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EXCHANGE RATE VOLATILITY, MONETARY POLICY, AND CAPITAL MOBILITY: EMPIRICAL EVIDENCE ON THE HOLY TRINITY

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ABSTRACT

This paper uses a panel of data from twenty-two countries between 1967 and 1992 to explore the tradeoff between the "Holy Trinity" of fixed exchange rates, independent monetary policy, and capital mobility. I use: flexible- and sticky-price monetary exchange rate models to parameterize monetary divergence; factor analysis to extract measures of capital mobility from a variety of different indicators; and conditional exchange rate volatility to measure the degree to which the exchange rate is fixed. Exchange rate volatility is loosely linked to both monetary divergence and the degree of capital mobility. Interestingly, exchange rate volatility is significantly correlated with the width of the explicitly declared exchange rate band, even after taking monetary divergence and capital mobility into account.

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I: Introduction

This paper is concerned with the compatibility of: fixed exchange rates; independent monetary policies; and perfect capital mobility, Mundell's "Holy Trinity". Many economists believe that the three components of the Holy Trinity are mutually incompatible. There is certainly a great deal of anecdotal evidence to support this claim. Most recently, the effective collapse of the Exchange Rate Mechanism (ERM) of the European Monetary System only a few years after the last barriers to European capital mobility were removed, is often cited as the result of conflict between the Bundesbank's desire for high interest rates and non-German desires for both lower interest rates and constant exchange rates (Eichengreen and Wyplosz (1993b) summarize the evidence).

In this paper, I attempt to quantify empirically the tradeoffs between exchange rate stability, monetary divergence, and capital mobility. To my knowledge, an econometric examination of the nature of these tradeoffs has not yet been undertaken in the literature. I exploit a panel of data for twenty-two countries with monthly observations from 1967 through 1992. This data set includes a large number of different exchange rate regimes, ranging from the nearly "clean" American float of the early 1980s to the tight Dutch and Austrian pegs of the 1980s and 1990s. The data set also includes a wide range of observations on capital mobility, including countries with extremely tight restrictions, as well as those with well-developed financial markets and few regulations. Finally, the data set includes different macroeconomic measures; I use these to construct measures of monetary divergence in the context of a number of different monetary exchange rate models.

In my econometric work, I ask the questions: "Is exchange rate volatility tightly linked to monetary divergence? Further, does this link depend on the degree of capital mobility?" The answers to these questions are somewhat affirmative, but perhaps surprisingly weak. While monetary divergence and (to a lesser extent) higher capital mobility are usually associated with increased exchange rate turbulence, the relationships

are not of overwhelming statistical significance, and of even less economic importance. On reflection, the absence of strong results does not seem unreasonable. While speculative attacks on fixed exchange rates are memorable, the intervening periods of tranquility are less notable. For instance, the ERM experienced an extended period of exchange rate stability, increased monetary divergence and high capital mobility, though this is often forgotten in accounts of the crises of 1992-3. During the latter, countries with both reasonable and divergent monetary policies were attacked with equal ferocity; similarly, countries which would not have imposed capital controls under any foreseeable circumstance (and did not) were attacked along with those which actually did impose restrictions. My econometric analysis merely treats the periods of tranquility symmetrically to the periods of crisis.

Above and beyond the effects of monetary fundamentals and capital mobility, I also find that exchange rate volatility is affected by an extremely naive measure of government exchange rate policy. In particular, I find a highly significant positive link between the width of the official exchange rate band (if one exists) and conditional exchange rate volatility. That is, the effects of *stated* exchange rate policy appear to be significant even after accounting for the effects of *actual* macroeconomic policy as manifest in monetary fundamentals.

In the section which follows, I present the theoretical methodology for the paper. The data set is discussed in section III; the empirical results follow. The paper ends with a brief conclusion.

II: Theoretical Framework and Methodology

The focus of this paper is the set of tradeoffs between fixed exchange rates, perfect capital mobility, and monetary independence. Accordingly, the framework for empirical analysis is a monetary model of the exchange rate which can be used in the context of both

fixed and flexible exchange rate regimes (as well as the range in between), for differing levels of capital mobility. I examine two different variants of the model: one with flexible goods prices, and one with prices which are sticky in the short run.[1]

IIa: A Monetary Model of the Exchange Rate with Flexible Prices

The generic monetary exchange rate model begins with a structural money-market equilibrium condition, expressed in natural logarithms as:

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

where: m_t denotes the (log of the) stock of money at time t; p denotes the price level; y denotes real income; i denotes the (log of unity plus the non-annualized) nominal interest rate (in percentage points divided by 100); ϵ denotes a well-behaved shock to money demand; and α and β are structural parameters.[2]

I assume for simplicity that there is a comparable equation for the foreign country, and that domestic and foreign elasticities are equal. Subtracting the foreign analogue from (1) and solving for the price terms:

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

If prices are perfectly flexible, then in the absence of transportation costs and other distortions, purchasing power parity (PPP) holds, at least up to a disturbance:

$$(p-p^*)_t = e_t + \nu_t \qquad (2^P)$$

where: e denotes the domestic price of a unit of foreign exchange; and ν is a stationary disturbance. Substituting this equation into (1'), it is trivial to solve for the exchange rate:

$$e_t = (m-m^*)_t - \beta(y-y^*)_t + \alpha(i-i^*)_t - (\epsilon-\epsilon^*)_t - \nu_t \qquad (3^P).$$

or

$$e_t = FUND^F_t - \nu_t,$$

where for simplicity, I introduce the notation

$$FUND^F_t \equiv (m-m^*)_t - \beta(y-y^*)_t + \alpha(i-i^*)_t - (\epsilon-\epsilon^*)_t$$

to denote the measure of monetary fundamentals derived from a flexible-price model.

The left-hand side of equation (3^F) is observable. Given data on money, output, and interest rates, the right-hand-side of this equation can also be measured, with the addition of two structural parameters (α and β), and two types of disturbances [$(\epsilon-\epsilon^*)$ and ν]. In the empirical analysis below, I use reasonable estimates of α and β taken from the literature in place of the unknown parameters. I use two different techniques to estimate the $(\epsilon-\epsilon^*)$ terms. Finally, I act as if $\nu_t=0$, or, more accurately, I assume that the conditional volatility of ν is small relative to the conditional volatility of the exchange rate. This assumption can be interpreted as saying that the shock to the deviation from PPP is small in relation to the exchange rate shock; it implies that the measurement error induced by assuming $\nu_t=0$ is "small" in the relevant sense. I use instrumental variable techniques to account explicitly for this measurement error.

IIb: A Comparable Model with Sticky Prices

In reality prices look sluggish, and deviations from purchasing power parity (i.e., ν_t) are large and persistent; the shocks to ν may be comparable in size to exchange rate shocks. Further, across OECD exchange rate regimes, nominal and real exchange rate volatility are highly correlated (except possibly at relatively low frequencies). For all these reasons, I also examine a monetary model that does not rely on flexible prices. (This can also be thought of as an explicit parameterization of ν.)

A standard way to allow for price stickiness is to substitute a Phillips-curve equation in place of the assumption of continuous purchasing power implicit in equation (2^F) (e.g., Obstfeld and Rogoff (1984)):

$$p_{t+1}-p_t = \mu(y-y^{LR})_t + g_t + E_t(\hat{p}_{t+1}-\hat{p}_t)$$

$$y_t = \theta'(e+p^*-p)_t + \phi' r_t$$

$$\Rightarrow \quad p_{t+1}-p_t = \theta(e+p^*-p)_t + \phi r_t + g_t + E_t(\hat{p}_{t+1}-\hat{p}_t) \qquad (2^S)$$

where: y^{LR} is the long-run level of output (which is ignored for simplicity by assuming that its growth-rate is constant); g is a well-behaved shock to goods market equilibrium; $r_t \equiv i_t - E_t(p_{t+1}-p_t)$ is the *ex ante* expected real interest rate; and $\hat{p}$ is defined by:

$$\theta(e+p^*-\hat{p})_t + \phi r_t + g_t = 0. \qquad (4)$$

Obstfeld and Rogoff (1984) provide a detailed discussion of the latter term.

