What Determines the Nominal Exchange Rate? Some Cross-Sectional Evidence

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Abstract

This paper examines the determination of long-run movements in nominal exchange rates across countries. We model the long-run movement in the nominal exchange rate as depending on (i) the long-run inflation differential; and (ii) the long-run change in the real exchange rate. We argue that the former depends on country characteristics such as openness, country size, the level of outstanding government debt and central bank independence and the latter on the rate of economic growth and the terms of trade. Empirical support for both channels is provided, suggesting the fruitfulness for the analysis of exchange rates of studying cross-sectional cross-country data.

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Section I: Introduction

This paper examines the determination of long-run movements in nominal exchange rates across countries. This issue is interesting and important for a number of reasons. First, explaining the long-run behavior of currencies is illuminating for those interested in tracking the evolution of the global economy. Second, an understanding of what determines long-run changes in the nominal exchange rate is potentially helpful to investors comparing expected returns on medium- or long-term nominal bonds denominated in different currencies. Third, modelling the long-run behavior of the exchange rate is the underpinning for even analysis of the short-run behavior of exchange rates: it is necessary to know the long-run in order to work out whether a given exchange rate movement is a deviation from its long-run path or represents convergence towards the long-run value of the exchange rate. Finally, long-run movements in exchange rates are less prone to the "noise" that is present in higher-frequency exchange rate data and hence may be more easily related to the fundamental determinants indicated by theory.

The basis for this paper is that unmodified purchasing power parity (PPP) in itself may not be an optimal model of the long-run nominal exchange rate. This is the case for three reasons. First, the long-run real exchange rate may not be a constant: for instance, a fast-growing economy may experience a long-run appreciation of its real exchange rate due to differential productivity growth in the traded and nontraded sectors. Second, inflation rates may contain both long-run and short-run components. Inflation can vary from its long-run value due to business cycle factors, temporary 'mistakes' or policies that shift inflation from the present to the future.[1] In this case, the PPP practice of identifying the long-run nominal exchange rate with the current inflation differential (controlling for any long-run in the real exchange rate) may be misleading. Third, if the long-run inflation rate is important in determining the long-run rate of change in the nominal exchange rate, this only begs the question of what determines the long-run inflation rate.

Accordingly, the approach in this paper is to model the long-run movement in the nominal exchange rate as depending on (i) the long-run inflation differential; and (ii) the long-run change in the real exchange rate. As such, this approach builds on the recent literature that has modelled long-run inflation in a Barro-Gordon policy game setting and derived theoretical and empirical results linking long-run inflation to variables such as trade openness, country size, central bank independence, political stability and government debt.[2] In extending this approach to nominal exchange rate determination, due attention has to be paid to the possibility of long-run movement in a country's real exchange rate. To see that this consideration is important, consider an economy that is growing rapidly and so faces a long-run appreciation of its real exchange rate. If its target inflation rate is low, its nominal exchange rate must be allowed to appreciate in order to reconcile low long-run inflation with real appreciation.

[1] For instance, the government may run an excessively tight fiscal policy or adopt a temporary exchange rate peg. See Sargent and Wallace (1981), Calvo (1986) and Tornell and Velasco (1995).

[2] See Romer (1993), Lane (1997) and Campillo and Miron (1997).

Japan presents a good example. Prior to the collapse of the Bretton Woods fixed exchange rate system, the positive long-run in its real exchange rate resulted in relatively high inflation; subsequently, with a floating nominal exchange rate, it was able to attain low inflation by offsetting the inflationary pressure generated by real appreciation with a robust rate of nominal exchange rate appreciation.[3] In this paper, as a first step, we model the long-run change in the real exchange rate in a fairly simple fashion, focusing on productivity growth and changes in the terms of trade as forces that drive the real exchange rate.

As noted above, long-run inflation can be modeled as the outcome of a Barro-Gordon game between the government and the public.[4] In this class of model, the focus is on the time-consistent rational expectations equilibrium inflation rate. A key result is that the greater is the incentive to inflate, the higher will be long-run inflation. The incentive to inflate is increasing, for instance, in the seigniorage needs of the government and in the payoff to surprise monetary expansion. For example, the former will be greater, all else equal, the greater is the stock of outstanding nominal government debt.[5] If the government cares about social welfare, the latter will depend on the real income effect of an increase in output that is generated by a monetary surprise and on the extent of distortions in the economy. From the analysis developed by Romer (1993) and Lane (1997), these factors are less important in more open and smaller

[3] Over 1962-70, Japan's average annual inflation rate was 5.8 percent; over 1974-92, it was significantly lower at 3.8 percent.

[4] See Barro and Gordon (1983).

[5] See also Campillo and Miron (1997).

economies, which suggests that long-run inflation will be lower in such economies. Finally, following Rogoff (1985), it is well understood that appointing a central bank governor that is perceived to gain less from inflation than the government can reduce the equilibrium inflation rate.

As is discussed in section 2.3, economic growth and movement in the terms of trade are potentially important factors in the determination of the long-run in the real exchange rate. It is a robust stylised fact that richer countries have higher relative price levels (eg, see Kravis and Lipsey 1983). A dynamic corollary is that if country i is growing more rapidly than the benchmark country, this will be associated with appreciation of country i's real exchange rate. If domestic tradable goods have a greater weight in the domestic price level than in the price level of the benchmark country (and conversely), then an improvement in the terms of trade also translates into a real appreciation. It follows that a country that is enjoying a long-run improvement in its terms of trade will also experience a long-run appreciation in its real exchange rate.

