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EVOLUTION OF DOLLAR/EURO EXCHANGE RATE BEFORE AND AFTER THE BIRTH OF EURO AND POLICY IMPLICATIONS

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ABSTRACT

One possible consequence of the establishment of the Euro is a challenge to the hegemony of the US dollar as the predominant international currency. No other currency has been able to rival the international role of the national currency of the US since World War II. The fact that the unipolar international monetary system can be unstable in the presence of large shocks opens a window of opportunity for the Euro to promote systemic stability. The present study pursues this conjecture by, first, exploring with cointegration and ECM techniques the interdependence between the dynamics of the Dollar/Euro exchange rate and economic fundamentals in the context of a monetary exchange rate model. Identification of the key determinants of the value of the Euro informs our analysis of the policy stance of the European Central Bank regarding the long-run global role of the Euro. Secondly, we explore whether the opportunity for a prominent systemic role of the Euro has been realized by examining the impact of the Euro on the global financial market.

Key Words: Euro, Exchange rate, Monetary model, Cointegration
JEL Classification: F15, G14, P34

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1 INTRODUCTION

Contrary to widely held expectations the value of the Euro has experienced sizable swings since its creation on Jan 1, 1999. These fluctuations have not been 'horrendously' large in historical perspective (Mussa, 2005). This paper explores the nature of movements in the Dollar/Euro exchange rate and discusses their implications for the international standing of the Euro, given the policy strategies of the European Central Bank (ECB). Specifically, it investigates whether economic fundamentals in Euroland and the USA have dominated the evolution of the Dollar/Euro exchange rate. Understanding of the forces driving this central exchange rate may carry important policy implications for the rest of the world.

Exchange rate theories based on economic fundamentals have spawned a vast empirical literature. However, its findings are mixed and the empirical validity of the theories is elusive, appearing mysteriously under short as well as long data spans only to disappear again as the dataset changes. This elusiveness is disconcerting in view of the seemingly sound analytical foundations of prominent exchange rate models and has caused academic interest to gravitate towards a theoretical random walk interpretations. More recently, fundamentals-based models have been enjoying some resurgence, and the creation of the Euro currency has boosted interest in empirical studies of exchange rate behaviour. The vast economy that backs the Euro is comparable in size to the USA, and the rising international role of the Euro is changing the structure of the international monetary system towards a bipolar system (Hartmann and Issing, 2002). In addition, the similarity in economic structure, close trade links and common floating exchange rate regime across the Atlantic Ocean provide an appropriate setting for empirical testing of exchange rate theories. For example, Michael et al (2005), employing a Markov regime switching model, claim that they have identified some nonlinear albeit variable relationship between the Dollar/Euro rate and economic fundamentals like differentials in interest rates, inflation and economic growth, and that these factors also drive the regime switching.

The three most prominent monetary exchange rate models are the flexprice, sticky price and hybrid monetary models. This paper adopts the hybrid model as theoretical foundation since it takes into account both flex and sticky price possibilities over different time horizons. This feature makes the hybrid model conform closer to the real world situation. We employ cointegration and error correction models (ECM) to unravel the statistical relations and interaction between the Dollar/Euro exchange rate and economic fundamentals.

A second objective of this paper revolves around the international role that the Euro has achieved over its five year existence. This role is closely linked with the behaviour of the Dollar/Euro exchange rate. While perceptions of success and failure are inherently subjective, the explicit consensus among academics, analysts and officials appears to be that the Euro has delivered an impressive initial performance, and that its long-run prospects seem promising if some obstacles are addressed (for example, Rogoff, 2005, and Issing, 2005). Rogoff (2005) briefly lists some initial successes of the Euro within and beyond Euroland and evaluates its achievements and status in the international monetary system.

The behaviour of the exchange rate plays a critical role in determining the position and role of a currency in the international monetary system. In particular, strength and stability promote the advance of the Euro as a major international currency while volatility and secular depreciation tend to erode market confidence in the currency. The Euro has a remarkable potential to achieve equal global status with the Dollar, and even to challenge its international dominance. For example, the Euro currency area

- produces annual GDP equivalent to approximately three quarters of US GDP, and is significantly larger than that of Japan;
- has an immense domestic market;
- has a reasonably integrated financial market (the integration process is still going on); and
- has successfully maintained a low inflation rate over a prolonged period.

