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Are Exchange Rates Macroeconomic Phenomena?

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This paper argues that macroeconomic variables are relatively unimportant determinants of exchange rates. The argument hinges on the fact that bilateral exchange rate volatility differs widely across pairs of countries, but macroeconomic volatility is much more similar across countries, at least at short- and medium-term frequencies. For instance, the French Franc/German Deutschemark exchange rate has dramatically lower volatility than the Canadian dollar/German Deutschemark rate, although France and Canada have approximately equal macroeconomic volatility vis-à-vis Germany.

I. Introduction

Most economists think that macroeconomic phenomena drive exchange rates. For instance, many economists believe that the 1992–1993 European Currency Crisis was the result (at least in part) of the Bundesbank's tight monetary policy, itself a response to the inflationary pressures generated by German unification. For another instance, the appreciation of the U.S. dollar in the early 1980s is frequently attributed to either Reagan's loose fiscal policy or Volcker's tight monetary policy, or both. Finally, most economists who model the exchange rate either theoretically or empirically, use macroeconomic models.

In this paper, I argue that macroeconomic phenomena are not especially important forces in driving exchange rates; there must be other things which are at least as important which also determine exchange rates, at least at short- and medium-term frequencies. While it is undeniable that macroeconomic forces are sometimes important, in this paper I seek to show that many shocks that drive exchange rates are not macroeconomic in nature.[1]

My argument is quite simple. Suppose that we treat Germany as the domestic country. Exchange rates of various OECD countries have significantly different exchange rate regimes vis-à-vis Germany. In particular, the countries that participate in the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS), like Belgium, France, and the Netherlands, have relatively fixed exchange rates with Germany. On the other hand, a number of other countries, like Canada, Japan, and the United States have exchange rates which float relatively freely vis-à-vis Germany. Thus exchange rate volatility differs significantly by partner country. However, this is not true of macroeconomic variables. Most OECD countries have quite similar macroeconomic volatility: Germany's macroeconomic volatility vis-à-vis the ERM countries is not significantly different from Germany's macroeconomic volatility vis-à-vis the floating-rate countries. This fact has implicitly been noticed before in, e.g., Baxter and Stockman (1989). Flood and Rose (1993) use a similar logic, but compare individual countries over time rather than different countries across the same interval of time.

1. Sometimes of overwhelming importance, for instance, during hyperinflations.

Most countries manage their exchange rates in some way. But if macroeconomic variables do not account for much exchange rate volatility, then adjusting macroeconomic policies probably will not change the stability of exchange rates much. Thus the purpose of this paper is to understand the determinants of exchange rates better, and thereby allow policymakers to devise more effective tools to manage exchange rates. I am also interested in whether there appears to be an identifiable tradeoff between macroeconomic stability and exchange rate volatility.

The next section lays out the theoretical analysis; the data are then presented in Section III. The actual empirical results are presented in Section IV, which is followed by a brief conclusion.

II. THEORY

The theoretical model I use is the simplest possible macroeconomic model of the exchange rate; it is a monetary model with flexible prices. I choose this model for two reasons. First, it is frequently used by economists. Second, it is also extremely simple to manipulate and understand. However, I will show explicitly that the lessons one can learn from the simple monetary model generalize in a very natural way to a much broader class of macroeconomic models of the exchange rate. Thus one should think of the monetary model as a paradigm rather than as a literal description of reality.

I assume that domestic residents are allowed to hold three assets: domestic money, domestic bonds, and foreign bonds. Money is held to finance domestic (consumption) transactions; money demand depends negatively on the domestic interest rate, and positively on output. I assume for simplicity that the money demand function is linear in natural logarithms (except for the interest rate). The equation that describes equilibrium in the domestic money market is thus:

$$(1) \qquad m_t - p_t = \beta y_t - \alpha i_t + \epsilon_t ,$$

where m_t denotes the (natural logarithm of the) stock of money at time t, p denotes the price level, y denotes real income, i denotes the (level of the) nominal interest rate, and ϵ denotes a shock to money demand. It is important to note that the equation is explicitly stochastic. Indeed, I need not assume that ϵ is observable or particularly "well-behaved"; it need not have a mean of zero, nor be either independent or identically distributed over time, so long as it is stationary. It is worth noting explicitly that α is modeled as a structural parameter (as is β).

For simplicity, I assume that there is a comparable equation for the foreign country, and that domestic and foreign elasticities are equal:

$$(1') \qquad m^*_t - p^*_t = \beta y^*_t - \alpha i^*_t + \epsilon^*_t ,$$

where an asterisk denotes a foreign variable. Subtracting (1′) from (1) and rearranging yields:

$$(2) \quad (p-p^*)_t = \alpha(i-i^*)_t + (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t .$$

I next assume that goods prices are perfectly flexible in both countries. While admittedly unrealistic, this turns out to be a useful simplifying assumption; nothing of substance hinges on this postulate in the argument that follows. I will discuss informally the impact of loosening this assumption later on; Flood and Rose (1993) deal with this matter more rigorously.

I also assume that there are no large barriers to international trade, either natural (e.g., transportation costs or differences in natural preferences) or artificial (e.g., tariffs or other barriers to trade). That is, I assume that purchasing power parity holds, at least up to a disturbance term:

$$(3) \qquad (p-p^*)_t = e_t + \nu_t ,$$

where e denotes the domestic price of a unit of foreign exchange, and ν is a stationary disturbance from purchasing power parity, assumed to be "small" in a sense that will be defined more precisely below.

Substituting this equation into (2), it is trivial to solve for the exchange rate:

$$e_t = \alpha(i-i^*)_t + (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t - \nu_t$$

or

$$(4) \quad e_t - \alpha(i-i^*)_t = (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t - \nu_t .$$

It is important to note that this equation is structural, and does not rely on important exogeneity assumptions (e.g., about the nature of the output, the exchange rate regime, or the sources of ϵ shocks). (The reason for combining exchange and interest rates on the left-hand side of (4) will be rationalized explicitly below.)

