same sources noted how large has been the accumulation of international reserves by the People's Bank of China (PBC = China's Central Bank). The juxtaposition of these two undeniable facts has led to accusation from many sources that the PBC was intervening in the foreign exchange market, with the objective of artificially manipulating China's (real) exchange rate, thus giving an artificial stimulus to that country's exports. In this section we attempt to examine these claims and to develop a clear picture of the process of real exchange rate determination in China over this period.

The starting point for analyzing Table 1 is the observation that China was on a fixed exchange rate system (8.3 yuan per dollar) from 1995 through 2004. Hence when we examine the period from December 1996 to December 2003, we should proceed with this in mind. In

particular, we should recall that in such a system the “rules of the game” call for the Central Bank’s buying and selling foreign exchange at this fixed rate.

It is clear that in following this rule the PBC bought lots of dollars over this period, creating 2,158 billion yuan of base money in this way. But base money (M_0) expanded by more than this, increasing by 2,597 billion yuan. Thus we can say that none of the base money

TABLE 1
Key Economic Data -- Mainland China, 1996-2006

	December 1996	December 2003	December 2006
Consumer Price Index (\bar{p}_D)	115	117	125
Nominal Exchange Rate (E)	8.30	8.28	7.80
World Price Level (\bar{p}^*)	95	102	129
Real Exchange Rate ($E\bar{p}^*/\bar{p}_D$)	6.86	7.22	7.90
Net Foreign Assets (PBC)	956b	3,114b	8,485b
Base Money PBC (M_0)	2,689b	5,284b	7,776b
Broad Money (M_2)	7,610b	22,122b	34,509b
Money Multiplier (μ)	2.83	4.19	4.44
Domestic Credit	6,424b	17,270b	23,954b
Nominal GDP (Y)	7,416b	13,540b	22,117b
Bonds Outstanding (PBC)	-	303b	2,974b

Source: International Monetary Fund, International Financial Statistics.

expansion stemming from foreign exchange purchases was offset by China's Central Bank operations during this period. It is true that the PBC did sell 305 billion worth of bonds during this period, thus sopping up an equivalent amount of base money. But even after this absorption was accomplished, M_0 rose by some 440b yuan more than what could be accounted for by the bank's foreign exchange operations.

Let us now focus on the huge increase in the PBC's foreign currency holdings and the great expansion of M_0 that it entailed. Let me at this point simply ask readers to accept that such an expansion of M_0 would cause panic or near-panic in any typical Central Bank trying to pursue a prudent policy and at the same time maintain a fixed exchange rate. We cannot prove the panic part of this story, but IMF data clearly show that the "standard" reaction of Central Banks to a large rise in their foreign exchange holdings is to "sterilize" a significant part of that monetization. This was not done by the PBC, and this leads to our next question -- why was it not done?

Again, I cannot get inside the thinking of the PBC authorities, but I believe I understand what must have been their reasoning. When the flood of dollars first began, and they found themselves printing ever more base money even at an accelerating rate, they must certainly have started to worry about the potential inflationary consequences. But as time went on, and no serious rise in the price level occurred, their fears were doubtless eased -- certainly the problem of potential inflation would have seemed less urgent. Thoughts of taking sterilizing actions must surely have entered their minds, but why do so while prices still remained stable? The proverbial counsel of "don't rock the boat when things are going well" would seem particularly apt in their case. Real GDP was growing at around 10% per annum, millions of people were being lifted out of poverty each year, the country's performance was being applauded all over the world -- even

being hailed as a miracle. Why put so happy a situation at risk by taking actions which in themselves are sharply deflationary? Particularly so if the inflation that one was thinking of fighting had not actually broken out, and showed little sign of doing so?

I paint this likely scenario in some detail, mainly to show that in order to rationalize the PBC's actions (or lack of them) in this period, one doesn't need the slightest element of "machinations" aimed at "manipulating the real exchange rate" so as "artificially" to stimulate the country's exports. All it takes is a passive attitude, following in the first place the "rules of the fixed-exchange-rate game", and then in the second place being quite content (even though maybe a bit surprised) to find that the economy was growing at a spectacular rate, with little sign that the consequence they most feared (an inflationary outburst) was imminent.

