

A Proposed Monetary Regime for Small Commodity-Exporters: Peg the Export Price (“PEP”)

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Summary

The question of the optimal monetary regime for small open economies is still wide open. On the one hand, the big selling points of floating exchange rates – monetary independence and accommodation of terms of trade shocks – have not lived up to their promise. On the other hand, proposals for credible institutional monetary commitments to nominal anchors have each run aground on their own peculiar shoals. Rigid pegs to the dollar are dangerous when the dollar appreciates. Money targeting doesn’t work when there is a velocity shock. CPI targeting is not viable when there is a large import price shock. And the gold standard fails when there are large fluctuations in the world gold market. This paper advances a new proposal called PEP: Peg the Export Price. Most applicable for countries that are specialized in the production of a particular mineral or agricultural product, the proposal calls on them to commit to fix the price of that commodity in terms of domestic currency. A series of simulations shows how such a proposal would have worked for oil producers over the period 1970-2000. The paths of real oil prices, exports, and debt are simulated under alternative regimes. An illustrative finding is that countries that suffered a declining world market in oil or other export commodities in the late 1990s, would under the PEP proposal have automatically experienced a depreciation and a boost to exports when it was most needed. The argument for PEP is that it simultaneously delivers automatic accommodation to terms of trade shocks, as floating exchange rates are supposed to do, while retaining the credibility-enhancing advantages of a nominal anchor, as dollar pegs are supposed to do.

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Among the many travails of developing countries in recent years have been fluctuations in world prices of the commodities that they produce, especially mineral and agricultural commodities, as well as fluctuations in the foreign exchange values of major currencies, especially the dollar, yen, and euro. Some countries see the currency to which they are linked moving one direction, while their principal export commodities move the opposite direction.

Consider the difficult position of Argentina, the victim of the worst emerging market financial crisis of 2001. As is well-known, Argentina’s “convertibility plan,” a rigid currency board, was very successful at eliminating very high inflation rates when it was first instituted in 1991, but later turned out to be unsustainably restrictive. Perhaps it would have been impossible in any case to obey constraints as demanding as the straightjacket of the currency board. But Argentina’s problems in the late 1990s became especially severe because the link was to a particular currency, the US dollar, that appreciated sharply against other major currencies, beginning in mid-1995. At the same time, the market for Argentina’s important agricultural export products (wheat, meat, and soybeans), declined sharply. Thus the declines in the prices of these commodities expressed in terms of dollars were particularly dramatic. The combination led directly to sharp increases in the ratio of debt to exports. Although the particular strong dollar

episode was not predictable when the currency regime was adopted in 1991, the likelihood that large swings of this sort would eventually occur was predictable. This is because the correlation is low between the value of the dollar and the value of commodities (expressed in some common numeraire). It was only a matter of time until they went sharply in opposite directions.¹

Argentina's dire difficulties have encouraged some to reconsider whether a currency board is a good idea after all. But perhaps more thought should be given to *what* anchor the peso has been pegged to, rather than the tightness of the peg.

The advantages and disadvantages of various exchange rate regimes -- fixed versus floating as well as various other places along the spectrum -- are far too numerous to be readily captured and added up in a single model. The academic literature is very large. The subject of this paper is a more finite question: conditional on the decision to peg (with whatever degree of firmness) to a particular anchor, what difference does it make what that anchor is? We consider four alternatives: (1) a rigid peg to the dollar, versus (2) a rigid peg to the euro, versus (3) a rigid peg to the yen, versus (4) a rigid peg to the price of the leading export commodity of the country in question.

The study offers a new proposal, called PEP, for Peg the Export Price. The idea is most relevant for a country that is relatively specialized in the production and export of a particular mineral or agricultural commodity. The proposal is to commit to a monetary policy that fixes the local-currency price of the export commodity. It is *not* a proposal to try to stabilize the *dollar* price of the commodity; that would be futile, especially under

¹ The late 1990s were in some sense a replay of the early 1980s. A major reason for the international debt crisis that surfaced in 1982 was the combination of an appreciating

the assumption that the country in question is too small to affect the commodity price on world markets. Operationally, the most practical way to implement the PEP proposal might be for the local central bank to announce a daily exchange rate against the dollar that varies perfectly with the dollar price of the commodity in question on world markets, and to intervene to defend that exchange rate. That technique would be equivalent to fixing the price of the commodity in terms of local currency.

Monetary theorists have in the past emphasized a particular argument in favor of regimes that fix the value of money: as a means for the central bank to establish a credible commitment against inflation. This argument usually leaves out the question whether one means of fixing the value of the money is superior to another. It is as if it doesn't matter whether the anchor is the dollar or the Swiss franc or gold, or any other stable currency or commodity. In reality, the choice of anchor can make an important difference. Lithuania can get into trouble if it links its currency to the dollar, when most of its trade is with Europe; the euro would be better, because so much of Lithuania's trade is with the European Union. Analogously, Argentina might be better off pegging to wheat, than pegging to the dollar. Ghana might be better off pegging to gold. Chile might be better off pegging to copper. Venezuela might be better off pegging to oil.

Part I of the paper elaborates on the basic argument. Part II shows how the proposal might work concretely through a set of simulations. We consider a list of developing countries that specialize in oil. How would the export competitiveness and financial health of each have been affected over the last 30 years by some alternative currency pegs -- to oil, to the dollar, to the euro or to the yen -- as opposed to the

dollar with weak world market conditions for the commodities exported by developing

currency regime that it actually followed? A new theoretical appendix can be considered Part III; it compares the stabilizing properties of the proposal to Peg the Export Price to two alternatives: pegging the exchange rate and pegging the CPI.

I. Pros and Cons of Different Monetary Regimes

Much has been written on the arguments for fixed versus flexible exchange rates.²

The Nominal Anchor Argument for Fixing the Value of Currency

There are a variety of advantages to fixed exchange rates. In recent decades, the leading argument for firmly fixing exchange rates is as a credible commitment by the central bank, to affect favorably the expectations of those who determine wages, prices, and international capital flows by convincing them that they need not fear inflation or depreciation. The desire for a credible commitment to a stable monetary policy arose as a reaction to the high inflation rates of the 1970s, which in the 1980s reached hyperinflation levels in a number of developing countries. But fixing the value of the domestic currency in terms of foreign currency is not the only way that a country can seek a credible institutional commitment to non-inflationary monetary policy.

Governments can achieve anti-inflation credibility by being seen to tie their hands in some way so that in the future they cannot follow expansionary policies even if they

countries. (E.g., Cline, 1984; Dornbusch, 1985.)

² Recent surveys appear in Edwards (2002), Eichengreen (1994), and Frankel (1999, 2003).

want to. Otherwise, they may be tempted in a particular period (such as an election year) to reap the short-run gains from expansion, knowing that the major inflationary costs will not be borne until the future. A central bank can make a binding commitment to refrain from excessive money creation via a rule, a public commitment to fix a nominal magnitude.

Currency boards or other firm exchange rate pegs constitute one of a number of possible nominally anchored monetary regimes. Others include monetarism, inflation targeting, nominal income targeting, and a gold standard. In each case, the central bank is deliberately constrained by a rule setting monetary policy so as to fix a particular magnitude – the exchange rate, the money supply, the inflation rate, nominal income, or the price of gold. Monetary policy is automatically tightened if the magnitude in question is in danger of rising above the pre-set target, and is automatically loosened if the magnitude is in danger of falling below the target. The goal of such nominal anchors is to guarantee price stability.

Preventing excessive money growth and inflation is the principal “pro” argument for fixing the price of gold or some other nominal anchor. What are the disadvantages? The overall argument against the rigid anchor is that a strict rule prevents monetary policy from changing in response to the needs of the economy. The general problem of mismatch between the constraints of the anchor and the needs of the economy can take three forms: (1) loss of monetary independence, (2) loss of automatic adjustment to export shocks, and (3) extraneous volatility.

First, under a free-floating currency, a country has monetary independence. In a recession, when unemployment is temporarily high and real growth temporarily low, the central bank can respond by increasing money growth, lowering interest rates, depreciating the currency, and raising asset prices, all of which work to mitigate the downturn. Under a pegged currency, however, the central bank loses that sort of freedom. It must let recessions run their course. But the last few decades have seen widespread disillusionment, both among academics and practitioners, with the proposition that governments are in practice able to use discretionary monetary policy in an intelligent and useful way. This is particularly true in the case of developing countries. As a consequence, the trend in the 1990s was away from government discretion in monetary policy and toward the constraints of nominal anchors.

The second point is that even if the central bank lacks the reflexes to pursue a skillful and timely discretionary monetary policy, under a floating exchange rate a deterioration in the international market for a country's exports should lead to an automatic fall in the value of its currency. The resulting stimulus to production will mitigate the downturn even without any deliberate action by the government. Some have argued, for example, that Australia came through the 1997-98 Asian crisis in relatively good shape because its currency was free to depreciate automatically in response to the deterioration of its export markets. Canada and New Zealand, like Australia, are said to be commodity-exporting countries with floating currencies that automatically depreciate when the world market for their export commodities is weak. Again, this mechanism is normally lost under a rigid nominal anchor.

A third consideration makes the pegging problem still more difficult. If a country has rigidly linked its monetary policy to some nominal anchor, exogenous fluctuations in that anchor will create gratuitous fluctuations in the country's monetary conditions that may not be positively correlated with the needs of that particular economy.

Each Candidate for Nominal Anchor has its Own Vulnerability

Each of the various magnitudes that are candidates for nominal anchor has its own characteristic sort of extraneous fluctuations that can wreck havoc on a country's monetary system.

- A *monetarist* rule would specify a fixed rate of growth in the money supply. But fluctuations in the public's demand for money or in the behavior of the banking system can directly produce gratuitous fluctuations in velocity and the interest rate, and thereby in the real economy. For example, in the United States, a large upward shift in the demand for money around 1982 convinced the Federal Reserve Board that it had better abandon the money growth rule it had adopted two years earlier, or else face a prolonged and severe recession.
- To some, the novel idea of pegging the currency to the price of the export good, which this study puts forward, may sound similar to the current fashion of *targeting the inflation rate* or price level.³ But the fashion, in such

³ Among many possible references are Svensson (1995) and Bernanke, et al. (1999).

countries as the United Kingdom, Sweden, Canada, New Zealand, Australia, Chile and Brazil, is to target the CPI. A key difference between the CPI (or GDP deflator) and the export price is the terms of trade. When there is an adverse movement in the terms of trade, one would like the currency to depreciate, while price level targeting can have the opposite implication. If the central bank has been constrained to hit an inflation target, positive oil price shocks (as in 1973, 1979, or 2000), for example, will require an oil-importing country to tighten monetary policy. The result can be sharp falls in national output. Thus under rigid inflation targeting, supply or terms-of-trade shocks can produce unnecessary and excessive fluctuations in the level of economic activity. [This point is demonstrated in the new theory appendix.]