Our observation period spans the decade surrounding the creation of the Euro (1994 – 2003). We find that a cointegration relationship exists between the Dollar/Euro exchange rate and economic fundamentals. The negative error correction coefficient in ECMs suggests reversion to long-run equilibrium with economic fundamentals. In order to discover potential changes in the dynamics of exchange rate behaviour generated by the structural shift attributable to the establishment of the Euro we subdivide the data into the pre- and post-establishment sub-periods, 1994-1998 and 1999-2003, respectively. The superior fit for the second sub-sample suggests that the cointegration relationship has strengthened after the unification of the predecessor currencies of the Euro. These findings support the conjecture that the hybrid monetary model depicts well the impact of economic factors on the behaviour of the Dollar/Euro exchange rate during the period of examination. Since the drivers of our model, money supply and interest rates, are prominent policy tools of monetary authorities, the salient results of this paper have important implications for central bank policy formation.

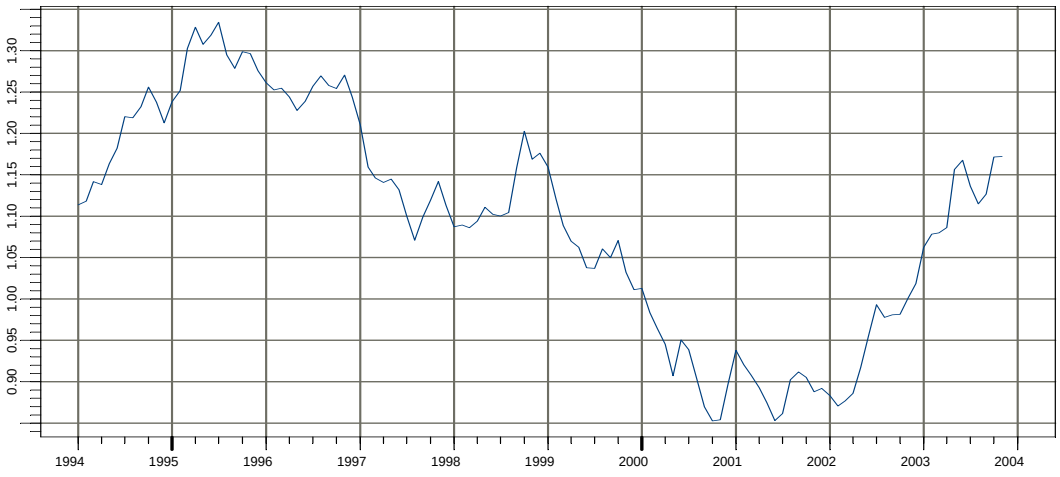
The following section reviews the behaviour of the Dollar/Euro exchange rate. Section 3 introduces monetary exchange rate models, with emphasis on the hybrid model. Section 4

presents the econometric methodology, empirical results and interpretation as well as data description. Section 5 discusses policy implications of the empirical results and the internationalization status of the Euro. Section 6 concludes the paper.

2 THE FOREIGN EXCHANGE MARKET BEHAVIOUR OF THE EURO

In this section we track movements in the bilateral Dollar/Euro (D-E) exchange rate over the period 1999-2003. The Euro was launched at 1.17 dollars at the start of 1999. During the lead-up to its launch many observers had predicted an appreciation of the Euro vis-à-vis the dollar.[1] Unification of financial markets during Stage 3 of the European Monetary Union (EMU)[2] was expected to rebalance portfolios of public and private agents in favour of the Euro. In fact, the Euro depreciated after its launch, falling below parity at the beginning of 2000. It continued its downward trend to reach a low of 0.852 dollar in October 2000. Contrary to most commentators, Mussa (2001) argues that the weakness of the Euro did not reflect shaky fundamentals, given that the Euro area economy was performing a bit better than the USA. He predicts a stronger Euro in the medium to long term, with the currency benefiting from expanding productive employment and capital accumulation. Eichengreen (2005) also notes that the large fluctuation of the Euro did not destabilize Europe's financial markets and economy as a whole. Still, the depreciation of the Euro was perplexing against the backdrop of the burgeoning US current account deficit (Figure 1). Cohen and Loisel (2001) emphasize the drastic easing of interest rates, caused by the tight fiscal policy imposed by the Maastricht fiscal criteria and relatively loose monetary policy, as the dominant driver of the initial weakening of the currency.