Equation (4) can be solved for $\hat{p}_t$ and thus $E_t(\hat{p}_{t+1}-\hat{p}_t)$; when these expressions are substituted back into (2^S), one arrives at:

$$p_{t+1}-p_t = \theta(e+p^*-p)_t + \phi r_t + g_t + E_t(p^*_{t+1}-p^*_t) + E_t(e_{t+1}-e_t) + \theta^{-1}E_t(g_{t+1}-g_t) + \phi/\theta E_t(r_{t+1}-r_t). \qquad (2^{S'})$$

Solving this for the exchange rate by substituting into (1'), one can derive:

$$e_t = (m-m^*)_t - \beta(y-y^*)_t + \alpha(i-i^*)_t - (\epsilon-\epsilon^*)_t - \theta^{-1}E_t[(e_{t+1}-e_t)+(p^*_{t+1}-p^*_t)] + \theta^{-1}(p_{t+1}-p_t) - \theta^{-1}g_t - \theta^{-2}E_t(g_{t+1}-g_t) - \phi/\theta r_t - \phi/\theta^2 E_t(r_{t+1}-r_t). \qquad (3^S)$$

This can be expressed simply as

$$e_t = FUND^S_t + w_t,$$

where

$$FUND^S_t \equiv (m-m^*)_t - \beta(y-y^*)_t + \alpha(i-i^*)_t - (\epsilon-\epsilon^*)_t - \theta^{-1}E_t[(e_{t+1}-e_t)+(p^*_{t+1}-p^*_t)] + \theta^{-1}(p_{t+1}-p_t) - \phi/\theta r_t - \phi/\theta^2 E_t(r_{t+1}-r_t),$$

$$= FUND^F_t + STICKY_t,$$

$$STICKY_t \equiv -\theta^{-1}E_t[(e_{t+1}-e_t)+(p^*_{t+1}-p^*_t)] + \theta^{-1}(p_{t+1}-p_t) - \phi/\theta r_t - \phi/\theta^2 E_t(r_{t+1}-r_t),$$

and

$$w_t \equiv -\theta^{-1}g_t - \theta^{-2}E_t(g_{t+1}-g_t).$$

The right-hand side of equation (3^S) differs from that of (3^F) by terms involving: two extra structural parameters (ϕ and θ); expectations of future values of p, e, and p*; and functions of g terms. I follow the same strategy when estimating the sticky-price model as I do for the flexible-price model. That is, I use the literature to generate reasonable ϕ and θ estimates. I produce empirical estimates of expectations in place of the unknown true expectations, and account for the resulting measurement error explicitly. Finally, I set g_t to zero, in the same way as I set v_t to zero in the flexible-price work.

IIc: Empirical Strategy

My empirical work plays off equations (3^F) and (3^S) for the flexible- and sticky-price variants of the monetary model respectively. Both of these equations express the exchange rate as a *structural* function of parameters and other (possibly endogenous) variables. The fact that these relationships are structural means that I need not make extra assumptions about exogeneity of variables or exchange rate regimes, or about the (e.g., time-series) characteristics of any variables. Indeed, it is critical to deal with structural relations, since I am interested in both flexible exchange rate regimes (where the money supply may be taken to be exogenous) and in situations where the monetary authorities are managing the exchange rate (e.g., by manipulating the money supply to hit an exogenous exchange rate target).

It is also worthwhile to note in passing that I have not made any assumptions about the degree of capital mobility in deriving the key equations (3^F) and (3^S).[3]

The issue in which I am interested is the degree to which fixed exchange rates, perfect capital mobility, and independent monetary policies are mutually incompatible. To

analyze this problem, I transform the structural exchange rate equations first by taking first-differences:

$$\Delta e_t = \Delta FUND^F_t - \Delta v_t, \qquad (5^F)$$

and

$$\Delta e_t = \Delta FUND^S_t + \Delta w_t. \qquad (5^S)$$

I next transform the equations by moving from first- to second-moments, so as to have conditional exchange rate *volatility* as the dependent variable. In so doing, I change the frequency of the data, taking *annual* standard deviations of the *monthly* observations of equations (5).[4] I assume that the covariances between the disturbances and the regressors of equations (5^F) and (5^S) are zero, and that all variables are stationary with finite second moments (as seems reasonable, given that the underlying variables are growth-rates):

$$\sigma(\Delta e)_\tau = \sigma(\Delta FUND^j)_\tau + u_{j\tau} \qquad (6)$$

where: {u} represents the appropriate conditional volatility (of Δv for the flexible- and of Δw for the sticky-price model respectively); j=F,S; and the observations are now available at time τ (with coarser frequency than t). Equation (6) states that conditional exchange rate volatility equals conditional fundamental volatility plus noise; the appropriate measure of fundamentals (and disturbances) is driven by whether prices are more accurately modelled as being sticky or flexible.

Equation (6) implies a testable hypothesis, namely that conditional fundamental volatility (appropriately measured) is reflected proportionately in conditional exchange rate volatility. However, I am interested in the incompatibility of fixed exchange rates, monetary divergence, and capital mobility. For this reason, and to allow for interesting departures from this null hypothesis, my final estimating equation allows for two additional alternatives. The first set of additional regressors, not strictly implied by the theory, are

the effects of the degree of capital mobility and capital mobility multiplied by (the volatility of) monetary fundamentals. These regressors are intended to capture the effects that the degree of capital mobility has on exchange rate volatility. I also include the explicitly declared width of the exchange rate band, if one exists.

The estimating equation is given by:

$$\sigma(\Delta e)_{it} = \Sigma_i D_i + \Sigma_t E_t + \beta_j[\sigma(\Delta FUND^j)]_{it} \qquad (7)$$
$$+ \delta_1 KMOB_{it} + \delta_{2j}\{KMOB_{it}*[\sigma(\Delta FUND^j)]_{it}\} + \phi BAND_{it} + u_{ijt}$$

where: subscript "i" denotes the exchange rate between country i and the home country; the {D} variables are a mutually exclusive and jointly exhaustive set of country-specific "fixed effect" dummy variables; the {E} variables are a comparable set of time-specific dummies; j = F, S for the flexible- and sticky-price versions of fundamentals respectively; "KMOB" is a measure of capital mobility; "BAND" is the officially declared bandwidth for the exchange rate; and the (measurement error) disturbance term is assumed to be well-behaved. The empirical analogues to the conceptual variables in (7) are discussed below.

The theoretical arguments presented above suggest the null hypothesis H_0: $\beta=1$, $\delta_1=\delta_2=\phi=0$. This joint hypothesis can be interpreted as a test of the validity of the underlying model of exchange rates, since it implies that fundamental volatility is proportionately reflected in exchange rate volatility, to the exclusion of both the degree of capital mobility and the explicit band width.