From this account of the determination of long-run inflation and the long-run change in the real exchange rate, it is possible to derive an expression for the long-run movement in the nominal exchange rate as a function of a set of country characteristics. The preceding discussion indicates that this set of country characteristics include openness, size, extant government debt, output growth, terms of trade movements and the degree of central bank independence. Such an expression for the long-run in the nominal exchange rate is useful because it allows us to obtain estimates for long-runs in nominal exchange rates from cross-country cross-sectional data. The major part of this paper consists of an attempt to perform this empirical implementation.

Previewing the empirical results, we find evidence in support of both inflation and real exchange rate factors in determining the rate of growth of the nominal exchange rate. Openness and the stock of nominal government debt – variables that affect the propensity to inflate – are significant in explaining the long-run rate of nominal depreciation. The evidence on another inflation variable – country size – is mixed and the data do not support a significant role for central bank independence, controlling for these other factors, in determining the rate of nominal exchange rate depreciation. The output growth rate – which affects the long-run in the real exchange rate – also is important in explaining the long-run movement in the nominal exchange rate. However, the results for the terms of trade, another factor that ought affect the nominal exchange rate via its influence on the real exchange rate, are mixed. For the OECD, the factors driving inflation appear to dominate the determination of the nominal exchange rate, even though the real exchange rate does in fact significantly comove with the output growth rate and the terms of trade in the OECD subsample. These findings suggest the potential fruitfulness for empirical analysis of exchange rates from studying cross-sectional cross-country data.

The empirical literature on nominal exchange rate determination has focused mostly on the high-frequency behavior of exchange rates or on statistical approaches to characterizing the long-run in nominal exchange rates for a small set of industrial countries.[6] However, Obstfeld (1995) follows a similar empirical approach to that in this paper in the sense that he allows both the inflation differential and productivity growth to affect the nominal exchange rate in a cross-section of OECD economies. As mentioned above, the work that is mostly closely related to this paper is the analysis of cross-country determinants of long-run inflation contained in Romer (1993), Lane (1997) and Campillo and Miron (1997).

The rest of the paper has the following structure. Section 2 provides a background theoretical discussion. The empirical analysis is contained in section 3. Section 4 concludes.

Section II: The Model

In this section, we lay out a simple theoretical framework that is helpful in clarifying the determinants of the long-run behavior of the nominal exchange rate. In particular, it is useful to decompose the long-run movement in the nominal exchange rate into its constituent parts: the long-run inflation differential and the long-run change in the real exchange rate. As our focus is on long-run behavior, we are able to abstract from factors that only have short-run effects on the nominal exchange rate.

[6] See the recent comprehensive survey by Frankel and Rose (1995).

A: Basic Framework

By construction, the price level of country i is linked to the price level of the benchmark country by the relationship

$$p_i = \frac{E_i p^*}{R_i}$$

where p_i is the price level of country i, E_i is the nominal exchange rate defined as the number of units of country i's currency per unit of the currency of the benchmark country (an increase in E_i is a nominal depreciation of the currency of country i), p^* is the price level of the benchmark country and R_i is the real exchange rate (an increase in R_i is a real depreciation). In log first differences, this expression can be rewritten as

$$\pi_i = \pi_i^E + \pi^* - \pi_i^R \qquad (1)$$

or

$$\pi_i^E = \pi_i - \pi^* + \pi_i^R \qquad (2)$$

where π_i^E is the rate of nominal depreciation, π_i is the rate of inflation in country i, π^* is the inflation rate of the benchmark country and π_i^R is the rate of real exchange rate depreciation. According to equation [2] the rate of nominal depreciation is faster, the higher is country i's inflation rate relative to that of the benchmark country and the faster is its rate of real depreciation. This expression is useful because, as was outlined in the introduction, there exist economic theories of long-run inflation and real exchange rate determination. It follows that if we can determine country i's equilibrium long-run inflation rate and the long-run change in its real exchange rate, we have an implicit account of what determines the movement in its nominal exchange rate. It remains to determine the rates of inflation and real depreciation. In the next subsection, we address the former problem; in subsection 2.3, we analyze long-run real exchange rate determination.

B: Inflation Determination

We follow the tradition of the literature initiated by Barro and Gordon (1983) by focusing on the determination of the time-consistent long-run equilibrium inflation rate. According to this approach, the equilibrium inflation rate will be increasing in the attractiveness of expected and unexpected inflation. As our focus is on the long-run inflation rate, we abstract from cyclical factors in the determination of inflation.

Even anticipated inflation can be attractive to a government if it desires seigniorage revenues. A government will rely more heavily on the inflation tax, the greater are its desired expenditures and the fewer are the alternative sources of tax revenue. For instance, the government's need for inflation tax revenue will be the greater, the larger is the stock of outstanding public debt.

Turning to the benefits of unanticipated inflation, a surprise monetary expansion inflation may increase the level of output and employment in the economy, in the presence of nominal price or wage rigidity. This will be more attractive to a government that cares (directly or indirectly) about social welfare, the greater is the effect on real income of an increase in output and the less socially efficient is the 'natural' level of output. Romer (1993) notes that the real income effect of an increase in domestic output will be smaller, the more open is an economy. The reason is that the adverse terms of trade effect of increasing the domestic output of tradables has a larger impact on the consumer price index in a more open economy, reducing the real income gain from increasing domestic production. Lane (1997) argues that more open economies are more efficient and hence the government in an open economy has less to gain from raising output above its natural level. For both these reasons, the payoff to surprise inflation is plausibly negatively related to the level of trade openness of an economy. In addition, the terms of trade effect highlighted by Romer is presumably more important, the larger is the economic size of a country, so that the gain to surprise inflation is also likely decreasing in the size of a country. Finally, unexpected inflation is attractive to the government if it has outstanding nominal debt, because it reduces the real value of this debt.