Domestic and foreign bonds are assumed to be perfect substitutes vis-à-vis risk, liquidity, tax treatment, and so forth. It will sometimes be convenient to assume that agents are risk-neutral and have rational expectations so that uncovered interest parity (UIP) holds:

$$(5) \qquad (i-i^*)_t = E_t(de_t)/dt ,$$

where $E_t(de_t)/dt$ is the expected rate of change of the exchange rate. However, none of the analysis I present relies on UIP. Below, I discuss the impact of allowing for deviations from UIP, which are well-known to be important empirically.

By substituting (5) into (4), the "flexible-price monetary model" can be written:

(6) $$e_t - \alpha E_t(de_t)/dt = f_t \equiv (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t - \nu_t,$$

where f_t denotes the "fundamental determinant" of the exchange rate.[2]

The objective of this paper is to investigate the fundamental determinants of exchange rates. I consider two different approaches to measuring fundamentals empirically.

In the flexible-price model, fundamentals are traditionally defined as:

(7) $$TF_t \equiv (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t.$$

Fundamentals in the monetary model of exchange rates with flexible prices are typically defined as *TF* (although sometimes the ϵ terms are set to zero); hence I call this measure "traditional fundamentals," denoted *TF.* This variable can be measured with data on money, income, shocks to monetary equilibrium, and the parameter β.

TF differs from the right-hand side of (6) by ν. Thus traditional fundamentals are equal to the right-hand side of (6) under the assumption that deviations to purchasing power parity are identically zero. Under the more realistic assumption that such shocks are negligible in the sense that their conditional volatility is low compared to the conditional volatility of *TF,* the latter differs from the right-hand side by the measurement error ν.

Traditional fundamentals represent the right-hand side of equation (4). However, the left-hand side can also be measured directly. Thus, a different measure of fundamentals is:

(8) $$VF_t \equiv e_t - \alpha(i-i^*)_t.$$

VF denotes "virtual fundamentals."

It was not necessary to make the assumption of uncovered interest parity in deriving (8). However, *if* UIP holds, then virtual fundamentals can be used as an empirical measure of "fundamentals" f in the context of *any* single-factor exchange rate model, as is apparent in (6). Thus the hypothesis of UIP explains the functional form of virtual (and traditional) fundamentals, but is not a requisite component of the analysis.

Virtual fundamentals and the exchange rate will be highly correlated if either α is small or the volatility of the interest differential is low (or both). Virtual (like traditional) fundamentals are observable; one only needs data on exchange rates, interest rates, and a choice of the α parameter. Virtual fundamentals, in contrast to traditional fundamentals, use high-frequency asset-market data (rather than coarser-frequency macroeconomic data). However, the two sets of fundamentals should behave similarly if the model describes reality "well."

If equation (4) holds exactly, then (7) and (8) are two different ways of measuring the same latent variable, namely, exchange rate fundamentals f. More generally, if the monetary model with flexible prices describes the actual data well, virtual and traditional fundamentals should have similar characteristics. Conversely, if virtual and traditional fundamentals are strikingly different, then this fact is strong evidence against the underlying model. Both virtual and traditional fundamentals are model-based, use raw economic data, and rely solely on the structural equation (4).

Much of the analysis that follows hinges on comparing characteristics of *VF* and *TF.* A particularly interesting characteristic to compare is conditional volatility; I use the standard deviation of the first difference of *TF* and *VF.* This statistic is a good choice for a few reasons. First, it is intrinsically interesting to policymakers concerned with exchange rate volatility. Second, as Meese (1990) shows, conditional volatility has proven to be difficult to explain with current exchange rate models. Third, it allows me to avoid various statistical issues associated with the potential nonstationarity of fundamentals. Finally, conditional volatility varies in an interesting and systematic way across countries with different exchange rate regimes and different measures of fundamentals. In particular, the volatility of virtual fundamentals differs systematically across currencies; unsurprisingly, fixed exchange rates have systematically lower conditional exchange rate volatility than more flexible rates. However, the conditional volatility of traditional fundamentals is, broadly speaking, similar across countries.

It is important to note in passing that my use of the term "fundamental" should not be taken to mean "exogenous," and I will certainly not assume that fundamentals are exogenous in the empirical work which follows. (This should be clear, since the empirical results of the paper stem from comparing measurements of both sides of equation (4), a structural equation.) The logic of the monetary model indicates that if the exchange rate is fixed perfectly, the money supply is endogenous; traditional fundamentals could only conceivably be exogenous for a country with perfectly freely floating exchange rates. Since most exchange rates are managed in some way, it would be wholly unreasonable (in the context of this theoretical model) to claim that fundamentals are exogenous. It is also unnecessary for me to assume that the exchange rate regime itself is exogenous.

2. In many empirical exercises, the ϵ shocks are assumed to be zero, $E_t(de_t)/dt$ is measured, and then various moments of the exchange rate are compared with those of fundamentals and $E_t(de_t)/dt$; Meese (1990) provides references. Here, I eschew explicit measurement of $E_t(de_t)/dt$.

III. THE DATA SET

My empirical work focuses on bilateral German Deutschemark exchange rates from 1960 through 1992 inclusive. I choose this sample because I am interested in comparing exchange rates and their fundamental determinants during a recent and interesting period; this period also happens to be one with a relatively high level of capital mobility. The fact that the sample includes regimes of both fixed and floating rates will also turn to be advantageous. Germany is chosen to be the home country since the Deutschemark is an important currency which has been the core of the fixed-rate ERM (and earlier of the "Snake"), while simultaneously floating against currencies like the yen and the U.S. dollar.

The data set is quarterly, and was extracted from the IMF's *International Financial Statistics* CD-ROM; it has been checked and corrected for transcription and rebasing errors. Since Germany is considered to be the domestic country, exchange rates are measured as the Deutschemark (DM) price of one unit of foreign exchange. The consumer price index is used to measure prices; short-term money market rates are used for interest rates (except in the cases of Canada, Sweden, and the U.K., where Treasury bill interest rates are used so as to maximize sample availability). All the series are transformed by natural logarithms, except for interest rates; the latter are annualized and measured as nominal rates divided by 100 so that e.g., an interest rate of 8 percent is used as .08. I consider eight industrial countries (above and beyond Germany): Belgium (which maintains a currency union with Luxembourg), Canada, France, Japan, the Netherlands, Sweden, the United Kingdom, and the United States.[3]

Time series graphs of the raw exchange rate data (not transformed by logarithms) are presented in Figure 1. I note that the nominal exchange rates are obviously quite stable during the Bretton Woods era. However, volatility during the period after the collapse of Bretton Woods in 1973 is currency-specific; ERM currencies are observably less turbulent than more freely floating currencies such as the dollar and the yen, at least vis-à-vis the DM.