However, the focus of this paper is not testing exchange rate models but rather the incompatibility of the Holy Trinity of fixed exchange rates, monetary divergence, and perfect capital mobility. The δ_2 coefficient is of special interest in this respect, since a positive value indicates that the higher the degree of capital mobility, the stronger the effect (on exchange rate instability) of a given amount of fundamental volatility. One hypothesis suggested by the incompatibility of the Holy Trinity is: H_0: $\beta,\delta_1,\delta_2>0$; higher levels of

fundamental volatility and capital mobility both contribute to exchange rate instability. Three more contrived hypotheses are: H_0: $\beta=\delta_1=\delta_2=0$; H_0: $\beta=\delta_2=0$; and H_0: $\delta_1=\delta_2=0$. The first hypothesis states that neither fundamental volatility nor capital mobility affects exchange rate instability; the second and third focus on just fundamentals and capital mobility respectively. Finally, it will also be interesting to test H_0: $\phi=0$, which states that there is no independent effect of the size of the explicit band on exchange rate instability, after accounting for fundamentals and capital mobility.

III: Description of the Data Set

Equation (7) links exchange rate volatility to measures of monetary independence, capital mobility, and the official explicit exchange rate bandwidth. There are potential problems in the empirical proxies for the four important conceptual variables. In this section, I first present the main data set, and then discuss these problems in sequence.

IIIa: The Basic Data Set

The macroeconomic data set used in this paper has been taken from the IMF's *International Financial Statistics* (or "IFS") cd-rom. The data set extends from 1967 through 1992 for the twenty-two countries with complete data series. The countries are mostly OECD countries: Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; India; Ireland; Italy; Japan; Korea; Netherlands; Norway; Portugal; South Africa; Spain; Sweden; UK; and USA. Germany, the anchor of the ERM, is taken to be the home country. The data set has been checked (and corrected) for e.g., transcription errors via graphical and statistical diagnostics.[5]

The raw macroeconomic data series are monthly. I use: the bilateral period-average price of an American dollar as the raw exchange rate measure (IFS mnemonic "rf"); a M1 index for money (IFS line 34i); the CPI for prices (64); an industrial production index for

output (66); and a short-term money market interest rate (60b). IFS data for aggregate exports and imports (lines 70 and 71 respectively) are also used.

The other source of data is the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (or "AREAER"). This publication contains tables on capital restrictions (and other variables) beginning in 1967; these tables are currently available through 1992 (hence the time-span of the data set). The following variables are used: 1) "Restrictions [in the form of quantitative limits, undue delay, or other official action which directly affects the availability or cost of exchange] exist on payments [of resident-owned funds to IMF member countries] in respect of capital (account) transactions" [other than restrictions imposed for security reasons]; 2) "Bilateral payments arrangements with [IMF] members"; 3) "Bilateral payments arrangements with nonmembers"; 4) "Advance import deposits" restrictions"; and 5) "Separate exchange rate(s) for some or all capital transactions and/or some or all invisibles". All of these variables are binary dummy variables, unity (zero) indicating the presence (absence) of the phenomena. In addition, information in both AREAER and IFS was used to construct data series on explicitly declared official exchange rate bands and the official exchange rate regime.

IIIb: Measures of Exchange Rate Volatility

An empirical investigation of the Holy Trinity requires an empirical proxy for the degree to which the exchange rate is fixed; I use the estimated (annual) standard deviation of the first-difference of the (monthly) natural logarithm of the bilateral (DM) exchange rate. The data spans twenty-five years and a number of different exchange rate systems (including the fixed but adjustable Bretton Woods pegs, the Narrow Margins Agreement or "Snake", generalized floating, the informal target-zone of the Louvre Accord, the many realignments of the EMS, and the relevant transitions in between these regimes). This variation makes it unlikely that the volatility estimates suffer from small-sample "peso problem" bias.

IIIc: Measures of Monetary Divergence

The monetary exchange rate theories summarized in sections IIa-IIb deliver precise parametric measures of monetary divergence, i.e., fundamentals for the flexible- and sticky-price models. Empirical measurement of these variables requires parameter values (of α and β, as well as ϕ and θ for the sticky-price model), above and beyond the data for the raw macroeconomic variables.

I follow Flood and Rose (1993) in taking parameter values from the literature; further detail is available in that paper. I choose an uncontroversial value of the income elasticity of money demand, namely $\beta=1$. The literature also indicates that values of $\phi=\theta=.1$ seem reasonable; I also use these values. The interest elasticity, α, is much less certain; in my benchmark analysis, I use two alternative values of α, .1 and .5. It is reassuring that the essential results of this paper are quite robust to alternative reasonable values for α.[6]

I use two tactics for handling the (ϵ-ϵ^*) terms. The first follows the literature in setting the (ϵ-ϵ^*) term identically to its expected value of zero; measures of monetary fundamentals produced this way are referred to as "traditional". The second technique implicitly estimates the disturbance directly from (1') [since (1') is a regression which generates estimates of the residual term (ϵ-ϵ^*)]. Measures of monetary fundamentals which rely on this technique are referred to as "augmented" fundamentals.[7]

The analogues to traditional and augmented flexible-price fundamentals for the sticky-price model merely add the extra term denoted "STICKY". The latter requires unobservable expectations of future exchange rate and foreign price changes. I measure these with country-specific fitted linear regressions of the appropriate variable on an information set consisting of current and lagged values of prices, interest rates, output, and money.