These factors notwithstanding, institutional reform can reduce the equilibrium inflation rate by making it harder for a government to pursue a discretionary monetary policy. For instance, as has been suggested by Rogoff (1985) and others, the government may choose to delegate monetary policy to an independent central bank. This can result in a lower equilibrium inflation rate if, for instance, the government appoints a 'conservative' central bank governor that places a greater weight on price stability versus reducing unemployment than does the government.[7]

[7] See Rogoff (1985). Alternatively, the government may write a contract with the central bank governor that imposes a penalty on her that is increasing in the rate of inflation (see Walsh 1995). Another option would be to give the central bank an explicit inflation

Accordingly, this line of work suggests that the level of outstanding government debt, the openness and economic size of a country and the degree of central bank independence are among the factors that may help to determine the long-run inflation rate and hence, for a given trend in the real exchange rate, the long-run rate of nominal exchange rate depreciation. These variables will be empirically examined in section 3 below.

C: Real Exchange Rate Determination

The other piece of the puzzle is to determine the long-run rate of real depreciation π_i^R. We focus on two forces that may drive movements in the real exchange rate. One is the relative rate of output growth, which shifts a country's relative income level. The other is a long-run change in its terms of trade.

A positive relationship between relative price levels and relative income levels has long been recognised (Balassa 1964, Samuelon 1964, Kravis and Lipsey 1983). One potential explanation is the Balassa-Samuelson hypothesis that long-run movement in the real exchange rate is largely driven by differential productivity growth in the traded and nontraded sectors.[8] Another is provided by Bhagwati (1984): a rising capital-labour ratio changes the product mix in the traded sector towards

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target and to impose a quadratic cost for deviating from that target (see Svensson 1997).

[8] See Balassa (1964), Samuelson (1964), Obstfeld and Rogoff (1996, Chapter 4). De Gregorio, Giovannini and Wolf (1994), Asea and Mendoza (1994) and Canzoneri, Cumby and Diba (1998) provide evidence that the relative price of nontradables in terms of tradables is driven by differential productivity growth between the two sectors but the explanatory power for the real exchange rate is much weaker, at least among the OECD set of economies.

more capital-intensive goods, raising economy-wide wages and the relative price of (labour-intensive) nontraded goods. Bergstrand (1991) points out that non-homothetic preferences which generate an income elasticity of demand greater than one for nontradables can also help explain the positive dependence of the price level on income.

An improvement in a country's terms of trade mechanically leads to an appreciation in its real exchange rate if there is home bias in the consumption of tradables.[9] In this case, an improvement in a country's terms of trade will appreciate its real exchange because domestic tradables enter with a greater weight in the domestic consumer price index than in the consumer price index of the benchmark country. To the extent that demand factors matter for the trend in the real exchange rate, an improvement in the terms of trade could also appreciate the real exchange rate via a wealth effect on the demand for nontraded goods.

D: Nominal Exchange Rate Determination

From the discussion in the last two subsections, we rewrite the nominal exchange rate equation [2] as

$$\pi^E_i = \pi(z_i) - \pi^* + \pi^R(g_i; g^*; \pi^{TTi})$$

where g_i and g^* are the home and foreign growth rates respectively and π^{TTi} is the growth rate of the terms of trade, or

$$\pi^E_i = \pi^E(z_i; g_i; \pi^{TTi}; \pi^*; g^*) \qquad (3)$$

[9] Trefler (1995) makes the case that home bias in consumption is required to explain trade patterns and volumes.

This equation for the long-run change in the nominal exchange rate is useful because it expresses the nominal exchange rate as a function of a set of country characteristics. As discussed in section 2.2, z_i may include the level of outstanding government debt, the openness and size of country i and the degree of central bank independence in country i. The growth rate and the terms of trade also matter because they alter the real exchange rate and hence, for a given inflation rate, the nominal exchange rate.

Section III: Empirics

A: Specification

We will work with a linear approximation to [3]

$$\pi_i^E = \alpha + \beta \Delta z_i + \gamma_1 \Delta g_i + \gamma_2 \Delta \pi^{TTi} + \epsilon_i \quad i = 1 \ldots N \tag{4}$$

where the $N + 1$th country is the benchmark country. The estimating procedure is ordinary least squares, with robust standard errors. As our focus is on the long-run movement in the nominal exchange rate and on country characteristics, the appropriate estimation framework is a cross-section of countries for the period 1974-92. The description of exchange rate determination in the previous section clearly does not properly apply to the Bretton Woods system that preceded this time period. The end point of 1992 is chosen in order to maximize the number of countries for which data on key variables is available. The US is chosen as the benchmark country. The US dollar is a major vehicle currency for international trade, with many international prices quoted in dollars, and hence this seems a natural choice.[10] The alternative of using a weighted average of the inflation rates of country i's trading partners would be computationally burdensome for the sample size in this study. Note that, in a cross-section, it is not necessary to actually compute each variable as a differential with respect to the benchmark country, as the values for the benchmark country would just enter as constants across the observations.

B: Data

Data on the nominal exchange rate and inflation are taken from the IMF's International Financial Statistics CD-ROM. Output, population and openness variables are taken from version 5.6 of the Summers-Heston Penn World Tables data set. The growth rate G is the average per capita output growth rate over 1974-1992. The openness measure is the average ratio of exports plus imports to GDP over 1974-1992.[11] Country size is proxied by total GDP in 1974. The debt variable, the ratio of government debt to GDP in 1975, is taken from Campillo and Miron (1995). The index of legal central bank independence is from Cukierman, Webb and Neyapti (1992). Terms of trade data are from the World Bank's World Tables. The set of countries that lack autonomous exchange rate policies, which will be excluded from a number of the regressions, is compiled from the IMF's Exchange Rate Arrangements and Practices and Obstfeld and

[10] The choice of benchmark country is less important in a cross-section than in time series or panel data analysis. This is because any common movement of the benchmark currency against the other currencies just shows up in the intercept term: in time series or panel analysis, a temporary common fluctuation in the benchmark currency generates non-spherical residuals.