IV. EMPIRICAL RESULTS

In this part of the paper, I construct both virtual and traditional fundamentals for eight different countries, throughout using Germany as the base country. I then compare the different proxies for fundamentals. One key conclusion emerges; *the volatility of virtual fundamentals differs widely across countries, but the volatility of traditional fundamentals does not*. Throughout, I attempt to show that this key result is relatively insensitive, for instance, with respect to reasonable perturbations in the parameters, or to the exact form of the structural equations such as the asset market equilibrium condition.

I begin by considering virtual fundamentals.

Virtual Fundamentals

Virtual fundamentals are the left-hand side of equation (4), and are defined as $VF_t \equiv [e_t - \alpha(i-i^*)_t]$. Given that exchange rates and interest rates are observable, the construction of virtual fundamentals requires only one piece of nonobservable information, namely, α.

The literature indicates that α, the interest semi-elasticity of money demand, is likely to be a small number (see, e.g., the discussion in Flood et al. (1991)). I believe that a value of $\alpha = 0.1$ is reasonable, and that $\alpha = 1$ is excessively high. While I believe that $\alpha = 0.5$ is implausibly high, I pick it as the default value so as to make the case under adverse conditions (lower, more realistic, values of α will typically strengthen the argument of the paper, since VF trivially converges to e as α shrinks). However, it turns out that the main results do not really depend on α that much; even α values of substantially greater than unity deliver the main point. This robustness will be demonstrated directly with sensitivity analysis.[4]

Figure 2 is a series of time series plots of the levels of virtual fundamentals for all eight countries, using the default value of $\alpha = .5$ and the entire sample period. (Analogues for my preferred value $\alpha = 0.1$ lead to similar conclusions.) As in Figure 1, the scales of Figure 2 vary by country. Clearly, the plots are related and similar to those of the level of the exchange rate presented in Figure 1. Thus, the series are all relatively stable during the Bretton Woods era of fixed exchange rates and more volatile after 1973 for countries that float freely against the DM. However, ERM

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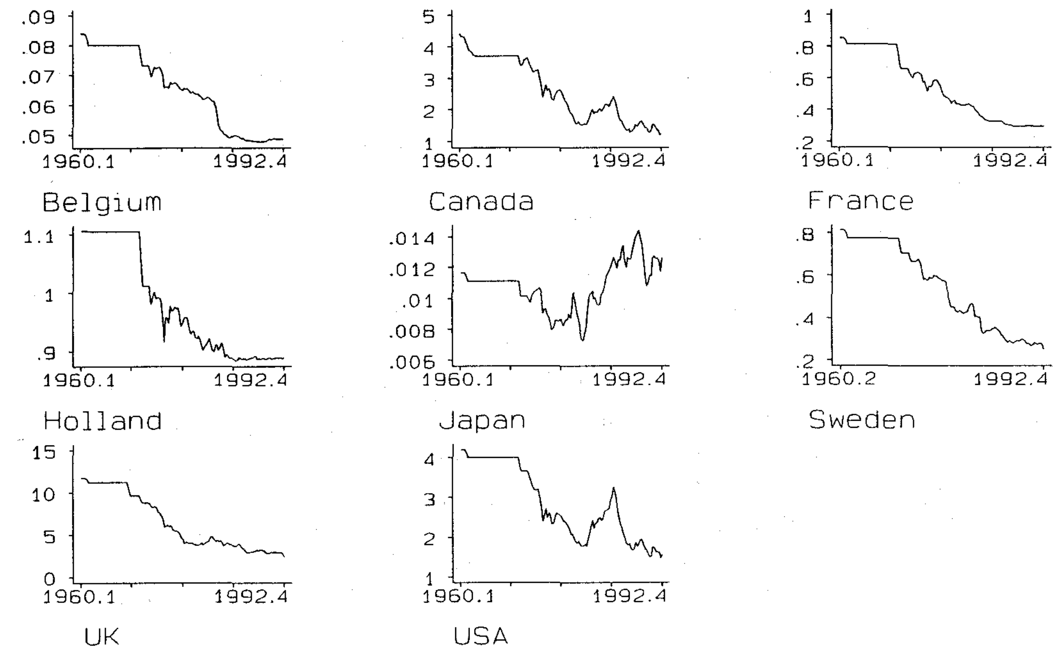
3. My STATA 3.0 programs and data set are available upon receipt of one formated high-density 3.5″ diskette along with a self-addressed stamped envelope.

4. I have attempted to estimate α directly. I derive the estimating equation by using UIP and taking first-differences: $\Delta e_t = \alpha\Delta(i-i^*)_t + \eta_t$, where the fundamental process is given by $f_t = f_{t-1} + \eta_t$ and η is a well-behaved disturbance term (white noise if f_t is a random walk).

To estimate this equation, I use IV, using three lags of both Δe and $\Delta(i-i^*)$ as instrumental variables. The results are poor in the sense that $\hat{\alpha}$ is usually imprecisely estimated, usually with a *negative* point estimate. (While I doubt that the instrumental variables are highly correlated with the regressor, OLS delivers similar results.) I have also tried to estimate α directly through various money demand equations with similarly poor results; α typically turns out to be small and insignificant, often negative.