Figure 1: Dollar/Euro Exchange rate, 1994-2003



An alternative view attributes the decline in the Euro to the divergent growth projections for the two regions. Corsetti and Pesenti (1999) show that the D-E rate during 1999-2000 can readily be explained by revisions of forecast growth rates of output in the US and Euroland. It should be noted that the correlation between growth forecasts and exchange rates does not hold for other currencies over the same period. De Grauwe (2000) attributes these disparate observations to the tendency of market participants to focus exclusively on one variable that supports their prior beliefs, and to ignore other fundamental determinants. Neaime and Paschakis (2002) emphasize substantial (positive) demand shocks in the US as major drivers of the bilateral exchange rate while Arestis et al (2002) focus on weak fundamentals in the Euro area.

However, the Euro started a strong bounce against the Dollar from mid 2001. The prolonged and dramatic appreciation of the Euro yet again challenged many researchers' preconceptions. It aroused concern that dwindling exports in the wake of the strengthening Euro would cause recession. Analysts are largely agreed that the Euro was undervalued around late 2000 and mid 2001, and that it had probably overshot its long-term equilibrium level. The most perplexing feature is that the substantial U.S. current account deficit which appears to be immune to the weakening of the Dollar. Mussa (2005) perceives a potential culprit in the resistance of some emerging currencies (especially of Asian countries) to appreciate against the Dollar. This imposes an excessively heavy burden on the D-E rate to correct international trade imbalances, a burden that could be carried more effectively by multilateral exchange rate arrangements or adjustments to achieve a safe international payment system.

3. Monetary Models of THE Exchange Rate

A brief review[3] of the polar flexprice and sticky price models sets the stage for the development of a hybrid monetary model. This hybrid model will be used to explore the behaviour of the D-E exchange rate.

A The Flex price Monetary Model

The monetary model was the most popular and dominant approach to the nominal exchange rate at the time of the breakdown of the Bretton Woods system. It defines the exchange rate as the relative prices of two monies that is determined by the interaction of the demands and supplies for those monies.

The core assumptions of the model are that prices are flexible and markets clear, that the aggregate price level is determined according to the quantity theory, and that purchasing power parity (PPP) holds continuously.

PPP: $s_t = p_t - p_t^*$ (1)

Price levels (domestic (p_t) and foreign (p_t^*)) are determined according to the quantity theory

$$p = m - l = m + \beta_2 y + \beta_3 i \quad (2)$$

Incorporating the two core assumptions into the price determination yields a generalised model of the exchange rate:

$$s_t = (m_t - m_t^*) + \beta_2 (y_t - y_t^*) + \beta_3 (i_t - i_t^*) \quad \beta_2 < 0,\ \beta_3 > 0 \quad (3)$$

where s_t is the spot rate in period *t* defined as the domestic currency price of foreign exchange, l_t *and* m_t are the stock demand for and supply of real balances, respectively, y_t the output level, and i_t the nominal interest rate. All variables, with the exception of interest rates, are in logarithmic form, and foreign variables are identified by an (*). *Ceteris paribus*, relative monetary expansion depreciates the domestic currency while relative strengthening of domestic money demand appreciates it.

Allowing for the role of inflation by recognizing the Fisher relationship of the influence of the expected inflation premium on nominal interest rates ($i = r + \pi_{t+1}^e$) yields:

$$s_t = (m_t - m_t^*) + \beta_2 (y_t - y_t^*) + \beta_3 (r_t - r_t^*) + \beta_3 (\pi_{t+1}^e - \pi_{t+1}^{e*}) \quad (4)$$

where r_t denotes the real interest rate and π_{t+1}^e the expected inflation rate. Further, assuming that perfect capital mobility equalises real interest rates internationally ($r_t = r_t^*$) leads to the following flexprice model of the exchange rate:

$$s_t = (m_t - m_t^*) + \beta_2 (y_t - y_t^*) + \beta_3 (\pi_{t+1}^e - \pi_{t+1}^{e*}) \quad (5)$$

Equation (5) suggests that fundamentals such as the stance of monetary policy (relative money stocks), economic performance (relative output levels), and expectations (expected inflation differentials) drive the spot exchange rate in a rational expectations environment (De Grauwe 2000).