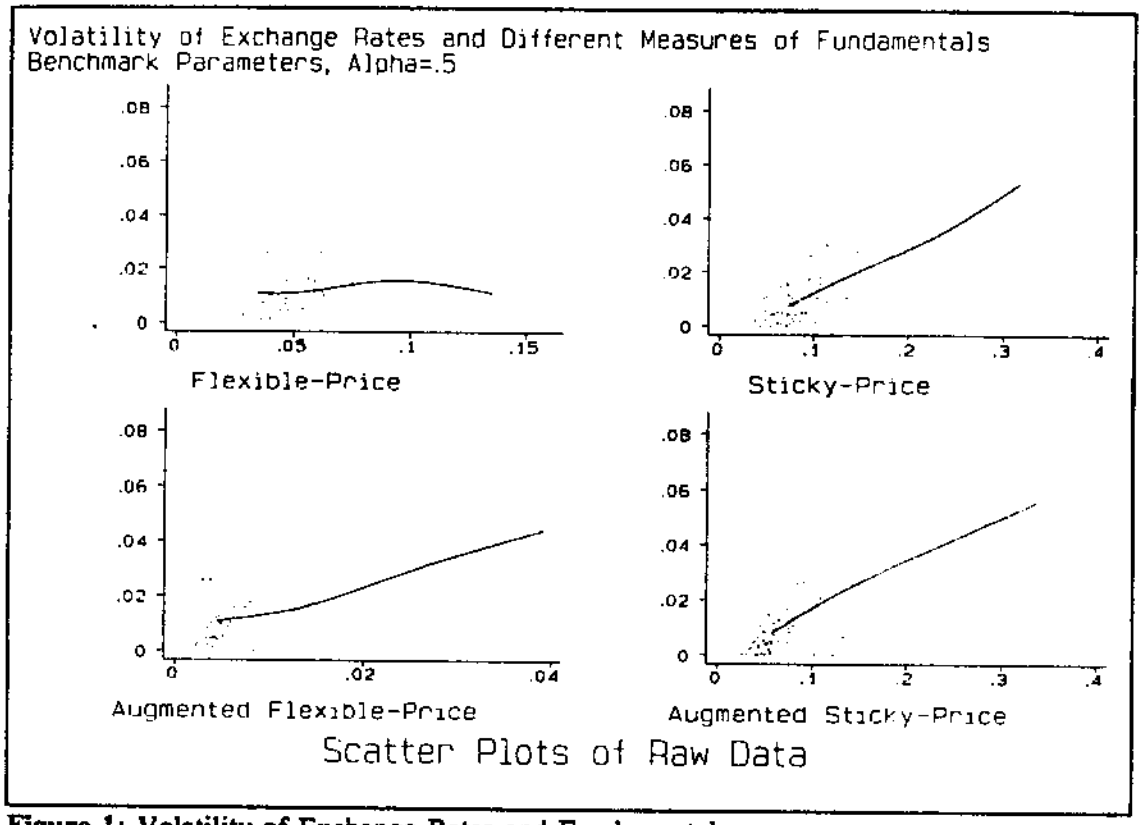

Figure 1: Volatility of Exchange Rates and Fundamentals

Figure 1 is a set of bivariate scatterplots which graph exchange rate volatility (on the ordinate) against the volatility of four different measures of monetary fundamentals (traditional and augmented fundamentals for both the flexible- and sticky-price models). Non-parametric data smoothers have been added to "connect the dots". The figures do not show a tight bivariate relationship between exchange rate volatility and fundamental volatility, contrary to the theoretical arguments of section II. Sticky-price fundamental volatility, unlike flexible-price volatility, is clearly positively correlated with exchange rate volatility; the measures are also more tightly correlated with exchange rate volatility than flexible-price fundamentals. The more sophisticated econometric analysis presented below corroborates the impression left by Figure 1, namely that exchange rate volatility is positively, but only weakly linked to the volatility of fundamentals.

Table I: Exchange Rates and Different Measures of Fundamentals

Simple Regressions of Exchange Rate Volatility on Fundamental Volatility

Fundamental	Coef	(s.e.)	R^2
Trad'l Flexible, α=.5	.031	.030	.003
Trad'l Flexible, α=.1	.030	.030	.002
Trad'l Sticky, α=.5	.147	.011	.307
Trad'l Sticky, α=.1	.147	.011	.307
Augmented Flexible	.750	.124	.063
Augmented Sticky	.153	.010	.345

Bivariate Correlations of Volatilities of Exchange Rates and Fundamentals

(N=442)		----Flexible----		-----Sticky------		Aug'd
	e	.5	.1	.5	.1	Flex
Trad'l Flex α=.5	.05					
Trad'l Flex α=.1	.05	1.0				
Trad'l Sticky, α=.5	.55	.35	.34			
Trad'l Sticky, α=.1	.55	.35	.34	1.0		
Aug'd Flexible	.23	.16	.15	.71	.71	
Aug'd Sticky	.59	.13	.13	.92	.92	.76

The simple linkages between exchange rate and monetary volatility are pursued farther in Table I which tabulates bivariate regressions of exchange rate on fundamental volatility. The top panel of the table shows that the linkage between fundamental and exchange rate volatility depends strongly on the measure of fundamentals. The regression coefficients range from close to zero in both economic and statistical terms, to coefficients which are large and highly significant (though different from the hypothesized value of unity). The goodness of fit also depends significantly on the fundamental, though it is never very high.

Clearly the simple regression results are sensitive to the measure of fundamentals; the reason is shown in the bottom panel of Table I which tabulates simple correlation coefficients between exchange rate and fundamental volatilities (as is also apparent from Figure 1). The volatilities of the two traditional flexible-price fundamentals are not highly correlated with the volatilities of other fundamentals; for this reason, it is important to

check if results rely exclusively on a single measure of fundamentals. The exact choice of α does not seem to matter very much.

IIId: Measures of Capital Mobility

The Holy Trinity states that monetary independence and fixed exchange rates are incompatible with a high degree of capital mobility. Any test of this hypothesis clearly requires an empirical measure of the degree of capital mobility. The latter is inherently difficult to measure; rather than rely on any one measure, I use several.

More specifically, I use factor analysis to combine together seven different (admittedly imperfect) measures of capital mobility. The variables are: 1) the AREAER dummy variable on capital restrictions (this variable has also been used by e.g., Alesina, Grilli and Milesi-Ferretti (1993)); 2-3) the AREAER dummy variables for bilateral payments restrictions to both IMF members and non-members; 4) the AREAER dummy variable for advance import restrictions; 5) the AREAER dummy variable for multiple exchange rates; 6) the absolute value of the ratio of net exports to gross exports plus imports; and 7) a linear time trend (to reflect exogenous technological development). I combine these series together into a panel and estimate a single factor using the technique of principal factors. The factor analysis seems to work well in that this factor explains a high fraction of the variance, and is negatively related to the first four dummy variables, and positively related to time (higher values of the estimated factor indicate a higher degree of capital mobility).[8] The resulting rankings of countries and years also make sense; averaged values are tabulated in Table II (for comparison, Table II also presents averages of the raw AREAER dummy variable on capital restrictions). It is reassuring that countries like Canada and the USA are characterized as a high degree of capital mobility compared to e.g., Greece and India. Also, the factor analysis indicates that the degree of capital mobility appears to be rising secularly.

Table II: Averaged Measures of Capital Mobility

Data Averaged Across Countries

Date	Dummy	Factor
1967	.81	-.70
1968	.81	-.61
1969	.86	-.54
1970	.86	-.56
1971	.86	-.50
1972	.86	-.34
1973	.86	-.42
1974	.86	-.19
1975	.86	-.19
1976	.86	-.08
1977	.81	-.14
1978	.81	.04
1979	.81	.04
1980	.71	.11
1981	.71	.22
1982	.71	.22
1983	.71	.29
1984	.67	.32
1985	.62	.38
1986	.62	.38
1987	.67	.32
1988	.67	.35
1989	.62	.38
1990	.62	.37
1991	.57	.39
1992	.52	.48

Data Averaged Across Time

Country	Dummy	Factor
Canada	0.	.71
USA	0.	.61
UK	.5	.52
Belgium	0.	.49
Australia	.69	.48
France	.88	.45
Japan	.5	.44
Italy	.88	.42
Netherlands	.42	.38
Ireland	1.	.37
S Africa	1.	.24
Sweden	1.	.17
Denmark	.85	.12
Norway	1.	.06
Korea	1.	.05
Austria	.92	.05
Portugal	1.	-.59
Spain	1.	-.68
Finland	.96	-1.25
Greece	1.	-1.36
India	1.	-1.69

"Dummy" denotes the average value of the AREAER dummy variable on capital restrictions, unity (zero) indicating that there are (not) restrictions; "Factor" is the average value of the estimated capital mobility factor, a higher value meaning greater capital mobility.

A number of alternative methods of measuring capital mobility are impractical. Reliable Euro-market data exist only later in the sample for some of the countries; thus onshore-offshore interest differentials, though desirable, are unavailable. The same is true of many of the other measures of "home market bias" discussed in the literature, e.g., Tesar and Werner (1992). A variety of other measures which are based on longer-run implications of capital mobility are surveyed by Obstfeld (1993). These include: cross-country consumption correlations; measures of convergence in capital/output ratios; and

correlations between domestic savings and investment flows. While such constructs are potentially desirable, they cannot be easily estimated so as to give annual observations because of the relatively coarse frequency of national accounts data, even ignoring the myriad problems involved in interpretation. In any case, the short-run mobility of financial capital seems to be more relevant in testing the incompatibility of the Holy Trinity than the long-run mobility of real capital. This notion is implicit in e.g., current suggestions for short-run foreign exchange deposit requirements (Eichengreen and Wyplosz (1993a)).[9]

My measure of capital mobility is clearly controversial and measured with error. For this reason, I use instrumental variables in my regression analysis below. I also compare my results to those which can be obtained with the simple AREAER capital controls dummy.