FIGURE 1

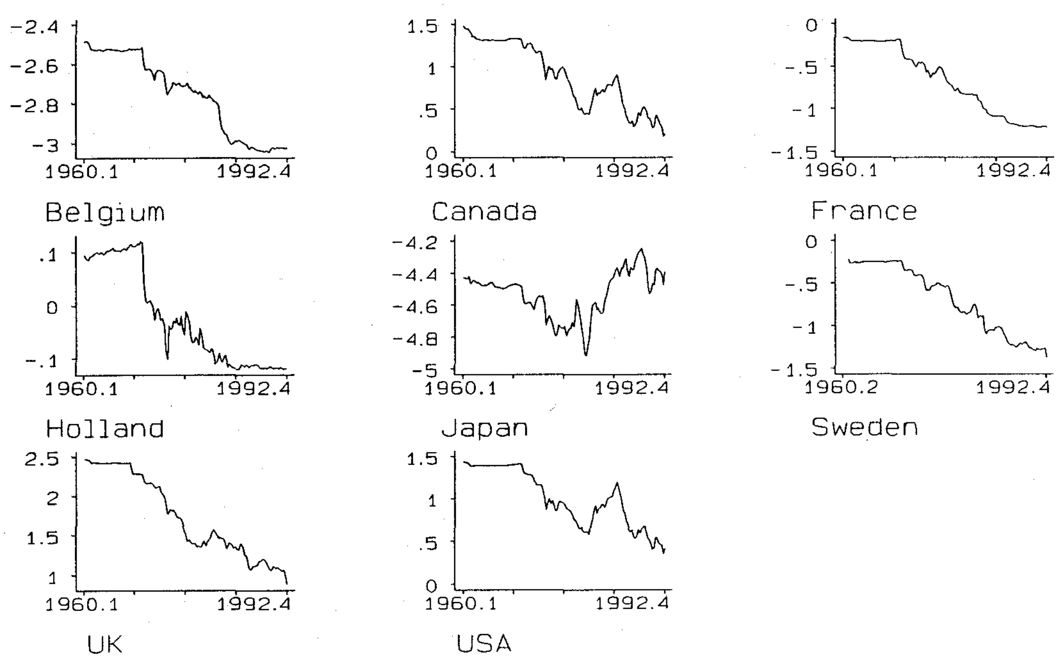
DM Price of Foreign Exchange



Scales vary by country

FIGURE 2

Virtual DM Fundamentals



Alpha=.5: Scales vary by country

participants have more stable virtual fundamentals; for instance, Holland, which has pursued a policy of pegging rigorously to the DM, has a very stable virtual fundamental. That is, the graphs show a striking phenomenon which is central to this paper, namely that *the volatility of virtual fundamentals is much higher for floating currencies than for currencies that are fixed.* This result does not depend on the exact choice of α.

Traditional Fundamentals

I now consider the right-hand side of equation (4), i.e., traditional fundamentals, defined to be: $TF_t \equiv [(m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t]$.

At first glance, it appears to be difficult to produce empirical measures of traditional fundamentals. While money and income are readily observable, one needs an estimate of β, the income elasticity of money demand. Money demand functions are notoriously unstable and unreliable, making β a difficult parameter to estimate with any sense of reliability. For the same reason, the ϵ terms, which represent shocks to money demand, are an additional source of difficulty in measuring traditional fundamentals precisely.

Nevertheless, it turns out that for simple money demand functions, the only additional information that is actually required to build traditional fundamentals is a measure of prices. This can be seen by considering a linear regression of the differential form of the money demand function (i.e., the difference between domestic and foreign money demand functions, (1) − (1′)):

$$(9) \quad (m-m^*)_t - (p-p^*)_t = \beta(y-y^*)_t - \alpha(i-i^*)_t + (\epsilon-\epsilon^*)_t$$

$$=> (\hat{\epsilon}-\epsilon^*)_t \equiv [(m-m^*)_t - (p-p^*)_t] - [\hat{\beta}(y-y^*)_t - \hat{\alpha}(i-i^*)_t].$$

Recall

$$(7) \qquad TF_t \equiv (m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t$$

$$=> \hat{TF}_t = (m-m^*)_t - \hat{\beta}(y-y^*)_t - \{[(m-m^*)_t - (p-p^*)_t] - [\hat{\beta}(y-y^*)_t - \hat{\alpha}(i-i^*)_t]\}$$

$$(10) \qquad => \hat{TF}_t = (p-p^*)_t - \hat{\alpha}(i-i^*)_t\,.$$

It might be objected that a simple static (differential) money demand function such as (9) is likely to fit the data extremely poorly. While this point is surely true, my interest in (9) is peripheral, since I am most interested in the *conditional innovations* of the traditional fundamentals. Including extra lagged terms in (9), which would improve the fit of the money demand model, will not change the conditional volatility of traditional fundamentals. Thus the levels of TF are less interesting to me than its first difference.

Time series plots of the levels of TF are presented in Figure 3; again the scales are country-specific. There are some differences across countries in TF volatility, and also differences for a given country between periods of fixed and floating rates. However, these differences tend to be relatively small and subtle. Thus, *in contrast with virtual fundamentals, the volatility of traditional fundamentals does not vary dramatically across countries.* This conclusion also does not depend on the exact value of α chosen.

Comparing Alternative Measures of Fundamentals

I now compare virtual and traditional fundamentals for the flexible-price monetary model.