- The need for robustness with respect to import price shocks argues for the superiority of *nominal income targeting* over inflation targeting.⁴ A practical argument against nominal income targeting is the difficulty of timely measurement. For developing countries in particular, the data are sometimes available only with a delay of one or two years.
- Under a *gold standard*, the economy is hostage to the vagaries of the world gold market. For example, when much of the world was on the gold standard

⁴ Velocity shocks argue for the superiority of nominal income targeting over a monetarist rule. Frankel (1995) demonstrates the point mathematically, using the framework of Rogoff (1985), and gives other references on nominal income targeting.

in the 19th century, global monetary conditions depended on the output of the world's gold mines. The California gold rush from 1849 was associated with a mid-century increase in liquidity and a resulting increase in the global price level. The absence of major discoveries of gold between 1873 and 1896 helps explain why price levels fell dramatically over this period. In the late 1890s, the gold rushes in Alaska and South Africa were each again followed by new upswings in the price level. Thus the system did not in fact guarantee stability.⁵

- One proposal is that monetary policy should *target a basket of basic mineral and agricultural commodities*. The idea is that a broad-based commodity standard of this sort would not be subject to the vicissitudes of a single commodity such as gold, because fluctuations of its components would average out somewhat.⁶ The proposal might work if the basket reflected the commodities produced and exported by the country in question. But for a country that is a net importer of oil, wheat, and other mineral and agricultural commodities, such a peg gives precisely the wrong answer in a year when the prices of these import commodities go up. Just when the domestic currency should be depreciating to accommodate an adverse movement in the terms of

⁵ Cooper (1985) or Hall (1982). On the classical gold standard, see also Bordo and Schwartz (1997) and papers in Eichengreen (1985).

⁶ A “commodity standard” was proposed in the 1930s – by B. Graham (1937) – and subsequently discussed by Keynes (1938), and others. It was revived in the 1980s: e.g., Hall (1982).

trade, it appreciates instead. Brazil should not peg to oil, and Kuwait should not peg to wheat.

- Under a *fixed exchange rate*, fluctuations in the value of the particular currency to which the home country is pegged can produce needless volatility in the country's international price competitiveness. For example, the appreciation of the dollar from 1995 and 2001 was also an appreciation for whatever currencies were linked to the dollar. Regardless the extent to which one considers the late-1990s dollar appreciation to have been based in the fundamentals of the US economy, there was no necessary connection to the fundamentals of smaller dollar-linked economies. The problem was particularly severe for some far-flung economies that had adopted currency boards over the preceding decade: Hong Kong, Argentina, and Lithuania.

Dollar-induced overvaluation was also one of the problems facing such victims of currency crisis as Mexico (1994), Thailand and Korea (1997), Russia (1998), Brazil (1999) and Turkey (2001), even though none of these countries had formal rigid links to the dollar. It is enough for the dollar to exert a large pull on the country's currency to create strains. The loss of competitiveness in non-dollar export markets adversely impacts such measures of economic health as real overvaluation, exports, the trade balance, and growth, or such measures of financial health as the ratios of current account to GDP, debt to GDP, debt service to exports, or reserves to imports.

To recap, each of the most popular variables that have been proposed as candidates for nominal anchors is subject to fluctuations that will add an element of unnecessary monetary volatility to a country that has pegged its money to that variable: velocity shocks in the case of M1, supply shocks in the case of inflation targeting, measurement errors in the case of nominal GDP targeting, fluctuations in world gold markets in the case of the gold standard, and fluctuations in the anchor currency in the case of exchange rate pegs.

Consider further the case of pegs to the dollar or other major currencies. Each of the currency crisis victims listed above (1994-2001) has since abandoned its links to the dollar or to the basket that included the dollar -- as have Chile, Colombia and others -- in favor of greater flexibility. Nevertheless, they continue to exhibit a “fear of floating.” Brazil found in 2002 that free floating offered little protection against financial pressure. Few countries are comfortable that they have found the right answer. Alternative suggestions are still welcome.

The aim of the present study is to address the question: given a degree of commitment by a country to fix the value of its currency, what anchor should it use? This question is best illustrated -- not by those countries who have abandoned pegs for enhanced flexibility, nor even by those who have moved in the opposite direction -- but, rather, by a country that has moved from one rigid peg to another. Lithuania, while retaining a currency board arrangement, responded to the difficulties created by the late-1990s appreciation of the dollar by switching recently from a dollar anchor to the euro. Argentina also debated some sort of switch. Economy Minister Cavallo, in 2001 before

his resignation and the abandonment of the convertibility system, had announced an eventual move to a currency board with an anchor defined as a basket of one half dollar and one half euro. In both cases, a large part of the motivation was an overvaluation stemming from the late-90s appreciation of the dollar.

The strong dollar of 1996-2001 is a transitory phenomenon. From 1988 to 1995 the dollar was weak, and it will no doubt one day be weak again. When that happens, it will be the countries that are pegged to the euro that will lose competitiveness. The relevant question is the choice of regime for the longer term, when it is not known which currencies will be weak and which strong, but it is expected that swings in both directions will eventually occur.

This study argues that for those small countries that want a nominal anchor and that happen to be concentrated in the production of a mineral or agricultural commodity, a peg to that commodity may in fact make perfect sense. For them fluctuations in the international value of their currency that follow from fluctuations in world commodity market conditions would not be an extraneous source of volatility. Rather they would be precisely the sort of movements that are desired, to accommodate exogenous changes in the terms of trade and minimize their overall effect on the economy. In these particular circumstances, the automatic accommodation or insulation that is normally thought to be the promise held out only by floating exchange rates, is instead delivered per force by the pegging option. Thus PEP gives the best of both worlds: adjustment to trade shocks *and* the nominal anchor.

Regime Choice for a Country Specialized in an Export Commodity

If a country is dependent on one particular export commodity, what exchange rate policy should it follow? Surprisingly, there is no standard textbook prescription for such a country, even as between fixed and floating exchange rates. On the one hand, the often-cited advice of Kenen (1969) is that only if a country is sufficiently diversified in the production of different commodities should it float, implying that a country where production is concentrated should peg. On the other hand, another famous prescription holds that a country where external shocks are large should float, to insulate itself against them. This advice would seem to contradict the Kenen line, in that the overall magnitude of external shocks will be larger in a specialized economy, whereas they will tend to cancel out in a diversified economy.

A good reconciliation of the two viewpoints is to distinguish between the degree to which exports (or tradable goods) are concentrated in a single commodity and the importance of exports overall (or tradable goods overall) in the aggregate economy. Both ratios contribute to the ratio of exports of the particular commodity to aggregate GDP:

$$(Commodity\ j / Total\ exports) * (Total\ exports / GDP) = (Commodity\ j / GDP).$$

Nevertheless, they can have opposite implications for the desirability of fixed versus floating exchange rates. To the extent exports are concentrated in a single commodity, or a few commodities that are highly correlated in price, then external shocks are large and floating may be desirable. This is especially true if the world price of the commodity or

commodities is highly variable. But to the extent that exports or tradables are large in GDP, the advantages of pegging are large.⁷

II. The Counterfactual:

What Would Have Happened Under Different Pegs?

The remainder of this study will consider the example of countries for whom oil is a dominant export commodity. Similar experiments for gold, wheat, and some other mineral or agricultural products are reported elsewhere.⁸

Our major criterion for whether oil is important to the country in question over the period in question (1970s through 1990s) is oil exports as a share of total exports on average. We look at six major oil exporters. In each, oil exports are a high percentage of goods exports: Nigeria 95%, Venezuela 53%, Ecuador 46%, Indonesia 32%, Mexico 31%, and Russia 18%. Given so many oil exporters to choose from, we have concentrated on those that have had international debt problems. Thus we have thus omitted some where oil constitutes more than 70% of goods exports (Libya, Saudi Arabia, Gabon, Iran, Oman), or more than 40% of GDP (Brunei, Qatar, and UAE), but that are mostly creditors rather than debtors. Nor are we interested in large countries

⁷ McKinnon (1963).

such as the United States and Canada, for whom oil production may rank high in absolute terms, but low as a share of their economies.

How Would the Commodity Price Have Moved Under Alternative Pegs?

The hypothetical experiment goes as follows. For each of the oil-exporting countries on our list, it is easy to calculate what would have been its exchange rate against the yen and euro, and what would have been the local currency price of oil, if it had pegged to the dollar during the period 1970-2000, instead of following whatever exchange rate policy it actually followed. We can then compute what would have been the movements of the price of oil in domestic terms. We can see whether the volatility of this relative price would have been higher or lower over these two decades under the dollar peg. We begin with the simulated price paths under alternative currency policies, and will then go on to look at implications for export performance.⁹

Nominal oil prices

Figures 1.1(a) through 1.6(a) show the nominal price of oil from the viewpoint of our six oil-exporting countries. For each, the dark black line shows the actual price of

⁸ Frankel (2002) and Frankel and Saiki (2002).

⁹ While this paper concentrates on the example of oil, we have also looked at gold, silver, copper, aluminum, platinum, wheat and coffee. Results are reported in Frankel (2002), including the importance of particular export commodities to particular countries, graphs of the computed commodity prices under alternative scenarios, and statistics on simulated price variability. These are also available at http://people.brandeis.edu/~smap/rank_price.html and http://ksghome.harvard.edu/~jfrankel.academic.ksg/counterfactual/rank_price.html. (Appendices there give further details on how the computations were done.)

oil on world markets, expressed in terms of local currency, that these countries encountered over the last three decades.

The nominal price of oil shows sharp increases in 1974 and 1979, followed by declines in 1986 and 1998. (The upward trend in the 1970s, followed by a downward trend in the 1980s and 1990s, is a story similar to that of many other mineral and agricultural commodities.) The specifics depend on what is assumed about exchange rates. The movements in terms of marks are a little less pronounced than the movements in terms of dollars. The standard deviation of the log mark oil price is .64, while that of the dollar oil price is .75. It is interesting that the volatility is high when the oil price is expressed in terms of dollars, because OPEC supposedly sets the price in terms of dollars. Certainly oil is indeed invoiced in dollars. But the implication of these statistics is that OPEC in fact does not succeed in stabilizing the price in terms of dollars on a yearly basis.