B The Sticky Price Monetary Model

The seminal version of this model is found in Dornbusch (1976). It recognizes that goods markets do not clear instantaneously, and that the adjustment path of prices affects the behaviour of the

exchange rate. Accordingly, short-run exchange rate behaviour is not constrained by the assumptions of perfect price flexibility and continuous PPP, but the long-run properties of the sticky price model are identical to the flexprice model. In the short run, the spot exchange rate (s_t) can deviate from its long-run equilibrium value ($\bar{s}_t$). Such deviations inform exchange rate expectations (Δs^e_{t+1}):

$$\Delta s^e_{t+1} = \alpha(\bar{s}_t - s_t) \qquad 0 < \alpha < 1 \tag{6}$$

Prices are driven by excess demand. They are "sticky" in the sense that adjustment occurs with a one-period lag:

$$\Delta p_{t+1} = \mu(d_t - y_t) \qquad \mu > 0 \tag{7}$$

where μ is a constant and d_t denotes the level of aggregate demand. The aggregate demand function includes a real exchange rate term to capture net exports:

$$d_t = \gamma_0 + \gamma_1(s_t - p_t) + \gamma_2 y_t - \gamma_3 i_t \qquad \gamma_0, \gamma_1, \gamma_2, \gamma_3 > 0 \tag{8}$$

The path of price change is obtained by substituting equation (8) into (7):

$$\Delta p_{t+1} = \mu[\gamma_0 + \gamma_1(s_t - p_t) + (\gamma_2 - 1)y_t - \gamma_3 i_t] \tag{9}$$

The sticky price path coupled with money market equilibrium determines the exchange rate evolution. A salient feature of the sticky price model is its ability to generate high volatility that typically involves overshooting as is commonly observed in foreign exchange markets.

C The Hybrid Monetary Model:

The hybrid monetary model (Frankel, 1979, 1980) integrates the flexprice and sticky price assumptions over different time horizons. In the long run, price stickiness disappears and the model conforms to the flexprice model. In the short run, price stickiness affects the speed of exchange rate adjustment and drives a wedge into cross-border interest rates:

$$\Delta s^e_{t+1} = \alpha(\bar{s}_t - s_t) + (\pi^e_{t+1} - \pi^{e*}_{t+1}) \quad 0 < \alpha < 1 \tag{10}$$

The first RHS term captures "sticky price" short-run exchange rate adjustment related to the speed of adjustment in goods markets (as in equation (6)). Though prices are sticky, they adjust in a stable manner to their equilibrium level. The second term captures the "flexprice" long-run evolution of the equilibrium exchange rate in response to inflation expectations which, in turn, reflect relative rates of money growth at home and abroad. Further, perfect capital mobility maintains uncovered interest rate parity (UIP) such that:

$$\text{UIP:} \quad \Delta s^e_{t+1} = i_t - i^*_t \tag{11}$$

The current spot exchange rate (s_t) is obtained by substituting equation (10) into the UIP condition (11):

$$s_t = \bar{s}_t - \frac{1}{\alpha}[(i_t - \pi^{e}_{t+1}) - (i^{*}_t - \pi^{e^*}_{t+1})] \quad (12)$$

The term in square bracket represents the expected real interest rate differential between countries. Substituting the long-run equilibrium exchange rate from equation (5) yields the general form of the hybrid model:

$$s_t = (m_t - m^{*}_t) + \beta_2(y_t - y^{*}_t) + \beta_3(\pi^{e}_{t+1} - \pi^{e^*}_{t+1}) + \beta_4[(i_t - \pi^{e}_{t+1}) - (i^{*}_t - \pi^{e^*}_{t+1})] \quad (13)$$

with parameter restrictions: $\beta_2, \beta_4 < 0$ and $\beta_3 > 0$.

Empirical implementation of these structural exchange rate models has yielded highly diverse and mutually exclusive findings. In a landmark paper, Meese and Rogoff (1983) demonstrate that a whole range of fundamentals-based models are unable to explain, much less to predict, out-of-sample short-term systematic movements in major nominal exchange rates and that a naïve random walk model consistently outperforms these models. More recently, Rogoff (1999) has revisited the issue and reaffirmed the low predictive content of these structural models. This apparent disconnect between macroeconomic fundamentals and bilateral exchange rates of major currencies has been attributed largely to exchange rate volatility which exceeds by far the volatility of relevant economic fundamentals.