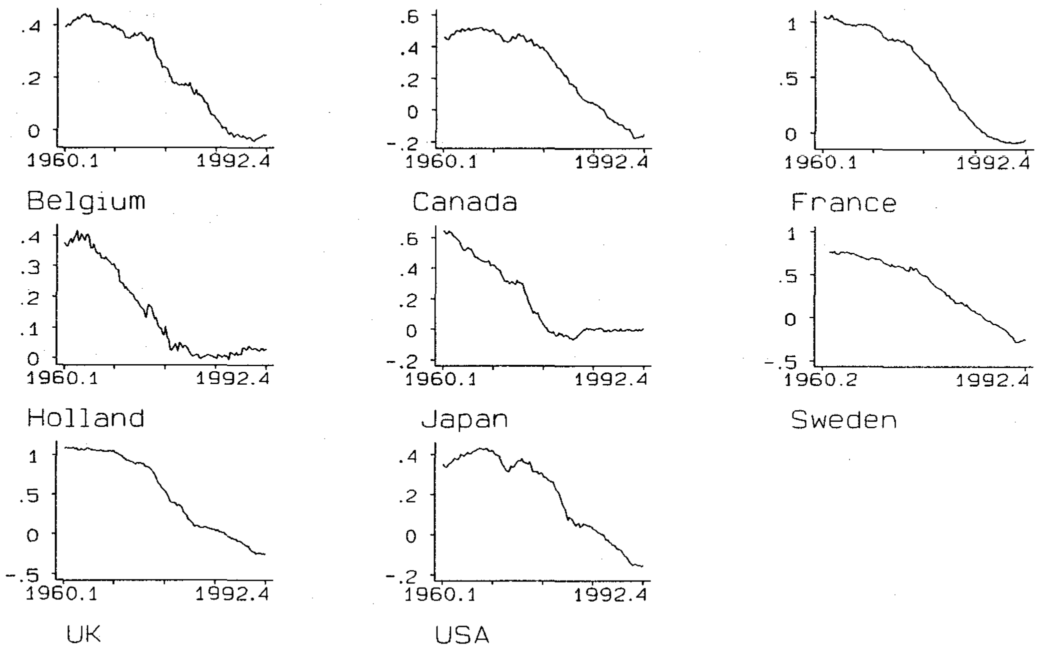
While Figures 2 and 3 can be used to compare virtual and traditional fundamentals informally, they are somewhat unhelpful in a number of respects. First, the scales on the "small multiple" graphics vary by country. Second, they do not emphasize the object of greatest interest, namely, the conditional innovations in fundamentals. This is especially important, given the issue of dynamic specification of the money-demand function which was discussed in the previous subsection. Finally, the distinctive properties of VF and TF can be easily emphasized by a close examination of an interesting subsample, namely, the period since the first quarter of 1979. This sample corresponds to the effective lifetime of the European Monetary System (EMS).

Figures 4 and 5 are analogues to Figures 2 and 3 in that they are respectively time series plots of virtual and traditional fundamentals for the eight countries. However, Figures 4 and 5 have three different features from Figures 2 and 3: (1) scales are comparable across countries within a figure (though still not across figures); (2) the sample is restricted to the period since the beginning of the EMS; and (3) the first differences (rather than the levels) are plotted. If fundamentals follow a random walk, then the first-difference is also the innovation.[5] Incorporating these features makes it much easier to compare traditional and virtual fundamentals.

5. The hypothesis that both virtual fundamentals and traditional fundamentals contain a unit root cannot typically be rejected at conventional significance levels. However, some mean reversion undoubtedly exists, especially at lower frequencies. This issue is addressed more closely by Mark (1992) and Chinn and Meese (1993).