[11] A volume-based measure of trade openness clearly has its limitations but it is difficult to think of superior alternatives that would be available for a large sample of countries.

Rogoff (1995). Data on war involvement and the black market premium are taken from Bruno and Easterly (1995).

C: Summary Statistics

Table 1 provides summary statistics for some of the key variables in the data set. The average currency depreciation against the US dollar over 1974-92 was 12.3 percent. However, there is a lot of variation around this mean: at one extreme, Argentina had an average annual currency depreciation rate of 131.7 percent; at the other, the Japanese yen appreciated against the US dollar at an average annual rate of 4.89 percent. Table 2 reports the fifteen countries that experienced nominal appreciation against the US dollar. Six are European, of which four are basically pegged to the DM (Austria, Belgium, Luxembourg, Netherlands).[12] Three are oil-rich countries (Bahrain, Qatar and United Arab Emirates). In addition, there are three fast-growing East Asian economies in this group: Japan, Taiwan and Singapore.

Table 3 reports the eighteen countries that experienced average annual depreciation rates over 1974-92 in excess of 30 percent. The mean depreciation rate among these countries is 60 percent. The list is dominated by countries that have undergone hyperinflations or endured chronic high inflation. Latin America is strongly represented in this group, led by Argentina, Brazil and Nicaragua, each with annual depreciation rates above 100 percent. There are also seven African countries on the list. Only two countries that were members of the OECD during this period

[12] Luxembourg has a currency union with Belgium.

– Israel and Turkey – are in this high-depreciation category.

Finally, in Table 4, we report the thirty one countries that did not have autonomy over monetary or exchange rate policy during this period. This group includes the members of the CFA zone in French West Africa and countries that have maintained currency boards or tight unilateral exchange rate pegs to other countries. It is unclear whether the model applies to these countries. We can think of a country adopting an exchange rate peg for two kinds of reasons. One is to implement its desired monetary policy: such a country may simply possess characteristics that would generate an equilibrium depreciation rate equal to that of its anchor country or a peg may be a kind of institutional reform to "tie the hands" of the government in its choice of an inflation rate. The other is when the peg is adopted for non-monetary reasons: eg, the CFA zone pegging to the Franc as part of a complex post-colonial relationship with France that also involves cheap debt financing and preferential trading arrangements or small "tourist economies" that are so reliant on international trade that an independently fluctuating currency would be too costly in terms of microeconomic inefficiency. For these countries, we can think of the peg as being compelling for non-monetary reasons and so their inflation rate and depreciation rate against the dollar (for a given change in the real exchange rate) is given to them by their anchor country. Accordingly, rates of inflation and nominal depreciation for these countries are not linked to the factors that are the focus of this study and the peggers are excluded from a number of specifications.

D: The Nominal Exchange Rate

For descriptive purposes, the nominal depreciation rate is plotted against the inflation differential with the US in Figure 1. As is clear from the graph, over the full sample of countries, there is a strong correspondence between nominal depreciation and inflation. This indicates that the factors driving the long-run in inflation are of high importance in explaining exchange rate movements. Indeed, a regression of the nominal depreciation rate on the inflation differential generates a coefficient of 0.996 and an $\bar{R}^2 = 0.98$ (see Table 5, column (1)). However, the strength of the purchasing power parity relationship may be overstated by the inclusion of the high-depreciation/high-inflation countries. In column (2) of Table 5, the countries with annual depreciation rates above 80 percent are excluded, which marginally reduces the explanatory power of inflation. Moreover, if the set of countries with depreciation rates above 30 percent are excluded, the $\bar{R}^2$ falls to 0.76; if the sample is further restricted to countries with depreciation rates below 10 percent, the $\bar{R}^2$ falls yet further to 0.61 and the coefficient on the inflation differential falls to 0.867 (see Table 5, columns (3)-(4)). This evidence for the subsamples that exclude the high-depreciation countries indicates that there is also considerable variation in real exchange rate movements in the sample. Finally, in column (5), the sample is restricted to the set of OECD countries. The PPP relationship appears particularly strong in this subsample. Scatter diagrams for the full sample, the sample excluding countries with depreciation rates above 30 percent and for the OECD are presented in Figures 1-3.

In Table 6, the most basic version of equation [4] is estimated. The righthand side variables are openness, country size, the per capita output growth rate and the growth rate of the terms of trade.[13] According to the theoretical arguments outlined in section 2, the former two variables are important because they influence a country's propensity to inflate, while the latter two variables enter because they affect the rate of real exchange rate depreciation.[14] Both openness and country size are entered in logs, in order to adjust for the presence of a small number of countries with very high values for these variables. In column (1), the full sample of countries is included. Openness, the output growth rate and the terms of trade enter with the expected signs and are significant. Finally, we note that country size is insignificant in this specification.

In column (2), the countries with non-autonomous monetary and exchange rate policies are excluded from the regression. The results are basically unchanged but the size of the growth and terms of trade effects increase slightly. The countries with depreciation rates above 30 percent are dropped from the sample in column (3). One reason to exclude these countries is to guard against reverse causality from high inflation/depreciation to growth: Barro (1995), Bruno and Easterly (1998) and Sarel (1996) each find that inflation is negatively related to growth

[13] It might be objected that output growth is endogenous to the inflation environment. This is most likely to be true at high rates of inflation. We adjust for this problem in some later specifications by excluding the set of countries with high rates of nominal depreciation/inflation.