Many of these oil-exporting countries experienced occasional jumps in the domestic price of oil when they devalued, which they would not have experienced if their currencies had remained pegged: Nigeria in 1999, Indonesia in 1998 (when it responded to a financial crisis -- itself exacerbated by a weak world oil market -- thereby reversing what would otherwise have been a sharp fall in the domestic price of oil), and Russia in the early 1990s (when it was merely offsetting very high domestic inflation) and again in 1999 (when it achieved a major improvement in international competitiveness, again in response to the 1998 financial crisis). On the other hand, the Indonesian rupiah and Ecuadorian sucre, for example, appreciated against the dollar in 1980; the result is that

they experienced a smaller increase in the price of oil than they would have if they had pegged to a major currency. For each of the seven oil-exporting countries the domestic nominal price of oil would have been much less variable if they had been pegged to one of the three major currencies. Needless to say the variability would have been lower still if they had sought as a matter of deliberate policy to stabilize the value of their currency in terms of oil.

Real oil prices

Some of these countries experienced substantial inflation: Ecuador, Venezuela, Mexico in the 1980s, Russia in the early 1990s, and Nigeria increasingly over time. Regardless the currency in terms of which the price of oil is expressed, it can be misleading to focus solely on the nominal price. To the extent that a rising price of oil reflects general inflation, it does not provide a particular incentive for resources to shift into oil production, because wages and prices in other sectors are rising as well. If our goal is to evaluate the implications of alternative monetary regimes for international price competitiveness and international debt, we should focus on the real price of oil. That is, we should deflate by the general price level in the country in question. Movements in the real price of oil are more important because they determine whether resources inside the oil-exporting country have an incentive to shift into the production of oil, or in the opposite direction. The real price of oil is simulated in the righthand graphs, Figures 1.1(b) through 1.6(b).¹⁰

¹⁰ The local price of the export good deflated by the domestic price level is one possible definition of the real exchange rate.

The world real price of oil, whether in terms of US, German, or Japanese goods, underwent large swings. But there was little net trend: the sum of the world market declines of 1986 and 1998 fully reversed the sum of the real price increases of 1974 and 1979.

Nigeria's erratic monetary history is evident in the graph. It would have experienced a more stable real price of oil if it had pegged its currency to either the dollar, yen or mark. The fall in world oil prices in 1998 hit Nigeria hard, contributing to its unfavorable international position, which in turn produced a collapse in the currency and a much higher local-currency oil price the subsequent year. The same is true of Russia and each of the Latin American oil producers: Ecuador, Mexico and Venezuela. While the exchange rates that these countries followed were ultimately flexible, in the sense that they experienced large currency depreciations in the 1990s, these depreciations reflected monetary crises. They did not succeed in stabilizing the real exchange rate. To the contrary, these countries experienced virtually as much variability in the real price of oil as they would have if they had been rigidly pegged to the dollar or mark. The worst cases are Nigeria, where the standard deviation was 55%, and 42% of observations were further than 50% from the mean real price of oil; and Mexico, where the standard deviation was 60%, and 35% of observations were further than 50% from the mean.¹¹ By comparison, a dollar peg would have produced a standard deviation of 55%, with 35% of the observations farther than 50% from the mean, and a DM peg would have produced

¹¹ Indonesia did not do badly in the 1980s, but experienced large fluctuations in the real price of oil in the late 1990s. Russia also experienced a more variable real price of oil over the last ten years, as a result of the travails of the ruble, than it would have if it have been rigidly pegged to one of the major currencies. But we don't have the data to extend the calculations for Russia back to the 1970s and 1980s.

a standard deviation of 56%, with 42% of observations further than 50% from the mean. This is remarkable, considering that flexible exchange rates are supposed to allow the offsetting of terms of trade shocks that rigidly fixed rates prevent.

Implications of Alternative Currency Pegs for Exports

We have seen what would have happened to the price of the principal export commodity under alternative pegs. But it would be desirable to go beyond that simple analysis. The relevant objective is not so simple as just minimizing variability in the real exchange rate. Rather, countries seek to maximize the long-run growth rate, avoid financial crashes, etc. If the goal were simply to minimize the variability in the price of gold or oil, then pegging the currency to the price of gold or oil would automatically be the right answer. While we wish to consider this regime, we don't want to pre-judge its merits. It might be desirable to have some variability in the real price of the export commodity, if the price increases came during periods when the country most needed boosts to export revenue e.g. to service debt.

Assumptions

We will need to make some crude assumptions about the behavior of exports and output, particularly with regard to price elasticities. Then we can simulate what the path of the economy's international sector might have looked like with alternative exchange rates and prices e.g. what would have happened if the country had been pegged to the dollar or to oil throughout the period, as opposed to following whatever exchange rate

path it actually followed. We can simulate paths for exports, the trade balance, debt, and debt service.

Our crude assumption will be that (1) for every one percent real depreciation of the local currency against major world currencies and commodities, total exports would have risen by one percent in that same year, and (2) GDP would have been unchanged. The assumption that exports would have risen proportionately could be interpreted as arising from two premises: that the local elasticity of supply is one; and that the price of the exportable good is determined in terms of foreign currency. This seems the appropriate model for small countries that produce mineral or agricultural products.

Our primary interest is not in a comprehensive comparison of the path that the economy would have followed if pegged to the dollar with the actual path. To do so would leave out important considerations such as, on the one hand, the inflation-fighting benefits of pre-commitment to a dollar peg, and, on the other hand, the potentially stabilizing benefits of a discretionary monetary policy when the exchange rate is flexible. Our primary interest, rather, is in comparing the dollar path with the path under a peg to oil or other candidates. We calculate, if the country had pegged to the yen instead of the dollar, what would have been the local currency price of commodities, and what would the effect have been on exports (again with crude assumptions about elasticities). We do the same with a peg to the euro, represented during our historical period by the German mark. Then we see what would have happened to the exports of the commodity-producing country if the value of the domestic currency had been fixed in terms of that commodity, rather than in terms of a major currency.

Simulated oil exports

Figure 2 shows the simulated paths of exports under the alternative currency regimes. All our oil producers experienced substantial cycles in their ratios of exports to GDP during the thirty-year period, though the fluctuations were on top of an upward long-term trend in the case of Ecuador, Indonesia, Mexico and Venezuela. As already noted, many of these countries achieved competitiveness gains by devaluation; look at the boosts to exports that were in fact experienced by Ecuador in 1999, Indonesia in 1998, Mexico in 1995, Nigeria in 1999 or Russia in 1998-99. On the one hand, these gains in the 1990s would have been eliminated by rigid pegs to any external anchor. On the other hand, in the 1970s, many of the oil producers, such as Ecuador, Indonesia, and Nigeria, would have experienced even bigger export booms than they did if they had been pegged to the dollar. A dollar peg would also have exaggerated the boost to Nigerian exports in 1995-98. A dollar peg for Mexico would have produced a long upward trend that was smoother, but otherwise similar in magnitude to other pegs.

There are periodic proposals that Southeast Asian countries ought to give more weight to the yen than they have in the past. A yen peg for Indonesia would have resulted in the same export booms in 1974 and 1980, but would have given a smoother path during the period after oil prices stabilized at a lower levels in 1986. In the critical year 1998, the simulation results for any of the pegs eliminate the sharp upward spike in the ratio of exports to GDP that Indonesia's currency collapse in fact produced. But some would argue that if a very firm peg had been in place, that crisis might not have occurred at all. Thus the more relevant comparison is between the dollar peg and the yen peg. A yen peg would have produced some gain in competitiveness between 1995 and

1998, but the boost to exports looks small compared to the very big reduction in the early 1980s.

Of our seven oil exporters, Russia is the only serious candidate for pegging to the DM or euro. The simulation shows that a firm peg to any of the three major currencies would have turned the 1994-1997 decrease in Russia's exports/GDP into a gain, presumably because it would have reduced Russian inflation. But, again, the interesting comparison is across pegs. A peg to the DM would not have produced the same 1998 peak in exports or subsequent reversal that a hypothetical yen peg would have produced. But if Russia had been tied to the euro in 1999-2000, it would have shared in that currency's depreciation and thus increased exports.

A peg to the price of oil would have had a negative effect on all oil exporters in the 1970s. Exports in Venezuela, for example, would have reached lows by 1979 that were more extreme than any other regime or year. But an oil peg would have had mostly positive effects on exports thereafter (exceptions are the years 1986 and 2000). In the critical year 1998, an oil peg would have boosted Colombia's exports to almost 30 % of GDP, Ecuador's and Venezuela's over 40 percent, Mexico's and Russia's over 50 percent (even without discrete devaluations), and Nigeria's to 100 percent. These are striking results, as all these countries were severely affected by international financial turmoil that year, and were desperate for higher foreign exchange earnings.

Simulated effects on other mineral and agricultural exports in the late 1990s

We have also looked at exports of other commodities by other countries. The results are too diverse to allow a succinct summary of the results. But a common general

pattern characterizes a cross-section of experiences in the late 1990s, a time of global financial pressures. Whatever the degree of exchange rate flexibility with which our countries entered this period, most gave more weight to the dollar than to other possible anchors. As a result, the appreciation of the dollar in the late 1990s added to their difficulties. During this period, a link to the DM/euro or yen would have done better. But that is largely coincidence. More interesting is what would have happened if they had pegged to the price of their leading mineral or agricultural export commodity. Because the prices of aluminum, coffee, copper, gold, and wheat – like the price of oil -- were depressed in the late 1990s, a peg to these commodity prices would have enhanced competitiveness. If the countries that were specialized in the production of these commodities had pegged their currencies to those prices, they would have boosted their exports at just the right time. This result is not entirely coincidence, in that weak commodity prices, especially in terms of dollars, were an important component of the wave of crises in emerging markets.

Other Indicators of Financial Health

A higher level or lower variability of exports is not the ultimate objective of economic policy. We need a way of evaluating whether the overall effect of various pegs on a given country would have been favorable or unfavorable. How should we gauge the financial or economic health of a country? According to economic theory, what ultimately matters is the country's standard of living, averaged over time. Technically, what matters is an intertemporal average such as the present discounted value of income or consumption. Swings in countries' export revenues can be smoothed over time -- by

borrowing when market conditions are bad and paying back when markets are good. In this view, variability in a country's income need not be damaging.

In reality, it is clear that this sort of theoretical approach in any case will not work. Financial markets do not in fact smooth consumption over time in the way the theory says. If they did, international capital flows would not be as procyclical as they are, periodic currency crises would not be as severe as they are, and the entire exercise of trying to reduce volatility by choice of monetary regime would be of less interest. It is more accurate to say that there is a flow of capital to Nigeria, Chile, Argentina, and South Africa when the world markets for – respectively -- oil, copper, agriculture, and gold are strong, than when they are weak. It is precisely when poor countries' export markets are weak that the world's investors pull out their money and when financial crisis is most likely. In other words, financial markets do not carry out their assigned smoothing function very well. It does not matter for our purposes what is the market failure, that is, the source of the deviation from textbook theory. The root of the problem could be imperfect domestic institutions (e.g. governments that can't resist launching grandiose spending projects when the export revenue is available, and bailing out banks and other domestic cronies when times are bad) or it could be fickle international investors (who participate in speculative bubbles and attacks, as in recent theories of multiple equilibria). All that matters is that these boom and bust financial cycles do in fact occur.