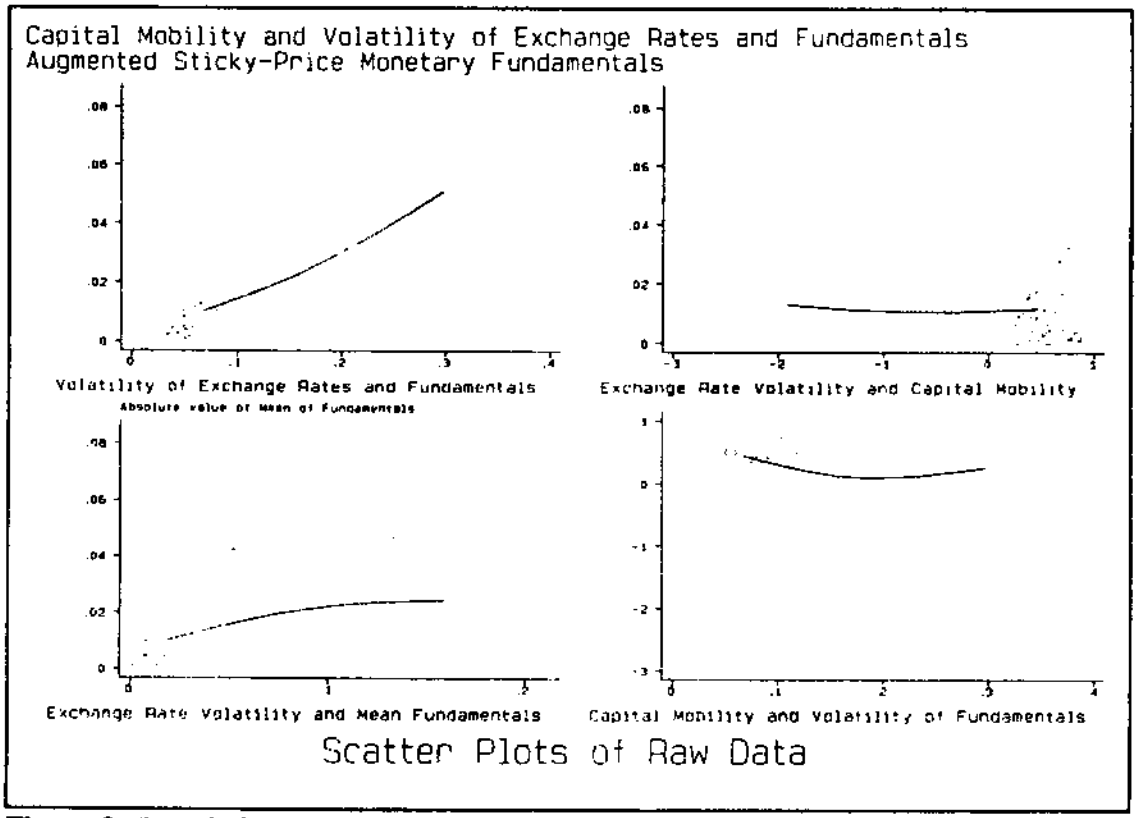

Figure 2: Descriptive Scatterplots of Raw Variables

Figure 2 is a set of four descriptive scatterplots. The first three graph exchange rate volatility (on the ordinate) against: 1) the volatility of augmented sticky-price fundamentals; 2) the degree of capital mobility; and 3) the absolute value of the mean of augmented sticky-price fundamentals. The fourth is a graph of the degree of capital mobility against the volatility of (augmented sticky-price) fundamentals. Figure 2 indicates that exchange rate volatility is loosely linked to fundamental volatility, but not to the absolute value of the mean level of monetary fundamentals. However, exchange rate volatility is apparently unaffected by the degree of capital mobility, consistent with equation (6). The multiple regression analysis presented below is basically only further corroboration of this impression.

Parenthetically, there is only a small relationship between the level of capital mobility and fundamental monetary volatility; the two measures are not closely linked in any obvious way in Figure 2. This result can be confirmed with regression analysis; even controlling for country- and time-effects, the capital mobility factor is not significantly correlated with any of the measures of fundamentals.

IIIe: Band Width

I include the officially declared width of the exchange rate band as an alternative regressor in equation (7) not strictly implied by any theory. However, the formal bandwidth need not be a very meaningful variable, for at least two reasons. First, some countries with explicit bands have different, more narrow, implicit bands; the Netherlands is often cited as a case during the EMS. Second, some countries do not have any official band width. (In my empirical work, I treat these countries as having an official width of 100%; I also test for the importance of this convention by estimating (7) on only those countries with official bands.) Many of the countries without official bands are not freely floating but instead have implicit bands; Austria and Canada are probably the best examples. For both of these reasons, one might expect the estimated effect of the officially

declared band width in equation (7) to be smaller than the true effect of setting up an exchange rate target zone.

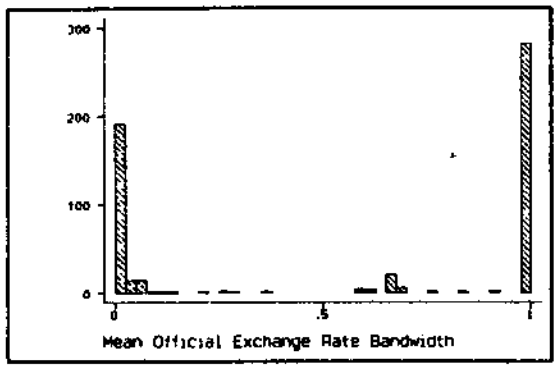

Figure 3a: Histogram of Entire Sample

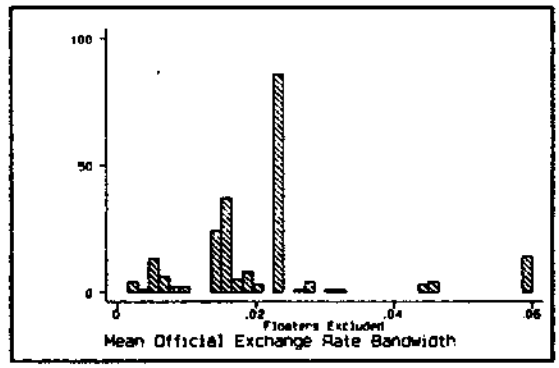

Figure 3b: Histogram of Fixers

Figures 3a and 3b are histograms of exchange rate bandwidths. Figures 3a graphs data for the entire sample of countries; the many observations for countries without an official band are recorded as having an official bandwidth of 1 (corresponding to 100%), and constitute the mode at the extreme right-hand side of the histogram. Figure 3b is the analogue for countries with officially declared bands.[10,11]

IV: Empirical Results

The problem of measurement error is potentially important for the monetary divergence and capital mobility measures in equation (7). The equation is therefore estimated with instrumental variables, so as to deliver consistent coefficient results in the presence of such measurement error. The instrumental variables used (above and beyond the fixed effect and bandwidth variables) are the standard deviations of: money growth; output growth; interest rate changes; foreign exchange reserve growth; and the five AREAER dummy variables.

IVa: Benchmark Results

The top panel of Table III contains benchmark estimates of equation (7). A few findings are worthy of special note.