[14] Lane (1997) and Campillo and Miron (1997) confirm that inflation performance is affected by both openness and country size. In section 3.4, we show that the output growth rate and the change in the terms of trade help explain real exchange rate movements.

at high rates of inflation but not at lower inflation rates.[15] In this regression, each of the regressors is significant, with the exception of the terms of trade. As a robustness check, column (4) replicates column (2), but with the exclusion of countries that were involved in a war for at least three years during the sample.[16] These countries are excluded because wars often involve price and other controls and may proxy for poor data. Openness, growth and the terms of trade are significant in this regression. In column (5), countries that experienced a large change in the black market foreign exchange premium over the sample period are also excluded. A good example is Iran: in 1974, its black market premium was -0.1 percent; in 1992, it was an extraordinary 3360 percent! As is evident from Figure 4, apart from these outliers, black market exchange rates and official exchange rates track each other quite well. In this regression, the openness effect is slightly weaker but the results are generally similar to column (4). Finally, in column (6), the sample is restricted to the set of OECD countries. Consistent with the PPP evidence in Table 5, the growth rate and the terms of trade are insignificant in this regression. However, both openness and country size are significant. The evidence from Table 6, then, provides initial support for the model outlined above, with both in-

[15] Instrumental variables estimation is inappropriate given the lack of strong instruments for output growth and the knowledge that non-instrumentation is superior to using weak instruments (almost every variable employed in growth regressions is either plausibly endogenous or is only relatively weakly correlated with growth). As Hall and Jones (1997) have pointed out, the level of income per capita plausibly has good instruments (eg, distance from Equator, main language spoken, ethno-linguistic heterogeneity in the population) but not the growth rate– indeed, they argue that this should redirect economists from studying growth rates to studying differences in income levels across countries.

[16] 25 countries fall into this category.

flation and real exchange rate factors typically proving important for the determination of the nominal exchange rate.

Two additional variables are added to the specification in Table 7. One is the initial stock of outstanding government debt, expressed as a ratio to GDP. As discussed in section 2.2, a country that has a larger stock of government debt will be more prone to inflate, both as a source of tax revenue and because its eroding effect on the real value of the debt raises the payoff to unexpected inflation. The other is the index of legal central bank independence developed by Cukierman, Webb and Neyapti (1992). If an independent central bank is more insulated from political pressures to inflate, this variable should have a negative effect on inflation. As pointed out by Barro (1995), a legal measure is less prone to the criticism that it is endogenous to inflation performance than alternatives, such as the rate of turnover of the central bank governor.

In column (1), the full sample, subject to data availability, is included. Openness, size, growth and debt are significant in this regression. A check on the data suggests that the relative insignificance of the terms of trade in this regression is the result of excluding countries from this regression that lack government debt data but which have a strong terms of trade effect. The central bank independence index is insignificant in the regression.[17] As in Table 6, the countries with non-autonomous exchange rate policies are dropped from the sample in column (2), but the results are very similar to those in column (1). In column (3), the countries with annual average depreciation rates in excess of 30 percent are also

[17] This also holds true for all the specifications reported below.

excluded. For this subsample, the growth effect is less significant and the debt variable is no longer significant. The latter result suggests that the debt effect is most important for high depreciation/inflation countries.

Column (4) replicates column (2), with the exclusion of countries involved in wars or that experienced a large change in the black market foreign exchange premium.[18] The results are similar to those in columns (1)-(2). Finally, the results for the OECD subsample are reported in column (5). In addition to openness and size, debt also enters significantly in this regression but the 'real' variables – the output growth rate and the terms of trade – are insignificant.

In summary, our model emphasized two kinds of determinants of nominal exchange rates: variables that affect the equilibrium long-run inflation rate and variables that affect the long-run real exchange rate. In this section, we have reported evidence in support of both kinds of effect on the nominal exchange rate. Openness, size and the stock of nominal government debt – variables that affect the propensity to inflate – are significant in explaining the rate of nominal depreciation. However, the evidence on central bank independence is weaker. The output growth rate – which affects the long-run in the real exchange rate – also is important in explaining the nominal exchange rate. However, the results for the terms of trade, another factor that ought affect the nominal exchange rate via its influence on the real exchange rate, are mixed. For the OECD, and consistent with the PPP evidence, the factors driving inflation appear to dominate the determination of the nominal exchange rate.

[18] For this regression specification, these two categories exactly match.

E: The Real Exchange Rate

In this subsection, as an additional check on our approach, we relate real exchange rate behavior to the output growth rate and the terms of trade. Recall that, according to the arguments laid out in section 2, the reason why these variables are important for nominal exchange rate depreciation is because they are important for real exchange rate depreciation.

In column (1) of Table 8, we report the regression of the average annual depreciation rate of the real exchange rate on the output growth rate and the growth in the terms of trade. Both enter with the correct sign but only the terms of trade is significant. However, the lack of a significant growth rate effect may be the result of data and other problems that lead to mismeasurement of the real exchange rate for a number of countries.

Accordingly, in column (2), we exclude those countries which had fixed exchange rates or were involved in a war during this period. The probability of mislalignment is likely higher for countries with pegged exchange rates, especially if a peg is maintained for political reasons, as with the CFA zone in Africa. In fact, there is some post-sample evidence in support of this argument: in January 1994, the CFA franc was devalued by 100 percent against the French franc. Also in 1994, Surinam, which had an official peg with the US dollar throughout the 1974-92 period, underwent an even larger devaluation. The exclusion of warring countries is done because of the likelihood of price controls in a war situation and a concern about data quality for these countries. The results in column (2) support a significant role for both the growth rate and the terms of trade in real exchange rate determination. In column (3), countries that experienced a large change in the black market foreign exchange premium are additionally excluded, with similar results.