FIGURE 3

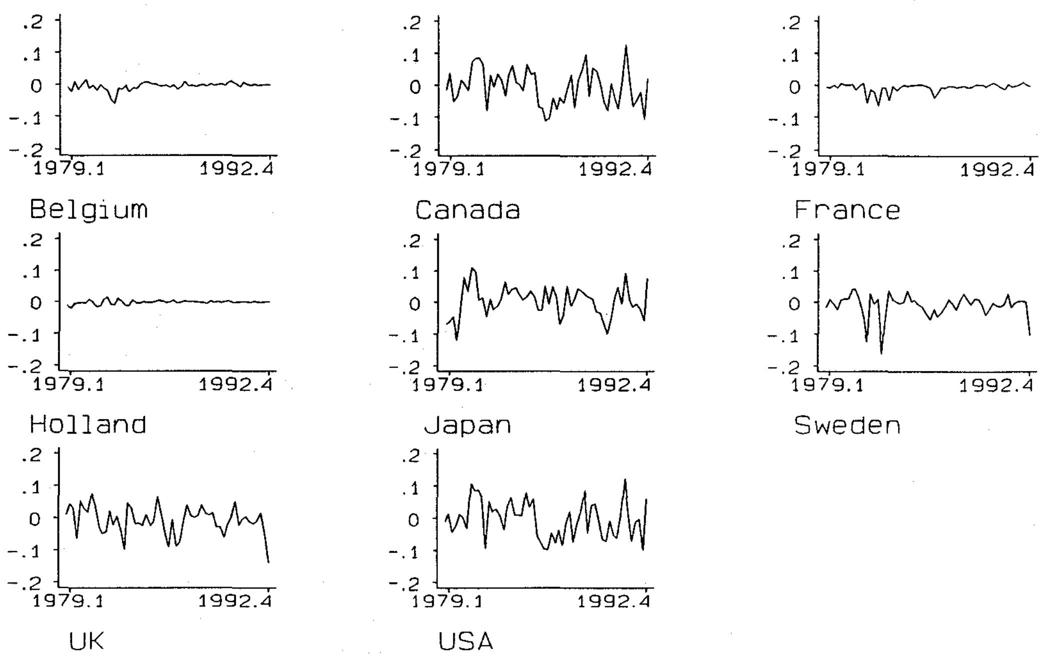
TRADITIONAL DM FUNDAMENTALS



Alpha=.5: Scales vary by country

FIGURE 4

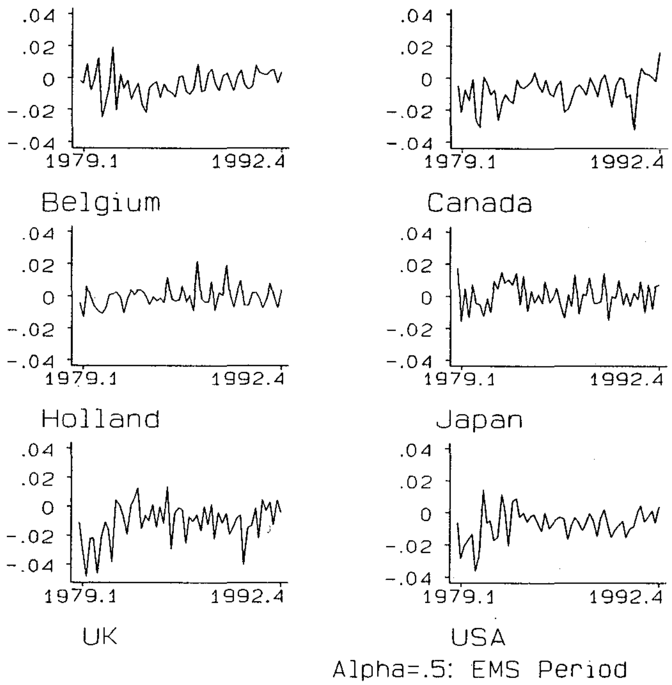
CHANGE IN VIRTUAL DM FUNDAMENTALS



Alpha=.5: EMS Period

FIGURE 5

CHANGE IN TRADITIONAL DM FUNDAMENTALS



A number of points emerge from Figures 4 and 5. First, Figure 4 clearly shows that the volatility of *virtual* fundamentals differs systematically and strongly by country. The three ERM members (Belgium, France, and especially Holland) have very stable virtual fundamentals. They stand in sharp contrast to countries with floating exchange rates like Japan and the United States. The differences in conditional volatility are statistically as well as economically significant. The actual sample standard deviation estimates of the first differences of virtual (and traditional) fundamentals are tabulated for three different values of α in Table 1. The statistics verify that the hypothesis of different levels of volatility can be confirmed at any reasonable level of statistical confidence.

Second, by way of contrast with Figure 4, the time series evidence in Figure 5, which portrays the first differences in *traditional* fundamentals, is not radically different across country. The actual sample statistics (again tabulated in Table 1 for three different values of α) confirm the presence of nontrivial differences in conditional volatility. However, the *TF* standard deviations are of the same order of magnitude for all eight countries considered, in contrast with the wild differences in *VF* volatility.

This point is perhaps easier to see in Figure 6, which is a graphical representation of some of the information presented in Table 1. The height of the bars measures the sample standard deviation of the first difference of fundamentals; two different values of α (.1 and 1.) are used for both traditional and virtual fundamentals. Figure 6 also emphasizes another interesting point; the typical measure of *TF* volatility is much lower than most comparable measures of *VF* volatility, (though there are obviously important differences across countries).

Perhaps the most striking presentation of the evidence is Figure 7, a simple scatterplot of *TF* volatility (on the ordinate) against *VF* volatility. The benchmark value of $\alpha = 0.5$ is used; the sample standard deviations for the EMS period are marked by the country name (the Canadian and U.S. observations overlap at the extreme right-hand side of the graph).

To summarize, there is overwhelming evidence that the volatility of virtual fundamentals for floating currencies is significantly higher than that for fixed currencies. However, this is by no means clear for traditional macroeconomic fundamentals; for reasonable parameter values, there is no substantial difference in volatility across countries with different exchange rate regimes.

TABLE 1

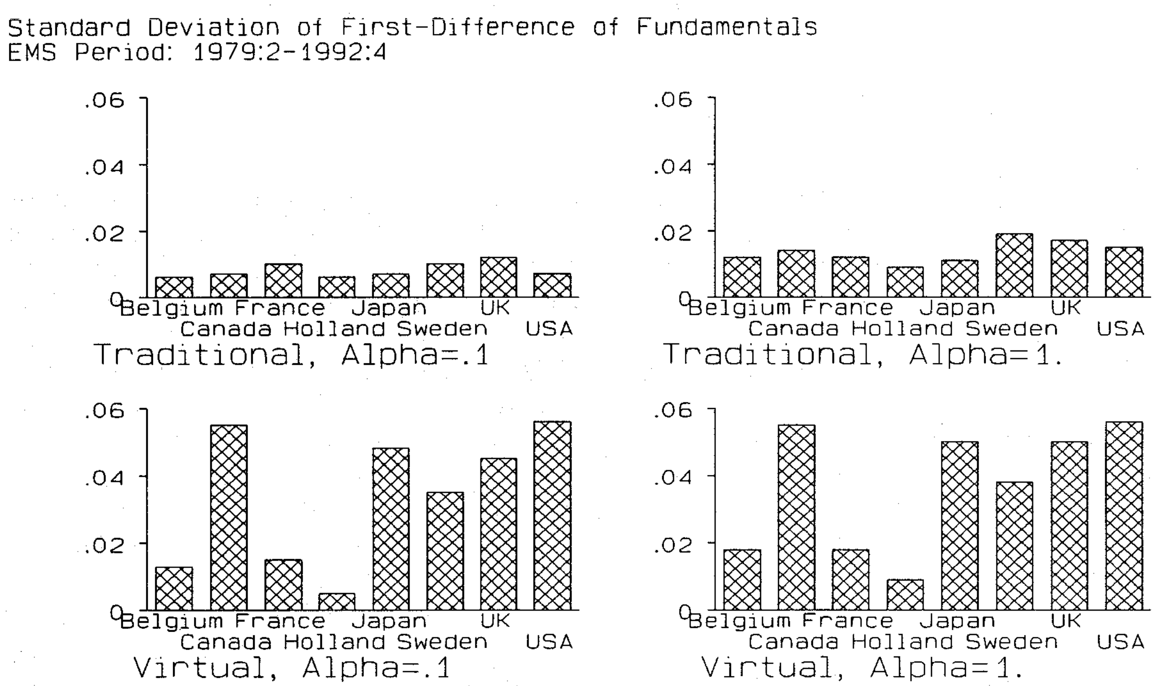
FUNDAMENTAL VOLATILITY DURING EMS
(SAMPLE STANDARD DEVIATIONS OF FIRST-DIFFERENCE)

	e	*TF*			*VF*		
Alpha		.1	.5	1	.1	.5	1
Belgium	.013	.006	.008	.012	.013	.013	.014
Canada	.055	.007	.009	.014	.055	.056	.057
France	.014	.010	.010	.012	.014	.014	.016
Holland	.005	.006	.007	.009	.005	.006	.008
Japan	.048	.007	.008	.011	.048	.048	.047
Sweden	.035	.010	.012	.019	.036	.037	.040
UK	.045	.012	.014	.017	.044	.043	.042
US	.056	.007	.009	.015	.056	.058	.060

$TF_t \equiv [(m-m^*)_t - \beta(y-y^*)_t - (\epsilon-\epsilon^*)_t] \equiv [(p-p^*)_t - \alpha(i-i^*)_t]$; $VF_t \equiv [e_t - \alpha(i-i^*)_t]$; Germany is the home country.