One strategy for the potential rehabilitation of structural models is inspired by the error correction framework. By employing unconstrained VAR models and including lagged values of the exchange rate as explanatory variables, Woo (1985) and Wolff (1987), for example, demonstrate superior forecasting ability of monetary models. More recently, MacDonald (1999) has demonstrated forecasting powers of structural models at horizons as short as two months ahead. Such findings suggest that structural models, albeit imperfect, are appropriate and significant tools for understanding exchange rate behaviour. Accordingly, we use a hybrid monetary model to estimate the effects of fundamentals on the long-run equilibrium exchange rate of the Euro. The regression form of the hybrid model is:

$$s_t = \beta_1(m_t - m^{*}_t) + \beta_2(y_t - y^{*}_t) + \beta_3(\pi^{e}_{t+1} - \pi^{e^*}_{t+1}) + \beta_4\left[(i_t - \pi^{e}_{t+1}) - (i^{*}_t - \pi^{e^*}_{t+1})\right] + z_t \quad (14)$$

where z_t is a disturbance term and the parameters are expected to satisfy the restrictions: $\beta_1 = 1, \beta_2, \beta_4 < 0$ and $\beta_3 > 0$.

4. METHODOLOGY AND EMPIRICAL RESULTS

4.1 Synopsis of Empirical Methodology

The regression model (equation (14)) in simplified notation is given in equation (14a):

$$s_t = \beta_0 + \beta_1 md_t + \beta_2 yd_t + \beta_3 \inf d_{t+1} + \beta_4 rd_{t+1} + z_t \qquad (14a)$$

where the RHS variables represent the various differentials written in explicit form in equation (14). The "home country" is the US, so that variables with an "*" represent the "EUROLAND". Since exchange rates, money supply and output are in logarithmic form, the parameters β_1 and β_2 represent relevant elasticity measures. The parameters β_3 and β_4 are semi-elasticities of the exchange rate because expected inflation and real interest rates are measured in level terms.

The object of the exercise is to examine whether any of the economic fundamentals captured in (14a) exert a stable influence on the exchange rate. Since exchange rates are likely to be non-stationary, we need to identify cointegration relationships between the D-E rate and the relevant macroeconomic fundamentals. Following Engle and Granger's (1987) two-step procedure for identifying cointegration, we perform unit root tests to test for non-stationarity of both dependent and independent variables. If the series involved in the model are all non-stationary with the same integration order (say *I(1)*), we proceed to estimate the cointegrating parameters in (14a) by OLS regressions. In the second step, the stationarity of the resulting residuals from the above regression will be tested. If they are found to be stationary (*I(0)* process), then the series involved in the regression (14a) are said to be cointegrated; that is, they are characterized by a long-run equilibrium relationship.

For the first step, we apply the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests[4]. Since the ADF test presupposes i.i.d error terms, whereas the PP test does not, we employ both tests to enhance the power of our testing and, hence, the robustness of and confidence in our findings.

Engle and Granger (1987) note that, in the presence of cointegration, the first differencing of all nonstationary variables creates too many unit roots that obscure any potentially important long-term relationship between the variables. Thus, inferences based on regressions of differenced series may lead to incorrect conclusions (Granger, 1981, 1988; Sims *et al*., 1990). This problem can be avoided by utilizing an alternative representation, the Error Correction Model (ECM). The ECM of spot exchange rate determination, taking account of short-run dynamics as well as long-run equilibrium relationships between cointegrated variables, has the following form:

$$\Delta s_t = \lambda_1 \hat{z}_{t-1} + \lambda_2 \Delta s_{t-1} + \lambda_3 \Delta md_t + \lambda_4 \Delta yd_t + \lambda_5 \Delta \inf d_{t+1} + \lambda_6 \Delta rd_{t+1} + \varepsilon_t \quad (15)$$

where the Δ before a variable indicates that the variable is in differenced form, ε_t is the disturbance term and $\hat{z}_{t-1}$ is the residual series estimated from (14a) that represents the cointegrating variable (disequilibrium error) in the ECM. If the adjustment coefficient λ_1 is estimated to be negative, then any deviation of the exchange rate from its long run equilibrium with economic fundamentals (namely, $\hat{z}_{t-1}$) will be corrected in the next period by $|\lambda_1|$ proportion of the deviation. Since exchange rate, money supply and output are in logarithmic form, differenced series of these logged variables can be interpreted as "return" series. The parameters λ_3, λ_4 in equation (14a) can be interpreted as the elasticity of exchange rate return with respect to changes of money supply and output, respectively. In the same vein, the parameters λ_5 and λ_6 are the semi-elasticities of exchange rate return with respect to the two differenced variables.