The exercise to be undertaken is to consider the case of a country that has already decided to adopt a long-term nominal anchor, and to consider the choice of alternative nominal anchors from the standpoint of maintaining external balance. The hope is that

this will help reduce the amplitude of the boom-bust cycle that produces periodic crises in emerging markets.

What would financial indicators have showed under alternative pegs?

We continue with our assumption that price elasticities are unity (contemporaneously). In the case of the export commodities, we are thinking of these as supply elasticities, since we are thinking of our countries as price-takers on world markets. We are also assuming that the entire production is exported, an assumption that is probably not too far off for gold, oil or coffee, but is admittedly unrealistic for wheat or rice. Under these (extremely restrictive) assumptions, commodity exports would have been one percent higher for every one percent increase in the price of the commodity in terms of local currency.

If Ecuador had been pegged to the euro in 1999-2001 instead of the dollar, the price received for oil exports would have been higher at precisely the time when it was needed; and if the sucre had been pegged to the price of oil, the benefits would have been even greater. But we want to see if this logic holds up in the simulation of financial indicators. Theory cannot give us the answer because the outcome depends on the nature of the shocks. If the most important shocks are those that occur in the world market for the export commodity, then a regime that leads to depreciation at those times when the world market is depressed should indeed be a regime that stabilizes export revenue. But if the most important shocks are idiosyncratic domestic shifts, such as new discoveries or a ruptured pipeline or monetary fluctuations, then there may be no systematic implication of the regime for volatility.

Here we assume that imports and transfers are exogenous.¹² We compute the counterfactual for the trade balance based on our calculations for the impact on exports. We have allowed for the endogeneity of total international interest payments, in proportion to the simulated difference in net international debt. A different trade balance in the first period implies a different change in the net international investment position or net debt position that is carried into the subsequent period. In each subsequent period, the simulated change in the current account balance then translates into net debt.

Debt/export ratios

We have simulated alternative paths for the current account and the debt/export ratio.¹³ These simulations assume, not only that exports respond to real exchange rates with an elasticity of one, but also that imports and transfers do not respond at all. Thus the export revenue response is assumed to translate directly into the trade balance. In the first period the effect on the trade balance is also assumed to translate directly into the current account. The current account each year, in turn, is assumed to be the change in the debt stock. But in the second and subsequent periods, the higher or lower debt stock is assumed to imply proportionately higher or lower interest payments, which are added

¹² One approach would be to apply the unit elasticity assumption also to imports, and assume that imports of a world basket of goods would have been 1 % lower for every 1 % depreciation of the currency in trade-weighted terms. Another approach would be to focus on the supply of tradable goods, taking the export calculations that we have already performed as a lower bound on the importance of tradable goods in the economy and taking 100% of GDP as an upper bound.

¹³ Simulations for producers of other mineral and agricultural commodities, and further details, are available in Frankel (2002), or electronically at: http://ksghome.harvard.edu/~jfrankel.academic.ksg/counterfactual/rank_price.html Simulated Debt/Export ratios are reported as Table Set V.

into the current account, that is, the change in next period's international investment position. These assumptions could of course be made more elaborate.

Figures 3.1 through 3.3 report the simulated debt/export ratios for Indonesia, Mexico and Venezuela. Mexico would have experienced a sharply larger current account deficit in the 1980s if it had been pegged to oil, followed by a sharp improvement in the 1990s. Its hypothetical debt/export ratio would have risen sharply early on, but by the end of the period would have been back to its actual. The same is true of Venezuela. In the case of Indonesia, the run-up in debt/exports during 1998-2000 would have been worse than the actual. The outcome results from gains in competitiveness in 1988 and 1998, relative to the actual path, but losses in competitiveness in 1974, 1980, and 2000.

3. Conclusion

The currency regime proposed in this study is not for everybody. But for small countries where a single commodity such as gold or oil makes up a large share of national production and exports, a novel strategy of pegging the currency to the price of that commodity might make sense. Of course this commitment would mean giving up the benefits of discretionary monetary policy. But some small developing countries have found those benefits to be elusive at best, and so have either already given up monetary independence anyway or are considering doing so. For such a country, a peg to its export commodity may give the best advantages of both worlds: the enhanced credibility that dollarization or the gold standard is traditionally supposed to deliver, combined with the

automatic adjustment to terms of trade shocks that floating rates are in theory supposed to deliver.

Summary of findings

Taking the example of oil exporters, our simulation results illustrate how a peg of the domestic currency to oil, if it had been applied in the past, would at times have been superior to conventional pegs to the dollar or to other major currencies. In particular, many commodity exporters in the late 1990s were hit by three simultaneous shocks: scarce international finance, a strong dollar, and weak commodity prices. If they had been pegged to their principal export commodity at this time, rather than to the dollar, they would have gained export competitiveness at precisely the time when their balance of payments was under maximal strain. Such countries as Mexico and Venezuela would during the sensitive years 1997-98 have achieved stronger current account positions if they had been pegged to oil.

Similar points apply to other commodities. If South Africa had been pegged to gold in the late 1990s, Jamaica to aluminum, Chile to copper, Colombia to coffee, Mauritania to iron ore, Mali to cotton, and Guinea-Bissau to peanuts (groundnuts), each of these countries would have seen their currencies depreciate at precisely the time when they most needed the boost to exports. This result would have obtained automatically – as is supposed to happen with a floating exchange rate -- and yet without having to give up the benefits of a nominal anchor.

Qualifications and drawbacks

These conclusions should be tempered by acknowledging some limitations. Each merits a response.

1. The simulation model used here is very unsophisticated. The results may not change much under more sophisticated models, so long as one defines the problem as seeking to maintain external balance under the constraint of a nominal target. But it would be desirable to find out.
2. If a substantial number of producers of a given commodity, representing a substantial fraction of global supply, were simultaneously to implement the proposal to peg their currencies to that commodity, then we would have to recognize that the commodity price would become endogenous. Shifts in the world demand for the commodity would induce contrary responses in world supply, thereby exacerbating the global price fluctuations: When the world price of the commodity falls, commodity-pegged producers would automatically depreciate, responding by raising production and thereby further dampening the world price. A possible response is that in the case of such commodities as oil, gold, and wheat, the United States and Canada constitute a large share of world production, and the pegging proposal is not intended to apply to them. But the results reported here are best understood as applying to regime decisions of an individual country.
3. Quota systems limit export quantities in the cases of some commodities, either on the importing side (e.g., rich-country quotas on sugar, dairy products, rice, and peanuts) or on the exporting side (cartels). Among the oil-exporting countries examined in our simulations, Ecuador, Indonesia, Venezuela and Nigeria are members of OPEC.

They may not have been able to take full advantage of the simulated depreciation without violating their OPEC oil quotas. On the other hand, OPEC's real power over most oil-exporting countries is questionable. Furthermore, when such countries are hurt by international conditions, including low world oil prices, additional dollars earned through boosts to their non-oil exports (included in these export simulations) are at least as useful as dollars earned through oil exports.

4. Most countries do not in fact have their exports concentrated in one commodity, and their leading export changes from decade to decade. A diversified country could set a target in terms of a basket of its export commodities, rather than a single commodity. The weights could change gradually over time along with the structure of the economy. But admittedly, the nominal anchor advantage might be attenuated in the case of a basket.
5. Even for countries that are relatively concentrated in a particular export commodity, pegging to that commodity would create volatility for other sectors of the economy, as in the "Dutch Disease." The response to this point is that, if the concern is for the impact on the other export commodities, that relative price must be taken as given on world markets, and thus no national regime can affect it. If the concern is for domestic wages and non-traded goods, it is an advantage of the PEP proposal that it stabilizes precisely their relative price vis-à-vis the leading export commodity. But it is true that the narrow form of the proposal could destabilize the third relative price: the price of *non-pegged* tradable goods in terms of domestic wages and nontraded goods.

6. To stabilize the local price of the lead export commodity would reduce risk and transactions costs in the production of this commodity (in itself, an advantage), perhaps leading in the long run to a gradual expansion of that sector, which may be unwelcome for any countries wishing to diversify the structure of their economies. If objections number 4 and 5 are addressed by adopting the broader form of the proposal, pegging to a basket of exports, then objection number 6 could be addressed by deliberately putting smaller weight on the leading export commodity, and greater weight on those commodities into which the government wishes to diversify.

Bottom line

Not all countries will benefit from a peg to their export commodity, and none will benefit in all time periods. One must go through the welter of simulation results to get a feeling for the variety of outcomes that is possible. Nonetheless, the results are suggestive. What they suggest is that, for countries specialized in a mineral or agricultural export commodity, the proposal that they peg their currency to that commodity deserves to take its place alongside pegs to major currencies and the other monetary regimes that countries consider.

References

Bernanke, Ben, Thomas Laubach, Frederic Mishkin, and Adam Posen (1999), *Inflation Targeting: Lessons from the International Experience*, Princeton University Press: Princeton NJ, 1999.

Michael D. Bordo, and Anna J. Schwartz (1996), "The Specie Standard as a Contingent Rule: Some Evidence for Core and Peripheral Countries, 1880-1990" in *Currency*

Convertibility: The Gold Standard and Beyond, J. Braga de Macedo, B. Eichengreen, J. Reis, eds., pp. 11-83 (New York: Routledge).

Calvo, Guillermo, and Carmen Reinhart (1999), "When Capital Inflows Come to a Sudden Stop: Consequences and Policy Options," in *Key Issues in Reform of the International Monetary System*, edited by Peter Kenen and Alexander Swoboda. Washington, DC: International Monetary Fund.

Cline, William (1984), *International Debt: Systemic Risk and Policy Response*. Washington, DC: Institute for International Economics.

Cooper, Richard (1985), "The Gold Standard: Historical Facts and Future Prospects" *Brookings Papers on Economic Activity*, 1, 1-45.

Dornbusch, Rudiger (1985), "Policy and Performance Links Between LDC Debtors and Industrial Nations," *Brookings Papers on Economic Activity* 2. Washington DC: The Brookings Institution.

Edwards, Sebastian (2002), "Exchange Rate Regimes, Capital Flows, and Crisis Prevention," in *Economic and Financial Crises in Emerging Market Economies*, edited by Martin Feldstein. Chicago: University of Chicago Press.

Eichengreen, Barry (1985), *The Gold Standard in Theory and History*. New York, Methuen.