Table III: Benchmark Estimates of (6)

Regression Results for Equation (7). Coefficient Estimates (t-statistics)

Fundamental	Fund'l β	Cap Mob δ_1	Interact δ_2	Bandwidth ϕ	σ
Full Sample N=432					
Trad'l Flex α=.5	.017 (.5)	.005 (.9)	-.141 (1.3)	.011 (6.4)	.0086
Trad'l Flex α=.1	.018 (.5)	.005 (.8)	-.141 (1.3)	.011 (6.4)	.0086
Trad'l Sticky α=.5	.087 (2.1)	-.016 (2.6)	.102 (2.4)	.006 (3.1)	.0086
Trad'l Sticky α=.1	.086 (2.0)	-.016 (2.6)	.103 (2.4)	.006 (3.1)	.0086
Augmented Flex	3.701 (2.2)	-.010 (1.8)	.857 (1.7)	.009 (3.9)	.0103
Augmented Sticky	.254 (3.4)	-.004 (.7)	.029 (.7)	.005 (2.6)	.0082
Sample of Countries with Official Bandwidth N=173					
Trad'l Flex α=.5	-.034 (.8)	.003 (.5)	-.033 (.3)	.056 (6.1)	.0037
Trad'l Sticky α=.5	-.008 (.2)	.006 (.8)	-.051 (.7)	.058 (6.1)	.0038
Augmented Flex	.775 (.9)	.000 (.0)	.080 (.1)	.057 (5.6)	.0039
Augmented Sticky	.170 (1.5)	-.000 (.0)	.032 (.3)	.042 (2.6)	.0047
Full Sample, with Absolute value of Mean of Fundamentals instead of Standard Deviation N=432					
Trad'l Flex α=.5	-1.09 (2.7)	-.004 (1.9)	1.66 (2.1)	.013 (4.5)	.0135
Trad'l Sticky α=.5	-.114 (1.1)	-.003 (2.2)	.077 (1.5)	.012 (5.4)	.0104
Augmented Flex	.542 (1.2)	-.004 (1.4)	.326 (.6)	.009 (4.9)	.0082
Augmented Sticky	.035 (.3)	-.003 (2.3)	.066 (1.5)	.011 (5.3)	.0089

All regressions have a complete set of time- and country-specific intercepts, and are estimated with instrumental variables. The root-mean squared error of the residual is denoted "σ".

The equations fit the data with moderate precision; the typical estimated residual standard error is around 85 basis points (.85%), compared with an estimated standard deviation for the regressand of 126 basis points. The augmented flexible-price measure of fundamentals fits substantially worse than the other measures; this measure of fundamentals also delivers substantially different coefficient estimates than the other fundamentals. The exact size of α has only a trivial effect on the results.

Fundamental volatility has the expected effect on exchange rate volatility; β is always estimated to be positive. The coefficients are moderately significant; they are also quite small in economic terms for traditional measures, much larger for augmented measures. The direct effects of capital mobility are never significantly positive, and are negative for four of the six measures of monetary fundamentals. The interaction between capital mobility and fundamentals is its complement, being e.g., negative and significant when the capital mobility coefficient is positive and significant.

Two perturbations of the methodology used to generate the benchmark results are also included in Table III. The middle panel uses a sample of observations restricted to countries which were officially fixed. The results are worse in the sense that neither fundamentals, capital mobility, nor their interaction has a significant effect on exchange rate volatility. The bottom panel substitutes the absolute value of the mean of fundamentals for the volatility of fundamentals, since it is possible that the average level rather than the standard deviation of fundamentals should be used to measure monetary divergence. However, the coefficients on fundamentals and capital mobility are not consistently signed; the interactive effect is always positive (though wildly varying in size). Most of the β and δ estimates are insignificant.

Perhaps the most striking finding of Table III is a consistently highly significant effect of the official size of the exchange rate bandwidth on exchange rate volatility. To gauge the economic size of this effect, consider the middle panel of Table III which deals only with officially fixed countries. A bandwidth coefficient of .05 indicates that a shift from a bandwidth of 2.25% to 15% (experienced by a number of ERM countries in August 1993) is associated with an increase in exchange rate volatility of .0064 (= .05 x .1275) or .64%. For comparison, average exchange rate volatility for the sample was .0074; thus the estimated effects of the explicitly declared exchange rate bandwidth are far from trivial.

Confidence levels for a variety of interesting hypothesis tests of relevance are presented in Table IV. Confidence levels are tabulated for three joint hypotheses. The

Table IV: Hypothesis Tests for Significance of Fundamentals and Capital Mobility

Hypothesis Tests for Equation (7). Confidence Levels for Joint Null Hypothesis.

Fundamental	Joint	Capital Mobility	Fundamentals
Full Sample N=432	$\beta=\delta_1=\delta_2=0$	$\delta_1=\delta_2=0$	$\beta=\delta_1=0$
Trad'l Flex $\alpha=.5$	.10	.04	.45
Trad'l Flex $\alpha=.1$	.10	.04	.45
Trad'l Sticky $\alpha=.5$	.00	.02	.00
Trad'l Sticky $\alpha=.1$	.00	.02	.00
Augmented Flex	.01	.20	.01
Augmented Sticky	.00	.76	.00
Sample of Countries with Official Bandwidth N=173			
Trad'l Flex $\alpha=.5$	.37	.59	.22
Trad'l Sticky $\alpha=.5$	.63	.65	.45
Augmented Flex	.83	.90	.68
Augmented Sticky	.49	.55	.31

All regressions have a complete set of time- and country-specific intercepts, and are estimated with instrumental variables.

first tests the hypothesis that the volatility of fundamentals, the degree of capital mobility, and their interactive effect jointly have an insignificant effect on exchange rate volatility. The second and third focus on the total effects (both direct and through the interactive term) of capital mobility and fundamentals respectively. All of these hypotheses are surprisingly consistent with the data for the traditional flexible-price fundamental, though less so for the others. Fundamental volatility affects exchange rate volatility significantly for the sticky-price and augmented measures of fundamentals; capital mobility is important only when the traditional measures of fundamentals are used. On the other hand, the sample of officially fixed countries is not significantly affected by fundamentals or capital mobility at traditional confidence levels, independent of the choice of fundamentals measure.

To sum up, there is evidence that fundamental macroeconomic volatility and the degree of capital mobility affect exchange rate volatility. However, this evidence depends on the exact measure of monetary fundamentals, and is perhaps disturbingly weak throughout.

IVb: Robustness

I now ensure that the benchmark results discussed in the previous sub-section are insensitive to minor variations of the basic methodology. My sensitivity analysis takes two different forms. First, I check how much the results of Table III depend on: a) the factor-analytic measure of capital mobility; b) the estimation technique; c) inclusion of country- and time-specific fixed effects; d) the particular choice of countries; and e) the particular choice of sample period. Then I informally check my results using a long-run British-American data set.

Table V: Estimates of (7) with Different Measure of Capital Mobility

Regression Results for Equation (7). Coefficient Estimates (t-statistics)
Capital Mobility Dummy Variable in place of Capital Mobility Factor.

Fundamental	Fund'l β	Cap Mob δ_1	Interact δ_2	Bandwidth ϕ	σ
Full Sample N=432					
Trad'l Flex α=.5	-.259 (1.1)	-.017 (1.0)	.339 (1.1)	.011 (6.4)	.0088
Trad'l Sticky α=.5	-.098 (0.6)	-.029 (1.5)	.306 (1.5)	.009 (4.8)	.0088
Augmented Flex	9.319 (1.3)	.020 (0.5)	-4.86 (0.7)	.010 (4.2)	.0128
Augmented Sticky	.314 (1.8)	-.016 (1.0)	.083 (0.4)	.004 (1.5)	.0108
Sample of Countries with Official Bandwidth N=173					
Trad'l Flex α=.5	-.004 (0.1)	.003 (0.8)	-.045 (0.6)	.054 (5.9)	.0037
Trad'l Sticky α=.5	-.037 (0.8)	-.004 (0.5)	.060 (0.7)	.054 (5.7)	.0037
Augmented Flex	-1.94 (0.4)	-.010 (0.5)	2.715 (0.5)	.056 (5.3)	.0042
Augmented Sticky	-.071 (0.2)	-.009 (0.6)	.158 (0.6)	.050 (4.1)	.0040

All regressions have a complete set of time- and country-specific intercepts, and are estimated with instrumental variables. The root-mean squared error of the residual is denoted "σ".