China -- 2003-2006

The Chinese economy continued to boom in this period, with real GDP still growing at around 10% per year, and exports expanding even faster. The Central Bank continued to purchase foreign exchange at an ever-expanding pace. All this simply continued the elements that characterized the prior period. But there was one major difference -- direct sterilization by the Central Bank reached massive proportions. The dollar value of the Central Bank's reserve holdings more than doubled, going from \$408 billion to \$1,068 billion in a mere 3 years. This was reflected in an expansion of M_0 by nearly 2500 billion yuan. But that great expansion of M_0 was modest compared to what might have been. For during the same period the PBC absorbed an additional 2,671 billion yuan through the sale of bonds. Thus we can consider the purchase of foreign exchange to have generated an expansion of around 5 trillion yuan in China's monetary base, of which little more than half was then reabsorbed in bond sales by the Central Bank.

All of this produced an expansion of over 50% in China's broad money supply, something which in most countries (over a three-year period) would cause a serious rise in the price level. But China was not like most countries in this regard. "Sterilization by the people" once again entered the picture, as people were willing to hold nearly all of net M₂ expansion as incremental real monetary balances. China's consumer price index ended up rising only about 7% (or 2 1/3% per year) over this three-year period. But if the PBC had not done any sterilizing, one can estimate that the price level would possibly have risen by an additional 34% (= 2,671 billion now not being sterilized, divided by 7,776 billion yuan of actual base money in December 2006). Can we read into the PBC's actions a desire to maintain price level stability (as against artificially stimulating exports)? Not with 100% certainty, of course, but yes, with a high degree of probability.

It is worth noting that starting in 2005, the policy of a fixed exchange rate with the U.S. dollar was relaxed, and a modest degree of appreciation of the yuan (about 6% over three years) was achieved. One sees here at least a hint: a) that China was allowing adjustment in both the real-exchange-rate components that are subject to its influence -- the internal price level and the nominal exchange rate, and b) that each of these variables contributed an approximately equal amount of adjustment. This foreshadows the next phase of Chinese Central Bank policy -- beginning in 2007.

China After 2006

The big change in PRC actions after 2006 was the shift away from sterilization through sales of bonds by the Central Bank. The actual break can probably best be dated around August of 2007. From December of 2006 to that date, PBC bond liabilities rise by over a trillion yuan to 4,067 billion. From August 2007 to May 2008, in contrast, the increase was only 325 billion. So

sterilization by the Central Bank was being sharply curtailed. But so too was the rate of monetary expansion. Whereas over the year 2006 both base money (M_0) and broad money (M_2) expanded at over 30% per year, that rate of expansion was more than halved during the first five months of 2008. Real monetary balances rose only by about 2% in this period. Thus, sterilization by the people was reduced practically to zero. Here again, domestic adjustment took place with the consumer price level rising and the nominal exchange rate falling (= appreciating). The CPI rose by around 3% while the nominal exchange rate fell by 5%. Again, the internal adjustment was divided close to equally between these two mechanisms.

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This brings me to a brief note on the nature of real exchange rate adjustment. In general, one can say that in any given moment, there is an equilibrium real exchange rate for a country. Policymakers can modify that equilibrium by changing some real variable (like the Central Bank's net foreign assets, or the country's policy concerning import restrictions), but if this is not done, natural forces will work to seek out that equilibrium. What we've seen in China is, throughout the period examined, a steady and very heavy inflow of foreign exchange. In the first period, 1996-2003, this disturbance (which by itself would cause a large real exchange rate appreciation) was offset by a huge increase in people's desired real monetary balances. This was an independent force operating on the RER, not a natural equilibrating response to the huge foreign exchange inflow. But fortuitously, in a sense, it succeeded in creating a situation in which the price level could remain virtually constant for several years. (One could also say that in this period the Central Bank expanded its domestic credit (i.e., antisterilized) with the effect of preventing the price level from falling as a result of the massive "sterilization by the people".)

In the next period, in spite of massive sterilization by the people, the price level threatened to rise (as part of the natural adjustment of the RER to the massive inflow of foreign exchange). Offsetting the PBC entered with huge bond sales, thus sterilizing close to half of the dollar inflow. This had the effect of containing the price level rise to a mere 7% over three years.

Russia -- 2000-2005

The Russian Federation experienced a serious balance-of-payments and debt crisis in 1998, which led to a major devaluation of the currency, with the exchange rate going from an average 5.78 rubles per dollar in 1997 to an average 28.13 in 2000. From that point forward one can say that the country maintained a nearly-fixed exchange rate for a period of some six years (January 2000 to March 2006). During this period the nominal exchange rate ranged between 28 and 33 rubles per dollar. The 2005 average rate of 28.28 barely differed from the 2000 rate of 28.13.