Eichengreen, Barry (1994), *International Monetary Arrangements for the 21st Century*. Washington, DC: Brookings Institution.

Frankel, Jeffrey (1995), "The Stabilizing Properties of a Nominal GNP Rule," *Journal of Money, Credit and Banking* 27, no. 2, May, 318-334.

Frankel, Jeffrey (1999), "No Single Currency Regime is Right for All Countries or at All Times," *Essays in International Finance* No. 215. Princeton NJ: Princeton Univ. Press.

Frankel, Jeffrey (2002), "Should Gold-Exporters Peg Their Currencies to Gold?" *Research Study No. 29*, World Gold Council, London.

Frankel, Jeffrey (2003), "Experience of and Lessons from Exchange Rate Regimes in Emerging Economies," Asian Development Bank, and KSG RWP03-011, Harvard University, Feb. 27; forthcoming in *Monetary and Financial Cooperation in East Asia*, Macmillan Press.

Frankel, Jeffrey, and Ayako Saiki (2002), "A Proposal to Anchor Monetary Policy by the Price of the Export Commodity," *Journal of Economic Integration*, 17, no.3, Sept.: 417-48.

Graham, Benjamin (1937), *Storage and Stability*. New York: McGraw Hill.

Hall, Robert (1982), "Explorations in the Gold Standard and Related Policies for Stabilizing the Dollar," in Hall, ed., *Inflation*. Chicago: University of Chicago Press, 111-122.

Kenen, Peter (1969), "The Theory of Optimum Currency Areas: An Eclectic View," in R. Mundell and A. Swoboda, eds., *Monetary Problems in the International Economy*. Chicago: University of Chicago Press: Chicago.

Keynes, John Maynard (1938), "The Policy of Government Storage of Foodstuffs and Raw Materials," *Economic Journal*, September.

McKinnon, Ronald (1963), "Optimum Currency Areas," *American Economic Review*, 53, September, 717-724.

Rogoff, Kenneth (1985), "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics* 100 (November): 1169-89.

Svensson, Lars (1995), "The Swedish Experience of an Inflation Target," in *Inflation Targets*, edited by Leo Leiderman and Lars Svensson. London: Centre for Economic Policy Research.

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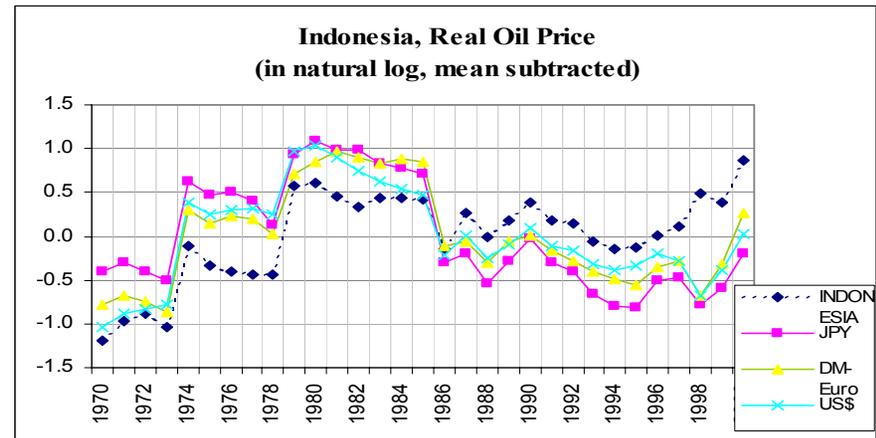
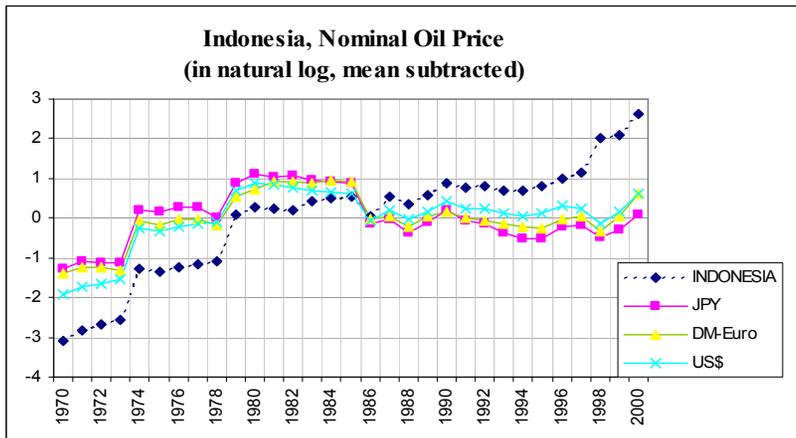
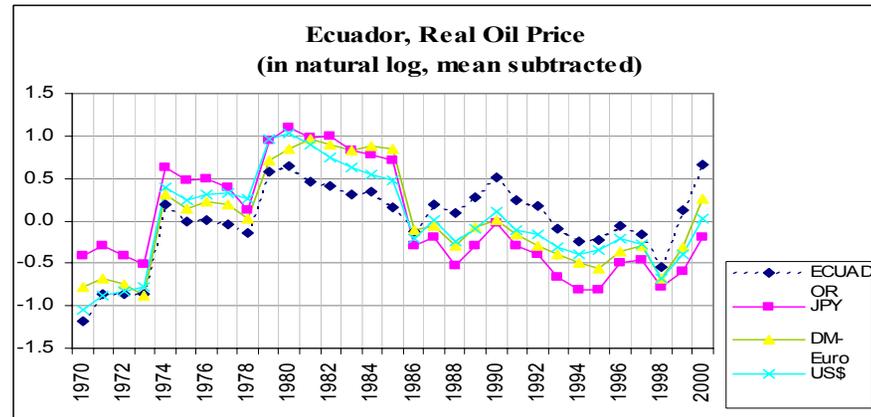
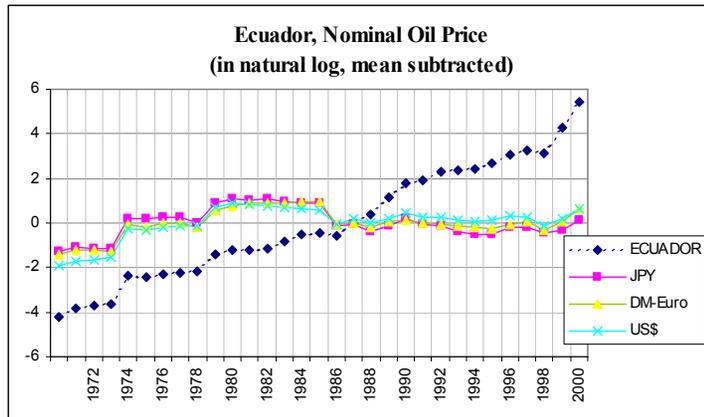
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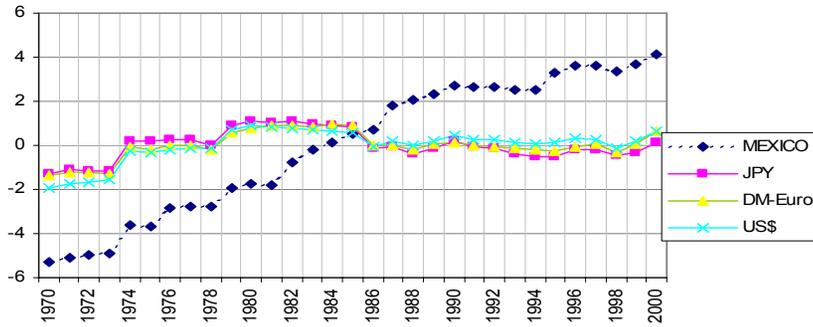
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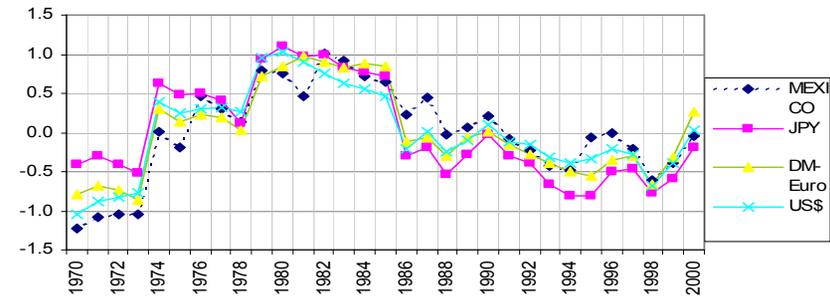
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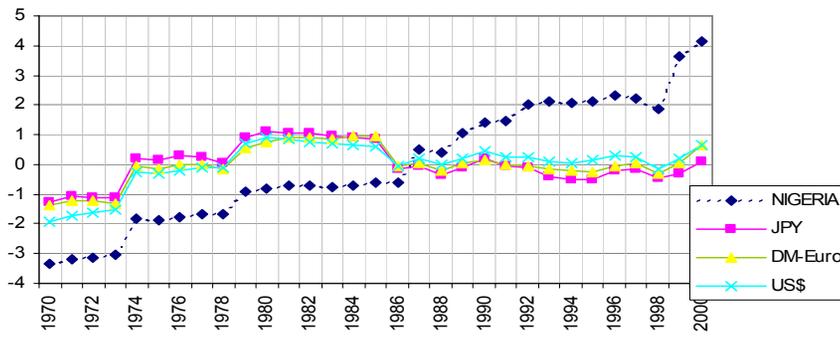
Mexico, Nominal Oil Price
(in natural log, mean subtracted)



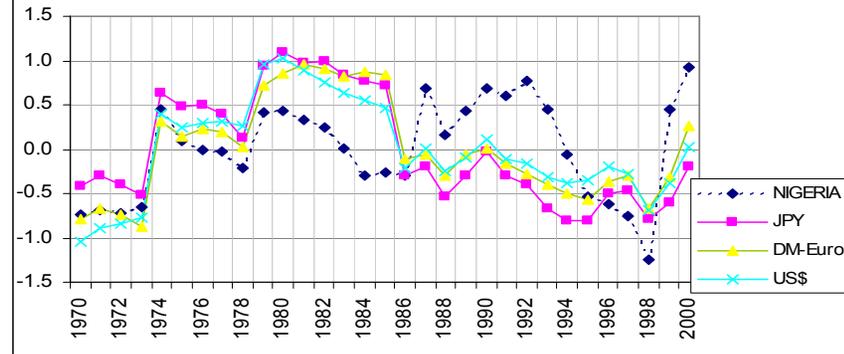
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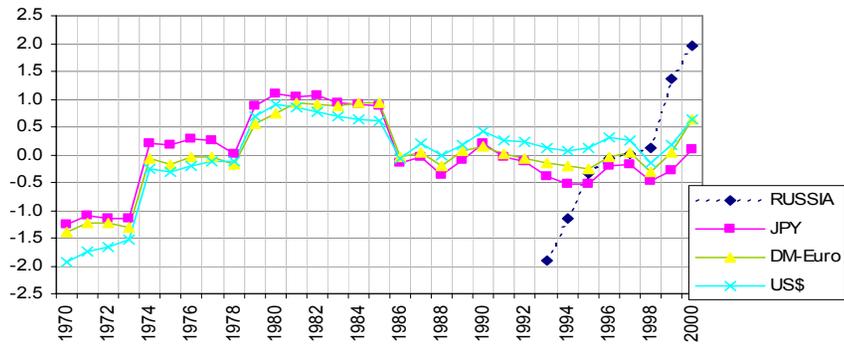
Nigeria, Nominal Oil Price
(in natural log, mean subtracted)