Table V contains the estimates of equation (7) when the binary capital mobility dummy variable from AREAER is substituted for the estimated capital mobility factor. These results typically fit the data slightly worse than those recorded in Table III. The coefficient results are also worse in the sense that there are almost no indications that the volatility of monetary fundamentals affects exchange rate volatility in a positive, significant fashion. There are also even fewer indications that capital mobility affects exchange rate volatility than are contained in the benchmark results in Table III. However, the significant effects of the bandwidth carry over from the benchmark results.

Table VI contains further sensitivity analysis; four different perturbations of the basic methodology are examined. From top to bottom, the four panels represent: 1) estimation of equation (7) with Ordinary Least Squares (OLS) instead of Instrumental Variables; 2) estimation without time- and country-specific intercepts (i.e., deleting the {D} and {E} terms in equation (7)); 3) splitting the sample by country so as to include observations only for eleven OECD partner countries of Germany (Austria; Belgium; Canada; Denmark; France; Italy; Netherlands; Norway; Sweden; UK, and US); and 4) splitting the sample by date, so as to include observations only from before 1980.

The results of the sensitivity analysis are consistent with those of the benchmark results in Table III. Fundamental volatility typically has a positive effect on exchange rate volatility, though this is often small and of only moderate statistical significance, while there are only weak indications that capital mobility plays a role. On the other hand, the exchange rate bandwidth is always a statistically significant determinant of exchange rate volatility.

Figure 4 uses a century of annual data for the United Kingdom and the United States to address the same issues. The data set is taken from Friedman and Schwartz (1982) and has been transformed by taking first-differences of natural logarithm of differentials between American and British values (except for the exchange rate). Time-series graphs

Table VI: Robustness Checks for Estimates of (7)

Regression Results for Equation (7). Coefficient Estimates (t-statistics)

Fundamental	Fund'l β	Cap Mob δ_1	Interact δ_2	Bandwidth ϕ	σ
OLS N=442 (except Augmented Flexible, where N=543)					
Trad'l Flex α=.5	.012 (.5)	-.000 (.0)	-.020 (.7)	.012 (8.0)	.0084
Trad'l Sticky α=.5	.124 (10.2)	-.001 (.6)	.004 (.4)	.010 (7.0)	.0075
Augmented Flex	.616 (4.2)	-.001 (1.1)	.023 (.2)	.010 (6.7)	.0093
Augmented Sticky	.133 (10.4)	-.002 (1.2)	.012 (1.4)	.009 (6.8)	.0075
Without Country- and Time-specific "Fixed Effect" Controls N=432					
Trad'l Flex α=.5	-.043 (1.5)	.009 (3.2)	-.160 (3.3)	.014 (12.3)	.0108
Trad'l Sticky α=.5	.123 (8.0)	.001 (.5)	.008 (.5)	.010 (8.4)	.0095
Augmented Flex	.369 (1.7)	.004 (2.0)	-.279 (1.4)	.014 (12.1)	.0106
Augmented Sticky	.141 (9.5)	-.001 (.3)	.027 (1.6)	.008 (6.8)	.0093
Sample Restricted to Eleven Countries N=238					
Trad'l Flex α=.5	-.030 (.6)	-.005 (.6)	.076 (.6)	.008 (4.4)	.0058
Trad'l Sticky α=.5	.165 (2.2)	.010 (.9)	-.134 (1.1)	.008 (5.3)	.0055
Augmented Flex	2.556 (2.0)	.016 (1.1)	-3.84 (1.1)	.008 (5.8)	.0065
Augmented Sticky	.091 (1.5)	-.013 (1.9)	.207 (2.0)	.005 (3.4)	.0049
Sample Restricted to Observations before 1980 N=182					
Trad'l Flex α=.5	-.017 (.3)	.007 (.7)	-.112 (.6)	.011 (4.2)	.0077
Trad'l Sticky α=.5	.093 (2.2)	-.003 (.5)	.038 (.8)	.010 (4.3)	.0065
Augmented Flex	3.438 (2.2)	.003 (.7)	.257 (.4)	.014 (3.8)	.0098
Augmented Sticky	.318 (2.4)	.008 (1.0)	-.028 (.4)	.010 (2.7)	.0102

are provided for four different series: 1) the nominal exchange rate; 2) the ratio of British to American money supplies; 3) the ratio of British to American prices; and 4) the flexible-price fundamental specified in (3^F), without ϵ disturbances. The last three series are intended to be alternative measures of monetary divergence; I make no attempt to measure the degree of capital mobility formally.

A number of features of the data portrayed in Figure 4 are of interest. Volatility of money and price differentials, is typically lower during regimes of fixed exchange rates; this is also true of flexible-price fundamentals. This finding stems largely from the Bretton Woods regime, which had lower volatility than the pre-WWI classical gold standard. Since Bretton Woods was presumably characterized by a higher degree of capital mobility than the gold standard era, this may well be a reflection of the incompatibility of the three

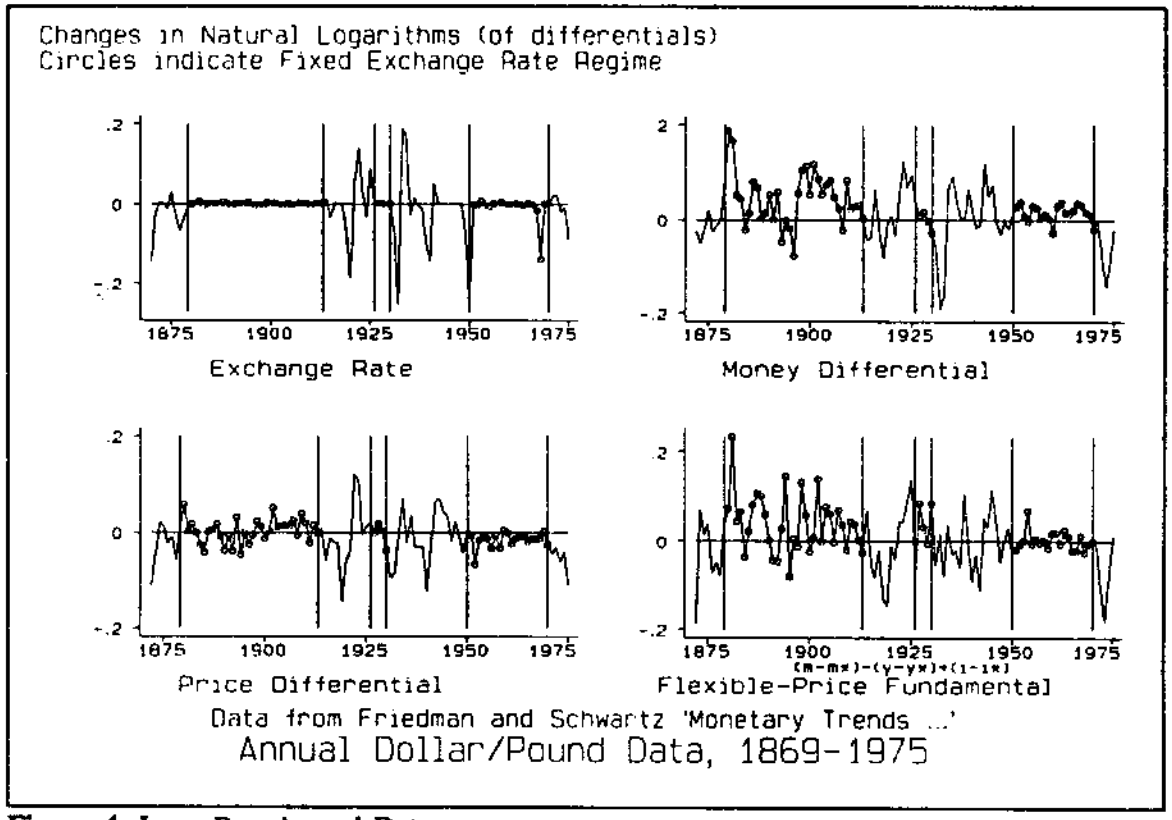

Figure 4: Long-Run Annual Data

components of the Holy Trinity. It is also interesting to note that the volatility of monetary fundamentals does not vary nearly as much across exchange rate regimes as the volatility of the nominal exchange rate, consistent with Flood and Rose (1993).