In this section we will compare what happened in Russia from 2000 to 2005 with the experience of China that we have just examined. Just as was the case in China, Russia enjoyed a great export boom in this period, with exports of goods and services rising from U.S. \$85 billion in 1999 to \$250 billion in 2005. In the same period, the country's balance of payments in goods and services rose from U.S. \$24.6 billion to U.S. \$84.4 billion. This in turn resulted in a huge increase in the foreign reserves of Russia's Central Bank, which went from U.S. \$8.46 billion to U.S. \$175.89 billion between the end of 1999 and the end of 2005. This increment, at an exchange rate of 30, would give rise to an expansion of ruble base money of a little over 5 trillion rubles. And indeed, over this period, the Russian Central Bank's foreign assets account went up by 5.16 trillion rubles. However, actual base money ("reserve money" in IMF

terminology) increased only by 2.51 trillion. This discrepancy automatically leads us to think of sterilization, which indeed took place, but via an unusual route.

In Russia's case during this period the main engine of direct sterilization was the government. Government deposits at the Central Bank rose by 2.07 trillion rubles, thus accounting for about 80% of the difference between 5.16 and 2.5 trillion.⁸

But what about sterilization by the people in the Russian case? Here the amount of broad money rose from 993 billion to 7,221 billion between December 1999 and December 2005, multiplying by a factor of 7.27. Meanwhile, the consumer price level (2000 avg = 100) rose from 90.62 to 206.17, the factor here being 2.275. Real monetary balances thus increased by a factor of 3.195 ($= 7.27 \div 2.275$). Thus the increase of real monetary balances was, in Russia's case, more important than the increase in the price level, in "accounting for" the huge increase in nominal broad money balances.

Thus we see that real monetary balances in Russia increased by a factor of 3.195 (over the 6 years between December 1999 and December 2005) which compares with an increase factor of 2.849 in China over the 7 years between December 1996 and December 2003. So "sterilization by the people" was just as present in the Russian as in the Chinese case. Yet the

⁸This somewhat unusual form of sterilization is partly explained by central government fiscal surpluses, which rose steadily from 173 billion rubles in 2000 to 1,633 billion in 2005. The motive for the government to put a lot of these funds on deposit at the Central Bank was pretty clearly a desire to help stem the rapid rise of the general price level in Russia. An added stimulus came from the fact that, at least during the early part of the period under review, Russia's Central Bank did not have the legal authority to engage in open market operations (i.e., it was not authorized to sell bonds in the open market). The Central Bank tried to overcome this limitation by an indirect route -- offering commercial banks the opportunity to earn interest on money they put on deposit at the Central Bank. The interest rates offered varied, with the rate being higher for longer-term deposits. This device had the potential of being almost the equivalent of a major open market operation, but it never reached such a size (in part, surely,

Chinese price level hardly moved, while Russian prices more than doubled. The paradox is only apparent, not real. It calls our attention to the fact that one must surely look at what is happening to the demand for real monetary balances in order to understand almost any aspect of monetary adjustment. But it also calls attention, as exemplified by the Russian case, that one can have a great deal of sterilization (in that case both by the government and by the people) and still suffer a very important rise in the general price level. Russia's real exchange rate was seeking a new equilibrium, and was endogenously finding it in spite of all sorts of sterilizations. The general price level was the "safety valve" -- the vehicle through which the final RER adjustment was achieved.

Finally, this comparison reminds us of the point, noted earlier, that "sterilization by the people" contributed enormously to the astonishing stability of China's price level in the face of a huge increase in the money supply, but that this was not the result of some automatic endogenous mechanism that tends to guarantee such a result. As noted, China's increase in $(M_2/p)^d$ can be thought of as an essentially independent force operating on the demand side, which in a given period just "happened" to come close to canceling the upward price level pressure that had its origins in China's huge export boom. If one wants to impute motives to China's monetary authorities, the most natural attribution would be that they were constantly seeking price stability. During 1996-2003, the demand for real monetary balances increased faster than the money supply would have increased based on foreign currency purchases, so in this period one might infer that the authorities actually consciously expanded Central Bank domestic credit in an effort to avert deflation. In the second period (2003-2006), the impact of

because even the highest interest rates that were offered tended to be below the ongoing rate of price inflation).

foreign currency purchases would have led to broad money supply increasing much more than its demand, so here the Central Bank engaged in massive bond sales so as to bring supply close to demand, thus greatly limiting the rise in the price level.