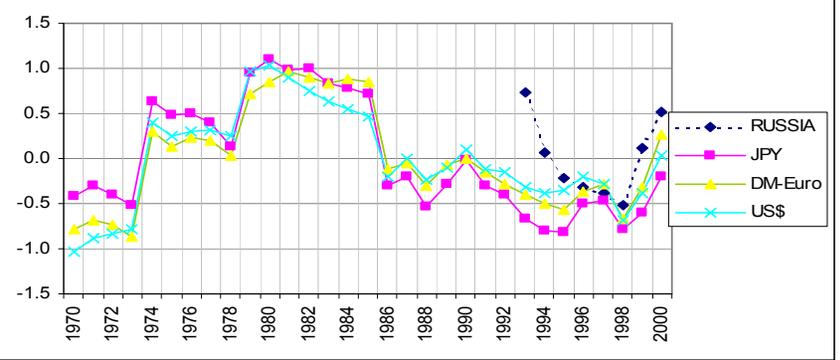
Nigeria, Real Oil Price
(in natural log, mean subtracted)



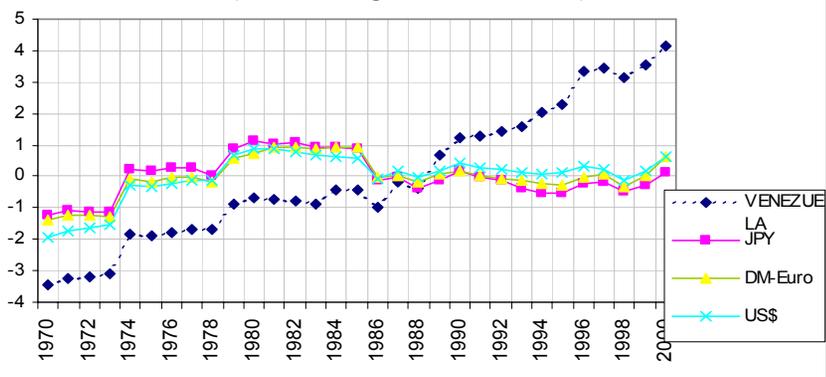
Russia, Nominal Oil Price
(in natural log, mean subtracted)



Russia, Real Oil Price
(in natural log, mean subtracted)