Finally, the sample is restricted to the OECD set of countries in column (4). Both the growth rate and the terms of trade are significant in explaining variation in long-run real exchange rate movements in the OECD and jointly explain 46 percent of the variation in the long-run real exchange rate. This is consistent with the evidence of only a minor effect of these variables on the nominal exchange rate because the real exchange rate displays relatively little variability in the OECD sample relative to the variability of inflation, so that the determination of the long-run rate of nominal exchange rate depreciation is dominated by inflation factors for the OECD.

The evidence in Table 8, then, is consistent with the arguments advanced in section 2.3. Finally, it ought to be noted that a large fraction of the variation in the real exchange rate is not explained by the output growth rate or the terms of trade. Identifying additional determinants of long-run movements in real exchange rates is a potentially interesting topic for future research.[19]

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[19] Unfortunately quality data on some candidate variables – such as government spending – are not generally available for a large number of the developing countries in the sample. Engel (1996) suggests that differences in the relative price levels of traded goods across countries may lie behind movements in real exchange rates.

Section IV: Conclusions

In this paper, we have investigated some determinants of long-runs in nominal exchange rates in a cross-section of countries. Our model emphasized two kinds of determinants of nominal exchange rates: variables that affect the equilibrium long-run inflation rate and variables that affect the long-run in the real exchange rate. We found evidence in support of both kinds of effect on the nominal exchange rate. Openness and the stock of nominal government debt – variables that affect the propensity to inflate – are significant in explaining the rate of nominal depreciation. The evidence on other inflation variables, such as central bank independence, country size, political instability and past inflation performance is weaker. The output growth rate – which affects the long-run in the real exchange rate – also is important in explaining the nominal exchange rate. However, the results for the terms of trade, another factor that ought affect the nominal exchange rate via its influence on the real exchange rate, are mixed. For the OECD, the inflation factors dominate the determination of the nominal exchange rate, although the real exchange rate does significantly vary with the output growth rate and the terms of trade in this subsample. These findings broadly support the contention in this paper that long-runs in nominal exchange rates can be related to a set of characteristics that vary across countries.

In extending this work, there is considerable progress to be made in achieving a better understanding of the determination of the real exchange rate. The evidence in Table 8 indicates that a large fraction of the long-run variation in real exchange rates across countries remains to be explained. These limitations of the current study notwithstanding, the results of this paper suggest the potential fruitfulness for empirical analysis of exchange rates from studying cross-sectional cross-country data.

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Table 1: Summary Statistics

	π^E	π	Open	G	GTT	Size
Mean	.122	.171	.6462	.351	-.004	2.11
Median	.043	.095	.5682	.45	-.0035	.011
Max.	1.317	.027	3.5063	3.01	.0152	230
Min.	-.0489	.024	.0538	-1.92	-.0259	.0001
S.D.	.227	.237	.4116	1.014	.007	21.5
N	144	109	133	117	125	114
	Debt	CBI	π^R	BLK		
Mean	.2565	.353	.014	.019		
Median	.1987	.36	.012	0		
Max.	1.552	.69	.151	1.866		
Min.	.0089	.14	-.088	-.195		
S.D.	.2242	.117	.031	.188		
N	73	65	105	102		

π^E is the average annual log change in the nominal exchange rate against the US dollar over 1974-92. π is the annual CPI inflation rate over 1974-92. Open is the ratio of exports plus imports to GDP. G is the average annual per capita output growth rate over 1974-92. GTT is the average annual growth rate of the terms of trade. Size is total GDP (in billions of international dollars) in 1974. Debt is the ratio of government debt to GDP in 1975. CBI is the legal central bank independence index. π^R is the average annual change in the real exchange rate against the US price level over 1974-92. BLK is the average annual change in the foreign exchange black market premium over 1974-92. See the text (section 3.2) for sources.

Table 2: Non-Autonomous Exchange Rates

Luxembourg	Bahamas	Barbados	Belize
Benin	Bhutan	Burkina Faso	Cameroon
Central African Republic	Congo	Cote d'Ivoire	Djibouti
Dominica	Grenada	Iraq	Kiribati
Lesotho	Liberia	Mali	Niger
Panama	St Kitts	St Lucia	St Vincent
Senegal	Swaziland	Syria	Togo
Surinam	Comoros	Gabon	

Classification is based on the IMF Exchange Rate Arrangements and Practices and Obstfeld and Rogoff (1995). The criterion for inclusion was a unilateral peg to another currency for virtually the entire sample period or membership of the CFA franc zone.

Table 3: Appreciating Countries

Country	π^E	Country	π^E
Belgium/Luxembourg	-.0047	Austria	-.0228
Bahrain	-.0009	Germany	-.0223
Japan	-.0489	Malta	-.0002
Netherlands	-.018	Neth. Antilles	-.0003
Taiwan	-.0223	Qatar	-.0045
Switzerland	-.0309	Seychelles	-.0043
Singapore	-.0189	UAE	-.0045

Countries that experienced nominal appreciation against the US dollar over 1974-92.

Table 4: "High Depreciation" Countries

Country	¼^E	Country	¼^E
Argentina	1.317	Bolivia	.679
Brazil	1.179	Ghana	.3398
Guinea-Bissau	.3257	Israel	.4687
Laos	.432	Lebanon	.3713
Mexico	.3066	Nicaragua	1.2218
Peru	.9753	Sierra Leone	.357
Sudan	.3312	Turkey	.3565
Uganda	.5413	Uruguay	.425
Zaire	.844	Zambia	.3515

List of countries with average annual depreciation rates against the US dollar in excess of 30 percent.