FIGURE 6

VOLATILITY OF FUNDAMENTALS



Sensitivity Analysis

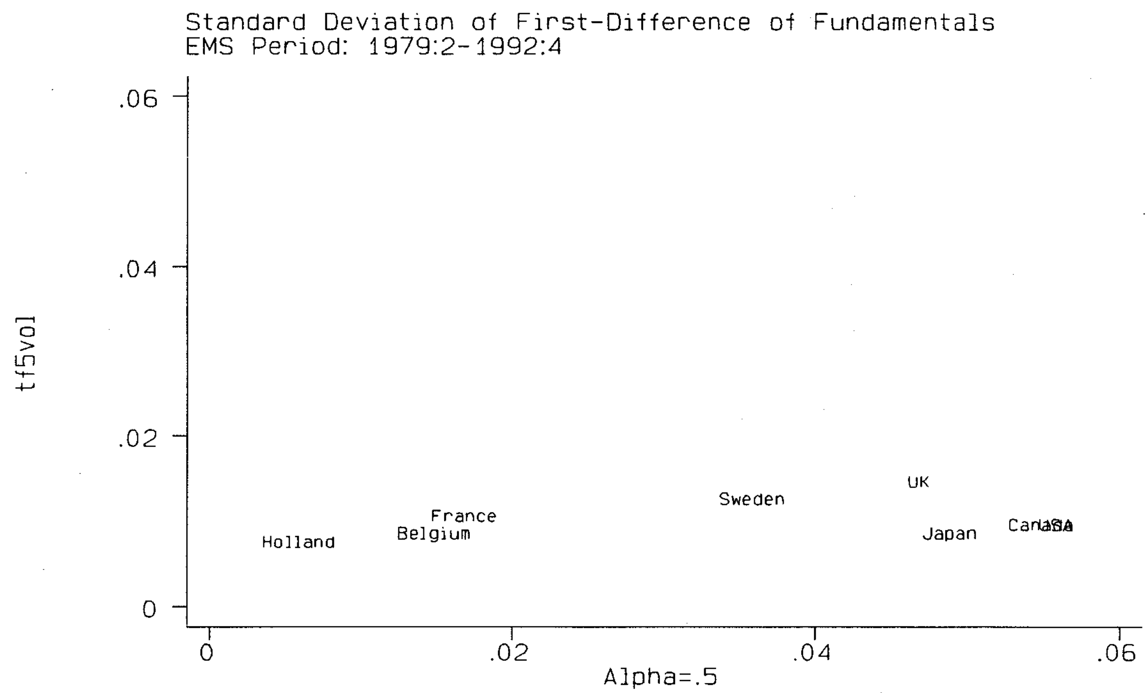
In this subsection, I show that the most important results of the empirical analysis are robust in the sense that a variety of perturbations in my basic methodology lead to the same conclusions.

Clearly α, the interest semi-elasticity of money demand, plays a critical role in the paper. The conclusion that *VF* volatility varies significantly more than *TF* volatility is consistent with a wide range of values for α.

Dealing with deviations from uncovered interest parity is only slightly more difficult. Under a strict interpretation of the monetary model, interest rates enter equation (4) because they affect money demand. Since the empirical work presented above merely compares measures of both sides of equation (4), UIP need not be assumed; hence

FIGURE 7

TRADITIONAL AGAINST VIRTUAL VOLATILITY



deviations from UIP have no impact on the analysis.[6] This seems especially reasonable since interest differentials enter the empirical measures of *VF* and *TF* symmetrically.

I have already discussed the impact of lagged terms in the money demand function; since the analysis relies on the conditional volatility of fundamentals, the impact of such dynamics is negligible. Still, this is part of a more general issue, namely misspecification of the asset market equilibrium condition, i.e., equation (4). The form of misspecification of greatest concern is omitted variable bias; that is, the fact that important variables that affect monetary equilibrium have potentially been omitted from the right-hand side of (4), causing the latter term to have insufficiently different conditional volatility across countries.

There are two important points of relevance. First, it was not assumed that the money demand function worked perfectly in equation (1); indeed, the equation need not even hold particularly well. Nontrivial deviations from money market equilibrium were incorporated into the ϵ terms; it may be recalled that there was no need to assume that these were particularly well-behaved. Specification errors in the money demand function can be dealt with in exactly the same fashion.