Venezuela, Nominal Oil Price
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Venezuela, Real Oil Price
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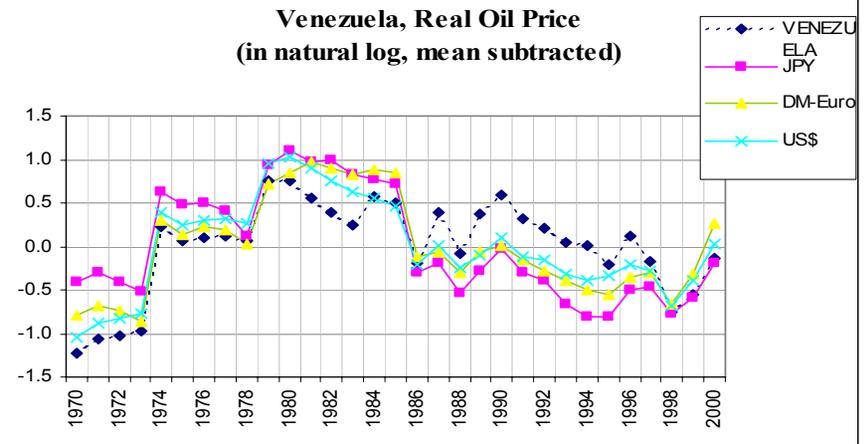
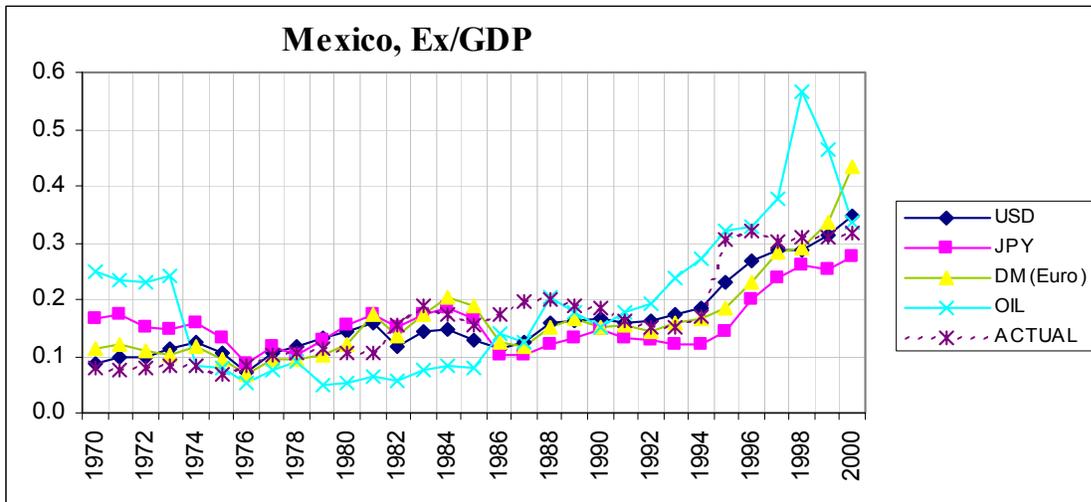
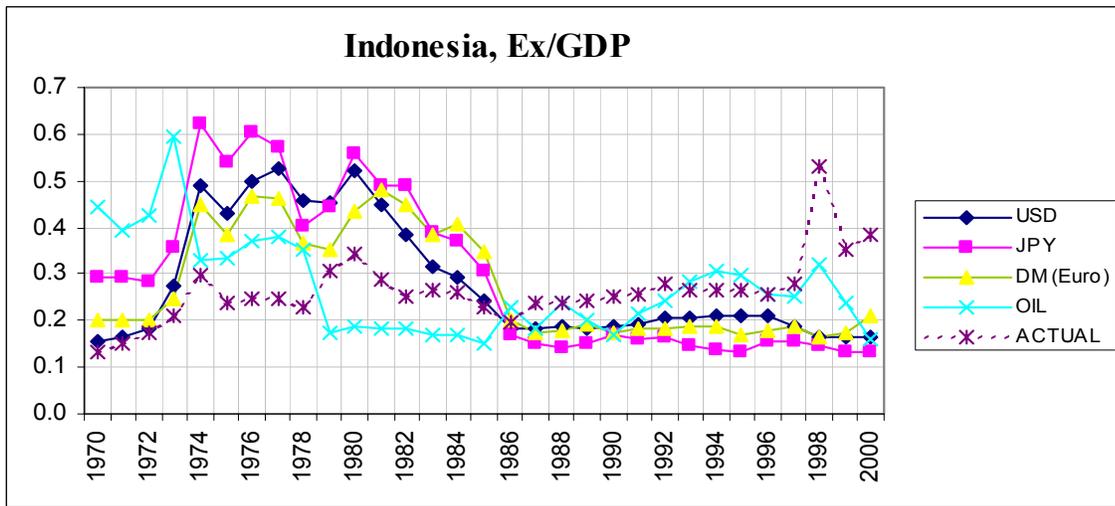
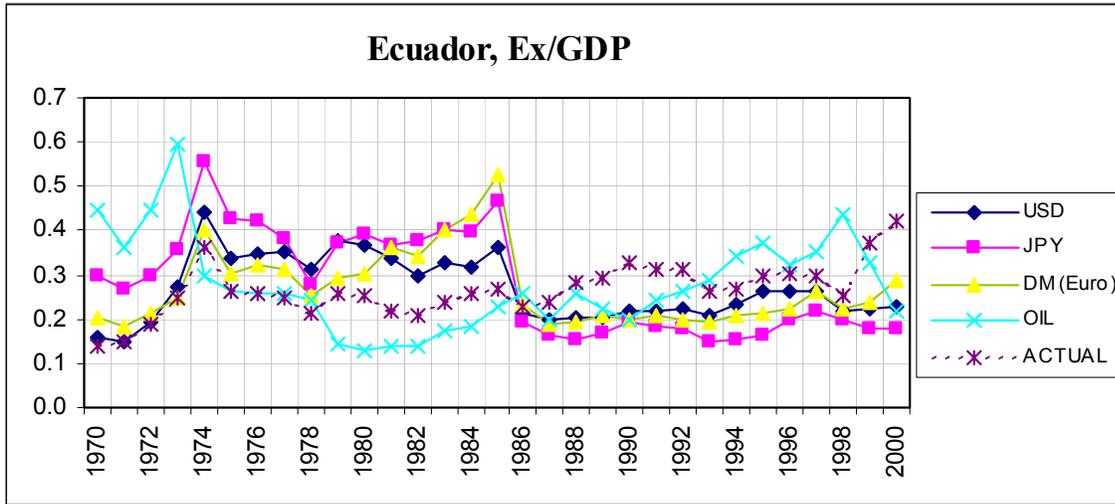
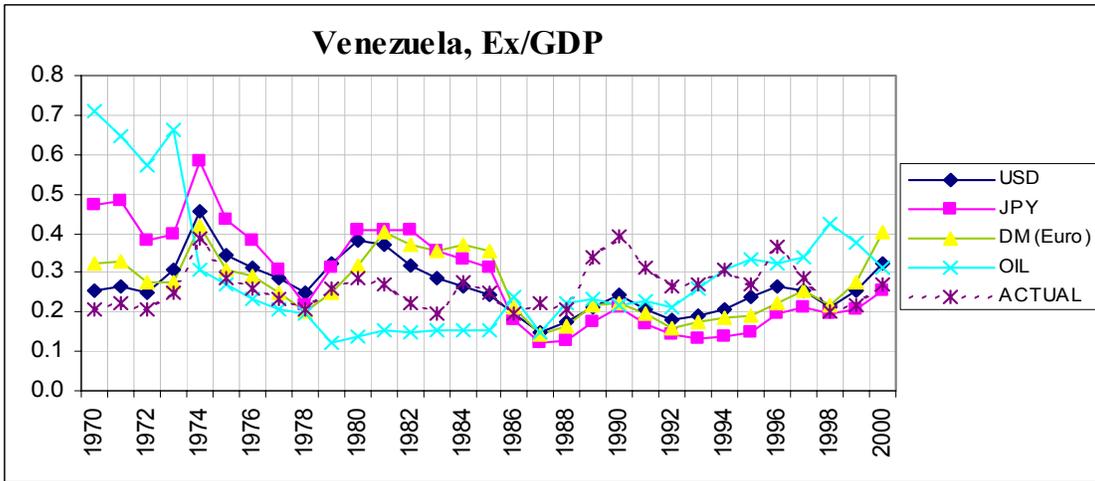
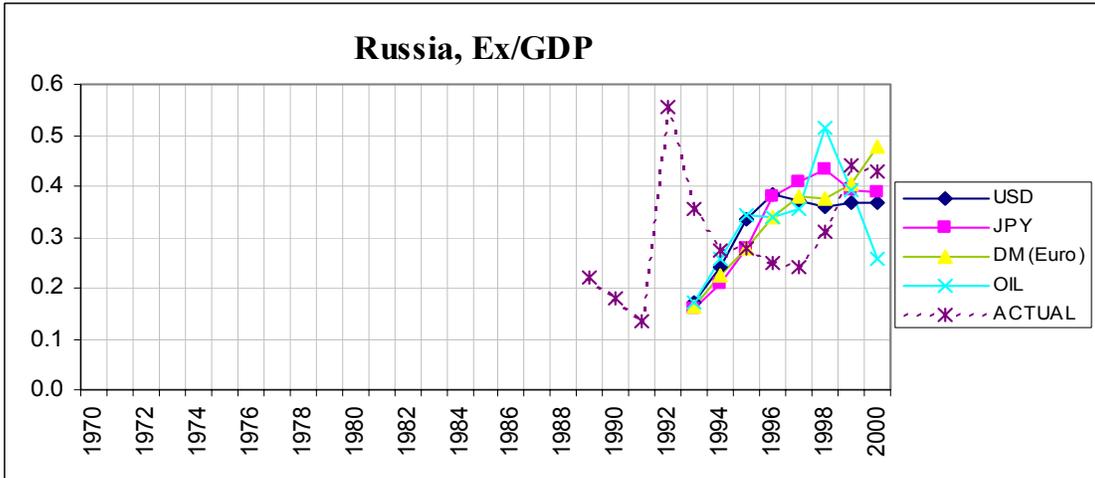
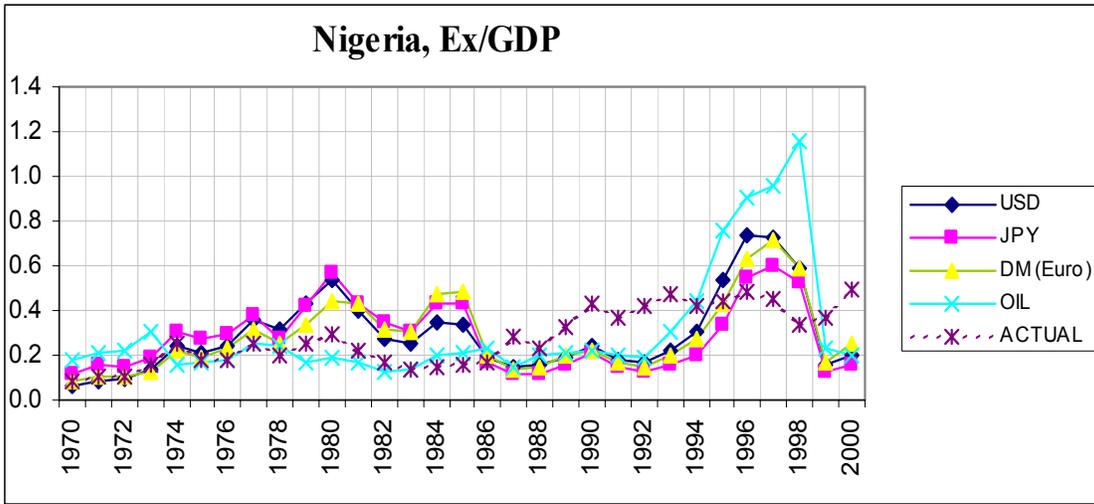
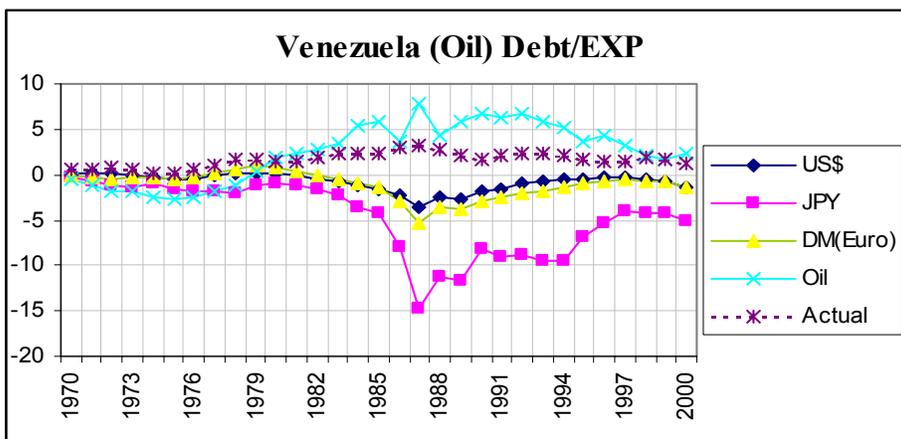
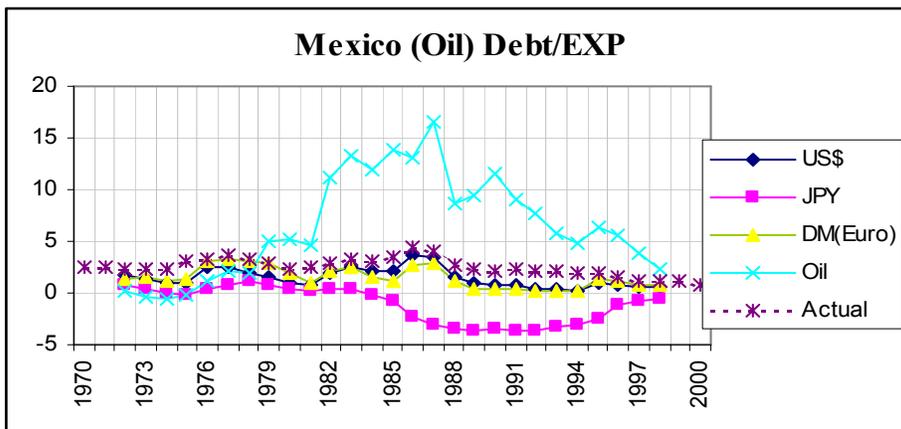
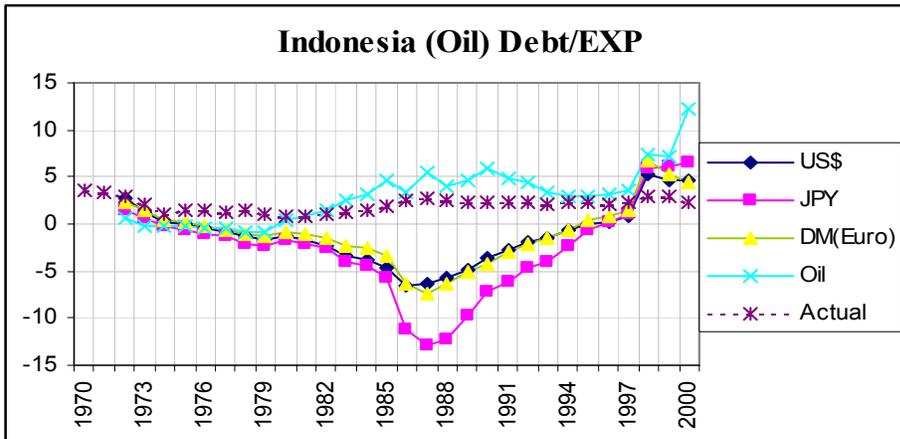


Figure 2.1 through 2.6: Simulated paths of exports of 6 oil-producers





Figures 3.1 through 3.3: Simulated debt/export ratios of 3 oil-producers



Part III -- Appendix:

Stabilizing Properties of Pegging the Export Price vs. Exchange Rate and CPI Rules

We compare three possible policy regimes: (1) a fixed exchange rate (2) the PEP proposal (fixed price of the export in domestic currency, so that the dollar exchange rate varies perfectly with the dollar price of the export commodity on world markets, and (3) a CPI rule. The approach, incorporating the advantages both to rules and discretion, follows Rogoff (1985b), Fischer (1988) and Persson and Tabellini (1990), who in turn added disturbances to the inflation-bias model of Barro and Gordon (1983). For an application of the model that includes the results for three more regimes -- discretion, a money rule, and a nominal GDP rule -- see Frankel (1995).

This version of the model extends it beyond the usual single sector.^{14/} One sector is NonTraded Goods; the other is the Tradable sector – an importable commodity Im on the consumption side and an exportable commodity X on the output side. We assume only one export commodity, with the price determined on world markets. An interpretation that would be more realistic for most countries would be a basket of export goods. In the case of each of the possible nominal anchors, proponents sometimes have in mind a target zone system. The assumption of a rigid rule in our theoretical analysis makes the analysis simpler. It must be acknowledged from the outset, however, that attaining a target precisely would be in practice be difficult in the case of a basket that included any goods other than agricultural and mineral products traded on centralized exchanges. It would be even more difficult for a CPI target. For these cases, a target zone would be more realistic.ⁱ

We assume an aggregate supply relationship in each of the two production sectors:

$$y_n = \bar{y}_n + b(p_n - p_n^e) + u_n \quad (1)$$

$$y_x = \bar{y}_x + d(p_x - p_x^e) + u_x \quad (2)$$

where y_n and y_x represent the log output of the nontraded and export sectors, respectively; \bar{y}_n and \bar{y}_x potential output in the two sectors; p_n and p_x the log prices in the two sectors in domestic currency, and p_n^e and p_x^e the expected log price levels (or they could be the actual and expected inflation rates, respectively); and u_n and u_x the supply disturbances.ⁱⁱ

We assume that the country is small, i.e., a price-taker on world markets for both its export good and its import good:

¹⁴ Another pass at the same problem is Schliesser (2001).