Table 5: PPP Regressions

	(1)	(2)	(3)	(4)	(5)
C	-0.044	-0.048	-0.048	-0.041	-.06
	(.0037)	(.003)	(.006)	(.009)	(.003)
D¼	0.996	1.02	1.02	0.867	1
	(0.015)	(.019)	(.075)	(.12)	(.01)
$\bar{R}^2$	0.98	0.93	0.76	0.61	0.99
N	107	103	94	76	23

Dependent variable is average annual log change in the nominal exchange rate against the US dollar. D¼ is the average annual in‡ation di¤erential relative to the US. Standard errors are corrected using the McKinnon-White procedure. The full sample is included in column (1). In column (2), the countries with annual depreciation rates above 100 percent are also dropped. In column (3), the countries with depreciation rates above 30 percent are also dropped. In column (4), the countries with depreciation rates above 10 percent are also dropped. In column (5), the sample is the set of OECD countries.

Table 6: Benchmark Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
C	0.76	1.11	0.47	1.14	0.76	1.74
	(.33)	(.43)	(.15)	(.38)	(.43)	(.5)
OPEN	-0.16	-0.165	-0.036	-0.16	-0.13	-0.075
	(.06)	(.065)	(.017)	(.07)	(.068)	(.024)
SIZE	0.0002	-0.012	-0.01	-0.015	-0.005	-0.053
	(.008)	(.01)	(.004)	(.009)	(.013)	(.016)
G	-5.97	-7.48	-2.63	-4.48	-4.8	-4.22
	(2.44)	(2.7)	(.9)	(1.77)	(2.3)	(5.4)
TT	-10.32	-10.63	-2.53	-6.62	-11.98	8.35
	(3.67)	(3.91)	(1.43)	(3.55)	(5.65)	(7)
$\bar{R}^2$	0.32	0.37	0.27	0.31	0.33	0.21
N	107	91	75	73	62	22

Dependent variable is average annual log change in the nominal exchange rate against the US dollar. Standard errors are corrected using the McKinnon-White procedure. The full sample is included in column (1). In column (2), those countries with non-autonomous exchange rate policies are excluded (see the list in Table 2). In column (3), the countries with annual depreciation rates above 30 percent are also dropped. Column (4) replicates column (2), but with the exclusion of countries involved in wars. In column (5), countries that experienced large changes (greater than an average 10 percent annually in absolute value) in the black market foreign exchange premium are additionally excluded. The sample is restricted to the OECD in column (6). See note to Table 1 for description of variables.

Table 7: Extensions

	(1)	(2)	(3)	(4)	(5)
C	2.03	2.19	1	1.77	1.6
	(.65)	(.62)	(.3)	(.46)	(.46)
OPEN	-0.24	-0.23	-0.063	-0.16	-0.12
	(.1)	(.09)	(.019)	(.05)	(.038)
SIZE	-0.04	-0.05	-0.027	-0.044	-0.045
	(.016)	(.016)	(.009)	(.013)	(.013)
G	-7.96	-7.65	-2.64	-6.6	-3.86
	(3.19)	(3.1)	(1.4)	(3.2)	(6)
TT	-3.31	-5.42	0.62	-5.1	5.4
	(5.3)	(6)	(1.5)	(4.2)	(2.97)
DEBT	0.26	0.25	-0.018	0.28	0.24
	(.066)	(.069)	(.04)	(.05)	(.05)
LCBI	0.25	0.21	-0.061	0.032	0.065
	(.17)	(.17)	(.054)	(.1)	(.063)
$\bar{R}^2$	0.46	0.48	0.33	0.62	0.74
N	45	43	35	34	21

Dependent variable is average annual log change in the nominal exchange rate against the US dollar. Standard errors are corrected using the McKinnon-White procedure. The full sample is included in column (1). In column (2), those countries with non-autonomous exchange rate policies are excluded (see the list in Table 2). In column (3), the countries with annual depreciation rates above 30 percent are also dropped. Column (4) replicates column (2), but with the exclusion of countries involved in wars and countries that experienced large changes (greater than an average 10 percent annually in absolute value) in the black market foreign exchange premium are additionally excluded. The sample is restricted to the OECD in column (5). See note to Table 1 for description of variables.

Table 8: Real Exchange Rate Regressions

	(1)	(2)	(3)	(4)
C	0.009	0.016	0.015	0.012
	(.005)	(.004)	(.005)	(.005)
G	-0.25	-1.03	-0.98	-1.8
	(.46)	(.41)	(.48)	(.66)
TT	-1.16	-1.4	-1.72	-0.617
	(.55)	(.46)	(.52)	(.263)
$\bar{R}^2$	0.05	0.28	0.31	0.46
N	92	62	56	22

Dependent variable is average annual log change in the real exchange rate against the US dollar. Standard errors are corrected using the McKinnon-White procedure. The full sample is included in column (1). In column (2), countries with non-autonomous exchange rate regimes or involved in wars are excluded. In column (3), countries that experienced large changes (greater than an average 10 percent annually in absolute value) in the black market foreign exchange premium are additionally excluded. The sample is restricted to the OECD in column (4). See note to Table 1 for description of variables.