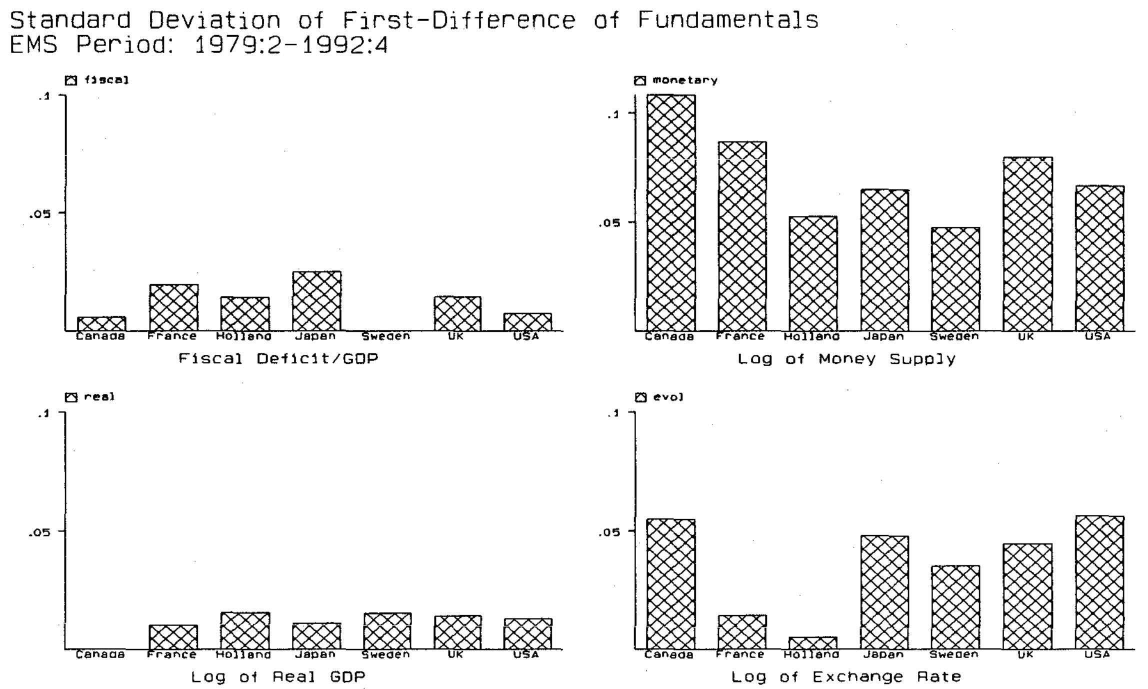
However, it turns out that there is no need to bury the issue by an appeal to the very general nature of the ϵ terms. Perhaps of greater importance is the fact that explicit inclusion of extra terms on the right-hand side of equation (4) will fundamentally change results only if the conditional volatility of these variables varies significantly across countries.[7] However, it is exceedingly difficult to find macroeconomic variables with conditional volatility that vary across countries as much as that of virtual fundamentals, let alone in the same way. Expressed differently, almost no macroeconomic variables have conditional volatility that varies by exchange rate regime. For instance, Figure 8 is an analogue to Figure 6, but instead portrays country-specific standard deviations of the first difference of three different macroeconomic variables: the ratio of

6. It is possible to interpret the left-hand side of equation (4) more generally. If one assumes UIP, then virtual fundamentals measure any single-factor model of the exchange rate. Correspondingly, if UIP holds up to a (possibly time-varying) risk premium, then virtual fundamentals measure this factor, plus the risk premium. So long as risk premia do not vary dramatically by country, such UIP deviations cannot account for the dramatic variation of *VF* volatility.

7. Implicitly, in a way that is correlated with the country-specific differences in conditional *VF* volatility.

FIGURE 8

VOLATILITY COMPARISONS: DIFFERENTIALS VIS-À-VIS GERMANY



the fiscal deficit to nominal GDP; the log of real GDP; and the log of narrow money (M1). (All three variables are displayed in differential form, so that the statistics are actually the sample standard deviation of, e.g., the first difference of the difference between the logs of German and domestic money. Also, the Swedish fiscal and Canadian real output data are missing.) Compared with the log of the exchange rate (which is also presented in Figure 8 and has dramatically different volatility by country), macroeconomic variables are just too similar to explain country-specific *VF* volatility. For this reason, it is not necessary to interpret the empirical work strictly within the confines of the monetary model with flexible prices, since plausible extensions that incorporate extra macroeconomic variables are unlikely to change the key conclusion of the paper. For instance, Flood and Rose (1993) replace the assumption of purchasing power parity with a sticky-price analogue (consisting of aggregate demand and Phillips-curves relationships) and show that extra terms must then be included in traditional fundamentals. However, inclusion of such terms leads to identical conclusions.

Succinctly, exchange rate volatility varies dramatically by country; macroeconomic volatility does not. For this reason it is hard to imagine that macroeconomic factors are very important determinants of exchange rates.

V. CONCLUSION

Expensive institutions such as the International Monetary Fund and the European Monetary System have been developed to combat exchange rate volatility; the latter is manifestly perceived by governments as being costly. Most developing and many developed countries in the world manage their exchange rates in some way, at least in part to reduce exchange rate volatility. These policy actions appear to have been at least partially successful; conditional exchange rate volatility varies strongly and systematically across countries. However, macroeconomic volatility does not vary nearly as dramatically. This brute stylized fact leads me to two policy conclusions and one puzzle.

First, countries concerned with "excessively high" exchange rate volatility should not look to macroeconomic conditions, at least not exclusively. This follows from the core conjecture of the paper, namely, that macroeconomic factors are not very important determinants of exchange rates. Empirically, this hypothesis finds a great deal of support in the data.

The second conclusion is that exchange rate stability need not come at the cost of macroeconomic instability.

This should be obvious simply from Figure 8; countries (like France and the U.K.) that are apparently quite similar in terms of macroeconomic volatility vis-à-vis Germany have dramatically different levels of exchange rate instability. Expressed alternatively, countries that have reduced their level of exchange rate volatility (such as Holland) do not appear to have paid a price in terms of macroeconomic volatility. If there are costs to reduced exchange rate volatility, they do not appear to be macroeconomic. This line of reasoning strengthens the case for fixed exchange rates, since low exchange rate volatility is manifestly a policy objective for many countries.

The remaining puzzle is, of course, "what can explain exchange rate volatility?" Unfortunately, there does not currently appear to be a good answer to this question. The empirical analysis has been shown to be relatively insensitive to a number of perturbations; it is hard to imagine that any set of macroeconomic variables has the characteristics necessary to explain exchange rate volatility. I am driven to the conclusion that much exchange rate volatility may be caused by microeconomic phenomena, such as noise traders and excessive speculation. However, this is just an unsubstantiated conjecture, which must be pursued further in future research. In the meanwhile, the determinants of exchange rate volatility remain an enigma.

For at least a decade it has been known that models of exchange rates work poorly in floating exchange rate regimes. This has led most economists to conclude that there may be an important variable (or set of variables) omitted from standard models. For instance, Meese (1990, p. 132) states: "It remains an enigma why the current exchange rate regime has engendered a time-series data base where macroeconomic variables and exchange rates appear to be independent of one another. One possible explanation is that economists have not yet discovered the appropriate set of fundamentals . . ." To date, relatively little progress has been made in identifying such variables. This paper has argued that the omitted (set of) variable(s) have an important identifiable characteristic, namely conditional volatility which is specific to the exchange rate regime. I am unaware of macroeconomic variables which have these characteristics.

References

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