To consider alternative regimes, we must be explicit about the money market equilibrium condition. (In the discretion case, one can leave it implicit that the money supply, m in log form, is the variable that the authorities use to control demand.)

$$m = p + y - v, \quad (9)$$

where y represents an index of total output, and v represents velocity shocks.

Under a money rule, the money supply is fixed at the level that gives an expected price level of zero. Some algebra produces the loss function for the case of the money rule. It dominates discretion if the inflationary bias is large, but the money rule performs badly if velocity shocks are large, because they are needlessly passed through to the economy.^{15/} This result is well-known; we concentrate here on the comparison of the exchange rate rule, export price rule, and CPI rule.

(ii) Pegged Exchange Rate

There is no point in specifying an elaborate model of the exchange rate. All the empirical results say that most of the variation in the exchange rate cannot be explained (even ex post, to say nothing of prediction) by measurable macroeconomic variables, and thus can only be attributed to an error term that we here call e . But we must include the money supply in the equation; otherwise we do not allow the authorities the possibility of affecting the exchange rate. Our equation is simply:

$$s = m - y + e. \quad (10)$$

Combining with equation (9),

$$s = p - v + e. \quad (11)$$

The velocity and exchange rate shocks may be correlated; since they will always be appearing together, it does not matter. Indeed, we could have just specified equation (11) directly, with a single error term, if we did not want to consider a money target as one of the regimes.

Under the fixed exchange rate rule, s is pegged at the level to give $E(cpi)=0$, which is $s=0$. From equation (11), the domestic output price index is now determined by currency conditions:

$$p = v - e \quad (12)$$

At the same time, the definition of the price index as the weighted average of two sectors, in equation (6), brings in the price of nontraded goods:

$$p = (f)(s+\varepsilon_x) + (1-f)p_n \quad (13)$$

Combining the two equations for p ,

$$(f)(s+\varepsilon_x) + (1-f)p_n = v - e.$$

With the exchange rate fixed, the price of nontraded goods is also determined:

$$p_n = \frac{1}{1-f} (v-e - f\varepsilon_x). \quad (14)$$

¹⁵ A nominal income target avoids the problem of the velocity shocks that cripple the money rule. Frankel (1995) shows the equations.

$$y_n = bp_n + u_n = b \left[\frac{1}{1-f} (v-e - f\varepsilon_x) \right] + u_n. \quad (15)$$

(Notice that a positive price shock in world markets imposes deflation on the domestic market, because the monetary authorities must contract if they are to avoid currency depreciation. This is a variety of “Dutch Disease.”)

The spirit of the simulations in Frankel (2003) and Frankel and Saiki (2002) is that export revenue – perhaps as a ratio to debt -- is the key variable to stabilize.^{16/} Export revenue in dollars is defined as

$$s + p_x + y_x. \quad (16)$$

With equation (2), the variable component of export revenue is

$$\begin{aligned} & s + p_x + d(p_x) + u_x \\ & = s + (1+d)(p_x) + u_x. \end{aligned} \quad (17)$$

In the case of the exchange rate target,

$$= (1+d)\varepsilon_x + u_x$$

Clearly export sector disturbances are a problem.

We also look at the more conventional macroeconomic objective function, where the objective is to stabilize the price index and output levels.

$$\begin{aligned} L &= a (cpi)^2 + f(y_x - y_x')^2 + (1-f)(y_n - y_n')^2 \\ &= a (fp_{im} + (1-f)p_n)^2 + f(dp_x + u_x)^2 + (1-f)(bp_n + u_n)^2 \end{aligned} \quad (18)$$

$$= a(f\varepsilon_{im} - f\varepsilon_x + (v-e))^2 + f(d\varepsilon_x + u_x)^2 + (1-f) \left[b \frac{1}{1-f} (v-e - f\varepsilon_x) + u_n \right]^2 \quad (19)$$

This value of the loss function is the basis on which to compare the fixed exchange rate with alternative regimes.

(iii) Pegged Export Price

Now we consider the PEP proposal: fixing the export price in terms of domestic currency or, equivalently, determining the exchange rate so as to vary perfectly with the dollar price of the export commodity on world markets.

$$p_x = 0 \Rightarrow s = -\varepsilon_x. \quad (20)$$

From equations (5) and (6),

$$cpi = fp_{im} + (1-f)p_n = f(-\varepsilon_x + \varepsilon_{im}) + (1-f)p_n \quad (21)$$

$$p = fp_x + (1-f)p_n = 0 + (1-f)p_n \quad (22)$$

Combining equation (22) with equation (12),

$$v - e = (1-f)p_n,$$

which determines the nontraded goods price, and quantity:

¹⁶ The idea is that, for emerging market countries, international capital markets in practice do not seem willing to fund transitory shortfalls in export earnings; to the contrary, “sudden stops” by foreign investors are the leading source of large economic contractions, and are best moderated by assuring a high and stable level of export earnings.

$$p_n = (1/f)(v-e) \quad (23)$$

$$y_n = b/(1-f)(v-e) + u_n \quad (24)$$

To repeat, equation (17), export revenue is given by

$$= s + (1+d)(p_x) + u_x .$$

If the export price is pegged, and using (20), export revenue is given by

$$= -\varepsilon_x + u_x \quad (25)$$

If the objective is taken to be stabilizing export revenue, then pegging the export price looks very good: export revenue is unambiguously more stable under the PEP rule than under the exchange rate rule, so long as $d > 0$.^{17/} This is consistent with some of the simulation results presented earlier.

Turning now to the more standard macroeconomic quadratic loss function, we substitute into equation (18),

$$L = a [f(\varepsilon_{im} - \varepsilon_x) + ((1-f)/f)(v-e)]^2 + f(u_x)^2 + (1-f)[b/(1-f)(v-e) + u_n]^2 \quad (25)$$

In this model, the expected loss under the PEP rule is likely to be smaller than under the exchange rate rule. Specifically, even if there are no export price shocks, then the expected loss is smaller under the PEP rule if $(1-f)/f < 1$, i.e., $f > 1/2$, i.e., the foreign sector is larger than the domestic sector. To the extent that export price shocks are non-zero, then the case is stronger, because ε_x enters the middle and third terms of the loss function for the exchange rate rule (such shocks affect both output of the export commodity and output of the nontraded good), whereas pegging the export price insulates the real economy against them. If the ε_x shocks are large, then the PEP rule dominates regardless of parameter values.

(iv) CPI rule

The last regime we consider is inflation targeting, which has gained popularity in recent years. We interpret inflation targeting as using monetary policy to fix the CPI. It turns out that this requires varying the exchange rate so as to exacerbate terms of trade shocks.

By definition of the regime, $cpi = 0$.

From equations (5) and (4), it follows that $f(s + \varepsilon_{im}) + (1-f)p_n = 0$. (26)

From equations (6) and (11),

$$s = (f)p_x + (1-f)p_n - v + e.$$

Substituting in from (3),

$$s = (f)(s + \varepsilon_x) + (1-f)p_n - v + e. \quad (27)$$

Combining (26) and (27),

$$s = e - v + f(\varepsilon_x - \varepsilon_{im}) \quad (28)$$

Notice that when an increase in the price of the import good on world markets worsens the terms of trade, the exchange rate must fall (the currency appreciates); the reason is to prevent the CPI from going up, but this is the opposite of what one hopes to get out of a

¹⁷ Unless ε_x and u_x happen to be negatively correlated in the right way. A negative correlation is possible: if a good harvest domestically coincides with a good harvest worldwide, and thus lowers the world price.

flexible exchange rate.

We need nothing more to evaluate the export revenue criterion.

Substituting (28) into equation (17), export earnings are given by

$$= e-v + f(\varepsilon_x - \varepsilon_{im}) + (1+d)(e-v + f(\varepsilon_x - \varepsilon_{im}) + \varepsilon_x) + u_x \quad (29)$$

The u_x term is the same as in equation (25), the PEP case. The coefficient of ε_x is greater by $f(2+d)+d$. In addition, $e-v$ shocks and ε_{im} shocks impinge on export earnings, via their effects on the exchange rate. Thus export revenue is likely to be more variable under the CPI target than under the PEP rule (unless these shocks happen to be negatively correlated in a very particular way).

A tougher test to meet is the macroeconomic loss function, for which we need to first find the equilibrium in the nontraded goods market. From equation (26),

$$p_n = -(f/1-f)(s + \varepsilon_{im}) .$$

With (28),

$$p_n = -(f/1-f)[e-v + f(\varepsilon_x - \varepsilon_{im}) + \varepsilon_{im}] \quad (30)$$

Substituting into equation (1),

$$y_n = -b(f/1-f)[e-v + f\varepsilon_x + (1-f)\varepsilon_{im}] + u_n \quad (31)$$

Not only do export price shocks affect the nontraded goods market under the CPI rule, as they also did under an exchange rate rule, but now import price shocks do so as well. Again, the reason is that an increase in import prices requires a monetary contraction and currency appreciation, if the CPI is not to rise.

When the CPI is fixed, the first term in the loss function, equation (18), disappears:

$$L = f[d(s + \varepsilon_x) + u_x]^2 + (1-f)[bp_n + u_n]^2$$

Substituting from (28) and (30)

$$= f[d(e-v + f(\varepsilon_x - \varepsilon_{im}) + \varepsilon_x) + u_x]^2 + (1-f)[-b(f/1-f)[e-v + f\varepsilon_x + (1-f)\varepsilon_{im}] + u_n]^2. \quad (32)$$

Compare to the loss function (25) under the PEP rule

$$L = a[f(\varepsilon_{im} - \varepsilon_x) + ((1-f)/f)(v-e)]^2 + f(u_x)^2 + (1-f)[b/(1-f)(v-e) + u_n]^2 .$$

Terms of trade shocks and exchange rate shocks hurt more under the PEP rule than under inflation targeting if a is large: if stabilizing the CPI is the highest priority then a CPI rule does the best by definition. But shocks to world export and import market prices destabilize both output terms under the CPI rule, while the real economy is insulated from them under the PEP rule; thus if a is small, the PEP rule dominates.ⁱⁱⁱ

ⁱ . Rogoff (1985b) warns that the welfare-ranking among the candidate variables for rigid targeting need not be the same as the welfare-ranking among the candidate variables for partial commitment.

ⁱⁱ . We assume that expectations are formed rationally. Some, however, may prefer to think that, because of the existence of contracts, these expectations are formed well in advance of the period in which actual inflation and output are determined. It should also be noted that, if the parameters b and d are thought to depend on the variance of the price level, then our results could be vulnerable to the famous Lucas critique.

ⁱⁱⁱ . The coefficients on export supply shocks and nontraded supply shocks are the same under the two rules. The comparison for exchange rate shocks depends on a number of parameters.