All in all, the results of this sub-section indicate that the benchmark results are relatively robust to minor modifications of the basic methodology. Fundamental volatility appears to have a positive effect on exchange rate volatility, though this effect is probably economically small and imprecisely estimated. There is much less evidence that the degree of capital mobility affects exchange rate volatility. However, virtually all of the results are consistent with the hypothesis that the officially declared width of the exchange rate band matters; a wider band tends to raise exchange rate volatility by an economically and statistically significant amount.

IVc: Interpretation

It is well known that models of exchange rate fundamentals work badly; Flood and Rose (1993) provide cross-regime evidence and references. The absence of strong linkages between exchange rate and fundamental volatility may simply reflect the profession's ignorance in this area. While this interpretation is perfectly plausible, it does indicate that economists should be more reluctant to believe strongly in the Holy Trinity since the latter is nothing but an unproven (though theoretically reasonable) proposition of approximately the same status as monetary models of the exchange rate.

Reisen (1993) believes that the Holy Trinity (which he refers to as the "Impossible Trinity") has been possible in South-East Asia. He argues that the three components are mutually compatible because large scale sterilized intervention is feasible; Frankel (1993) provides a closely related discussion. More generally, if the world can be well characterized by a portfolio-balance model where domestic and foreign bonds are imperfect substitutes (where sterilized intervention is potent) then the Holy Trinity does not consist of three mutually exclusive parts. Thus one interpretation of my results is that bonds are imperfect substitutes. In some sense, this states that my results stem from measurement error, since the monetary model delivers the incorrect set of fundamentals if the world is best characterized by a portfolio-balance model.

An alternative interpretation relies on the short-run existence of monetary independence in the presence of temporary nominal price stickiness. For instance, Stockman (1992) presents a model with short-run monetary independence and pegged exchange rates; see also Stockman and Ohanian (1993) and Svensson (1992). Stockman (1992) also presents some empirical evidence that countries had some degree of short-run monetary independence during the Bretton Woods era. An alternative interpretation of my results is that the actual degree of price stickiness affords countries considerable short-run

monetary independence; this is also consistent with the longer-run evidence presented above.

V: Conclusion

In this paper, I have investigated the historical tradeoffs between fixed exchange rates, monetary independence, and capital mobility. It is not easy to find economically reasonable and statistically significant determinants of exchange rate volatility; that is, there is surprisingly little evidence of an obvious tradeoff between the three components of the Holy Trinity. While greater volatility of underlying monetary and macroeconomic fundamentals tends to be associated with greater exchange rate volatility, such effects are weaker than one might have imagined. Even more surprising is the fact that the size of these effects does not depend very much on the degree of capital mobility.

Succinctly, I have not found strong support for the mutual incompatibility of the three parts of the Holy Trinity of fixed exchange rates, monetary independence, and perfect capital mobility. Indeed, the strongest result of this study lies in the positive and significant relationship between the size of the official exchange rate bandwidth and the degree of exchange rate volatility, even after taking into account both capital mobility and monetary fundamentals. Words evidently speak as loudly as actions; *stated* government exchange rate policy affects exchange rate volatility far above and beyond the effects of *actual* macroeconomic policy.

These results should not be taken as definitive, especially given the difficulties associated with measuring both monetary independence and capital mobility. Nevertheless, they may be still be of interest, given the perpetual concern with reform of the international financial system. For instance, Williamson (1985) argues in favor of wide (and loose real) exchange rate bands, arguing that says that these will deter real exchange rate volatility (and, more importantly, exchange rate misalignments). However, if the bandwidth itself

matters, then a policy of implicit wide bands may not realize the full benefits of lower exchange rate volatility. On a different, but related topic, there have been a number of different calls for European capital controls since the widening of the ERM bands in the summer of 1993. The results of this paper do not indicate that these will clearly have a strong impact on exchange rate volatility. However, the estimates in the paper do indicate that the widening of the ERM bands in 1993 may well result in significantly higher exchange rate volatility. Further, the weak links between macroeconomic fundamental and exchange rate stability is consistent with the "multiple equilibrium" hypothesis of Eichengreen and Wyplosz (1993b); monetary divergence appears to be neither necessary nor sufficient for collapse (this is also true of the degree of capital mobility). Thus macroeconomic convergence need not deter exchange rate instability.

Finally, official exchange rate policy appears to have a significant effect on exchange rate volatility even after taking into account macroeconomic phenomena. This constitutes further evidence that exchange rate volatility may be partially explicable in terms of microeconomic phenomena (e.g., Flood and Rose (1993)), and represents an intriguing opening for future research.

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Endnotes

1. The contribution of this paper is empirical rather than theoretical in nature; the analysis which follows makes no pretensions to theoretical novelty, and is partly taken from Flood and Rose (1993).

2. It is both striking and consistent with the analysis which follows that exchange rate regimes are never mentioned in the money demand or supply equations; e.g., the chapters by Goldfeld and Sichel, Brunner and Meltzer, and Friedman in Friedman and Hahn (1990).

3. An alternate way to express the Holy Trinity is through the condition of uncovered interest parity (UIP), which can be expressed:

$$(i-i^*)_t = E_t(\Delta e_{t+1})/dt.$$

UIP states that the interest rate differential equals the expected rate of change of the exchange rate. If the exchange rate is truly fixed, then the right-hand side is zero (or "small" in a credible target-zone system). Since perfect capital mobility implies that infinite capital flows in response to expected returns, and domestic and foreign assets are perfect substitutes, the left-hand side must also be zero. This ensures that monetary independence, *in the sense of different domestic and foreign interest rates*, is impossible. However, it is difficult to pursue this line empirically, since UIP is known to work badly in practice.

4. A change of frequency is not strictly necessary, since one could imagine using an ARCH-like procedure to estimate conditional volatility. The problem with this is the time-varying (regime-specific) nature of the underlying distributions.

5. My STATA data set and programs are available upon receipt of a formatted 3.5" diskette and a self-addressed stamped envelope.

6. I note in passing that expectations of changes in band width or the location of the band (i.e., realignment expectations) should be accounted for in fundamentals, since the former enter the interest differential.

7. Elementary algebra indicates that augmented fundamentals for the flexible-price model can be measured merely with the price differential, and thus do not rely on parameter values.

8. The actual scored factor is kfac ≡ -(.11*ka)-(.35*bm)-(.43*bn)-(.10*rd)+(.02*differe)-(.16*trade)+(.09*date).

9. This is perhaps more obvious from the discussion of uncovered interest parity in endnote 3.

10. Intermediate values come from countries which split a year between fixed and floating.

11. It is sometimes asserted that countries with fixed exchange rates need to resort to capital controls in order to maintain their exchange rate pegs. In this context, it is interesting to note that there is a significant positive simple correlation between the degree of capital mobility and the bandwidth of fixers. However, this simple correlation is insignificant if the entire sample is used. In addition, if country- and time-specific fixed

effects are partialled out, the correlation becomes significant and negative for the entire sample of observations, but positive for the sample of official fixers.