4.2 Data description

Monthly data[5] are used for the observation period January 1994 to December 2003, covering 120 observations. Following the approach of Chinn and Alquist (2000), we include data from the pre-stage3–period of the EMU to obtain a reasonable number of observations. Bilateral exchange rates (D-E), quoted in US$/Euro, are obtained from Pacific Exchange Rate services. We use monthly averages. EU interest rates are proxied by offshore 3-month deposit rates while the Federal Funds rates represent the domestic (US) interest rates. Nominal stocks of money are measured by the respective national M1s. Both interest rates and narrow money data are taken from IMF *International Financial Statistics* while the data for the remaining variables are obtained from OECD Economic Outlook.

4.3 Empirical Results and Interpretations

In this subsection, we investigate the adequacy of conventional models for predicting the external value of the Euro. Our empirical findings are used to draw inferences about the effect of ECB monetary policies on the exchange rate. Table 1 reports the non-stationarity test results for the D-E exchange rate and its fundamentals.

Table 1: Unit Root Test Results

Variables and Tests	ADF test		PP test	
	t-statistic	P-value	t-statistic	P-value
s_t	-1.268	0.6426	-1.060	0.7295
md_t	-1.535	0.5128	-1.742	0.4076
yd_t	0.753	0.8753	1.443	0.9625
$\inf d_{t+1}$	-2.126	0.5257	-2.301	0.4296
rd_{t+1}	-2.518	0.3190	-2.343	0.4076

Note: The null hypotheses in both tests are "the series is a unit root process".

The t-statistics and corresponding P-values in Table 1 do not reject the hypothesis at the conventional significance level that all the variables in the model follow an *I(1)* process for the entire period of observations. We then proceed to estimate the cointegration regression (14a) and present the corresponding results in the following table:

Table 2: Cointegration Regression Results

Estimates	Value	Std. Error	t value	Pr(>|t|)
$\hat{\beta}_0$	0.0973**	0.0417	2.3315	0.0215
$\hat{\beta}_1$	0.5576***	0.0359	15.5180	0.0000
$\hat{\beta}_2$	0.1183***	0.0242	4.8919	0.0000
$\hat{\beta}_3$	4.3304**	1.7456	2.4808	0.0146
$\hat{\beta}_4$	-0.0056	0.0071	-0.7939	0.4289
R^2		0.685		

Note: Refer to Equation (14a) for the Cointegration model being adopted . ***, ** and * denote significance at the 1%, 5%, and 10 %.levels.

The present model is able to explain 68.5% of the variation in the D-E rate. This result suggests that macroeconomic fundamentals are potentially significant explanators of the D-E rate. $\hat{\beta}_1$ has a highly significant positive value, albeit significantly smaller than 1. This value does not support the simple monetarist emphasis on monetary expansion as the dominant driver of nominal exchange rates. The significant estimates for $\hat{\beta}_2$ and $\hat{\beta}_3$ capture the transactions role of money. Only the

estimate $\hat{\beta}_4$ representing the influence of the real interest differential is not significant in the traditional statistical sense. The right sign of $\hat{\beta}_3$ reveals some support for both the flexprice and sticky price models, affirming the appropriateness of adopting the hybrid model.

The stationarity properties of the regression residuals are reported in Table 3. As all of the p-values are smaller than the conventional levels, we conclude that the residuals are stationary and thus the fitted model is adequate and successful in capturing the cointegration relation between the spot rate and economic fundamentals.