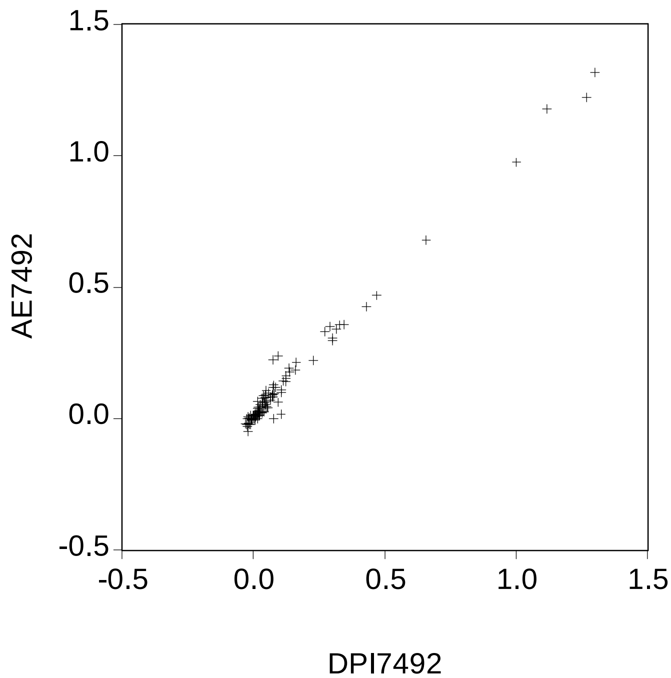

Fig. 1: Scatter of nominal depreciation against inflation differential over 1974-92 for entire sample.

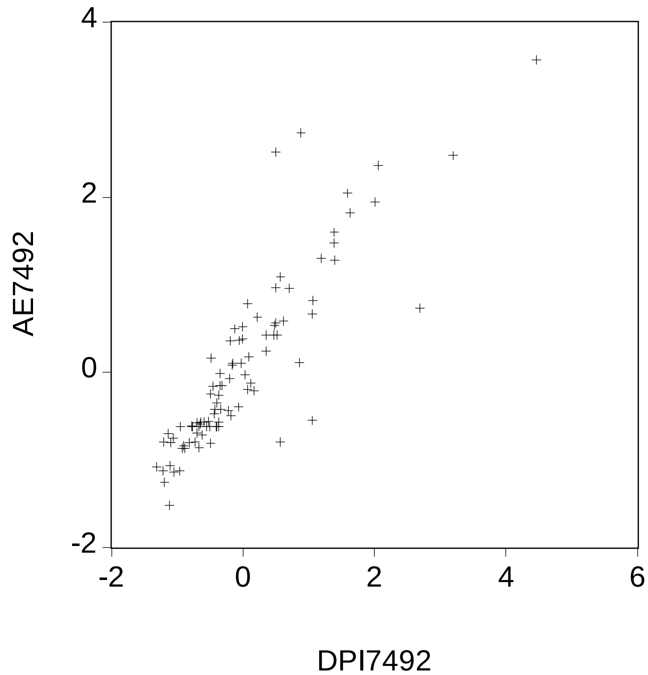

Fig. 2: Scatter of nominal depreciation against inflation differential over 1974-92 with exclusion of countries with depreciation rates above 30 percent.

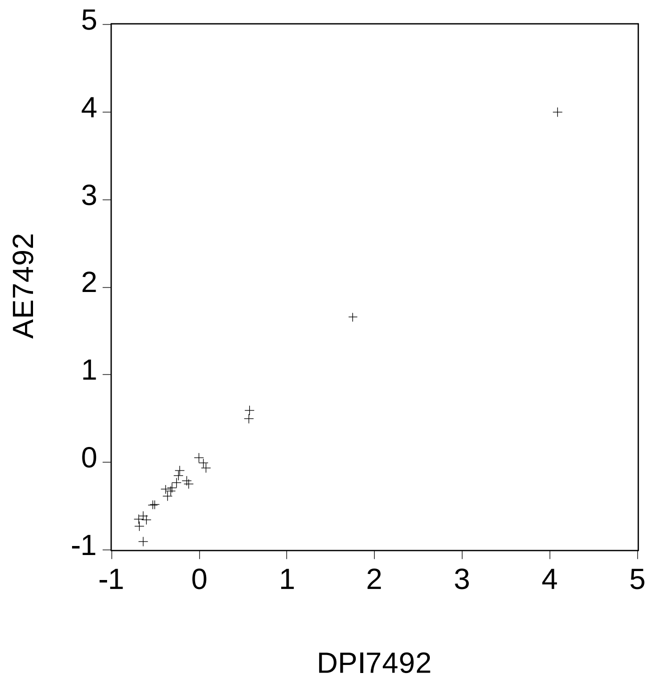

Fig. 3: Scatter of nominal depreciation against inflation differential over 1974-92 for OECD sample.

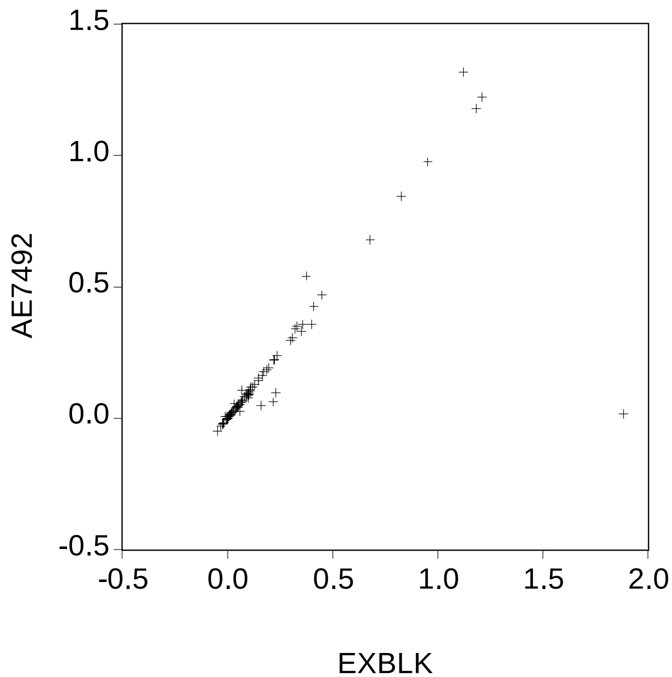

Fig. 4: Scatter of depreciation rate of official exchange rate against depreciation rate of black market exchange rate over 1974-92 for full sample.