Table 3: Unit Root Test for Cointegration Residuals

Variables and Tests	ADF test		PP test	
	t-statistic	P-value	t-statistic	P-value
$\hat{z}_t$	-3.104***	0.002146	-2.655***	0.008219

*** denotes significance at the 1% level

Table 4: Estimated Results for ECM

Estimates	Value	Std. Error	t-value	Pr(>|t|)
$\hat{\lambda}_1$	-0.0670**	0.0292	-2.2954	0.0236
$\hat{\lambda}_2$	0.3752***	0.0881	4.2578	0.0000
$\hat{\lambda}_3$	0.0323	0.1032	0.3128	0.7550
$\hat{\lambda}_4$	0.0335*	0.0189	1.7706	0.0794
$\hat{\lambda}_5$	1.8996**	0.8314	2.2848	0.0242
$\hat{\lambda}_6$	-0.0074	0.0064	-1.1667	0.2458

Note: Refer to Equation (15) for the ECM. *, **, *** denote significance at the 10%, 5% and 1% levels

Estimation results for the ECM (equation (15)) are summarized in Table 4, using the residual series $\hat{z}_t$ as the cointegration variable. Several observations can be made from Table 4. First, the error correction coefficient ($\hat{\lambda}_1$) is significant at around the 2 per cent level. The negative sign implies that the long-run relationship between the exchange rate and fundamentals drags the exchange rate back to equilibrium. That is, the disequilibrium error term does indeed exert a correction effect on the long-run equilibrium between the exchange rate and economic fundamentals. Secondly, the highly significant parameter estimate $\hat{\lambda}_2$ (for Δs_{t-1}) shows the presence of serial correlation in the

exchange rate return, albeit not very persistent. This is consistent with widespread findings of exchange rate behavior reported in the finance literature.[6] Thirdly, the large magnitude and statistical significance of $\hat{\lambda}_5$ demonstrate the importance of inflationary expectations for exchange rate evolution. Finally, the negative sign of $\hat{\lambda}_6$ complies with international finance principles given the primitive representation of financial integration phenomena in our hybrid exchange rate model.

4.4 Sub-sample Evidence

The launch of the Euro was a significant event with the potential to change underlying structural relationships. By way of recognising this potential structural break, we divide the sample into two five-year subperiods covering the pre-Stage 3 period 1994–1998 and the Stage 3 period 1999–2003 of the EMU. The purpose of this exercise is to allow estimation results to capture structural shifts, and to check the internal consistency of the results.

The non-stationarity test results[7] show that all variables follow the I(1) process in both periods with the exception of the interest differential (i.e., β_4) in period 1 which receives only marginal support of first-order stationarity. Thus, we proceed to fit the cointegration regression (14a) to the two sub-samples separately, and report the results in Tables 5 and 6.

TABLE 5: Cointegration Regression Estimates for Sub-period 1994 - 1998

Estimates	Value	Std. Error	t value	Pr(>|t|)
$\hat{\beta}_0^{\,1}$	2.3132	2.4081	0.9606	0.3410
$\hat{\beta}_1^{\,1}$	0.4674 *	0.2719	1.7190	0.0912
$\hat{\beta}_2^{\,1}$	-1.1796	1.4392	-0.8197	0.4160
$\hat{\beta}_3^{\,1}$	5.6410 ***	1.7794	3.1701	0.0025
$\hat{\beta}_4^{\,1}$	0.0252 ***	0.0092	2.7408	0.0083

Notes: The Superscript 1 of the relevant adjustment coefficient estimates denotes results for the first sub-sample, 1994-1998

*, **, *** denote significance at the 10%, 5% and 1% levels

TABLE 6: Cointegration Regression Estimates for Sub-period 1999 - 2003

Estimates	Value	Std.Error	t value	Pr(>|t|)
$\hat{\beta}_0^{\,2}$	0.3037	0.2032	1.4943	0.1409
$\hat{\beta}_1^{\,2}$	0.9440***	0.3412	2.7664	0.0077
$\hat{\beta}_2^{\,2}$	0.1113***	0.0265	4.2006	0.0001
$\hat{\beta}_3^{\,2}$	14.0011***	3.4215	4.0921	0.0001
$\hat{\beta}_4^{\,2}$	-0.0709***	0.0203	-3.4864	0.0010

Notes: The Superscript 2 of the relevant adjustment coefficient estimates denotes results for the second sub-sample, 1999-2003

*, **, *** denote significance at the 10%, 5% and 1% levels

The immediately compelling observation is the superior fit for the second subperiod in the sense that the parameter estimates are substantially more robust. All parameter estimates in the second sub-sample, except for the intercept, are significant at the 1 per cent level. Secondly, the results for the second subperiod conform to the a priori constraints and sign restrictions of the hybrid monetary model. In particular, $\hat{\beta}_1$ is not statistically different from unity, $\hat{\beta}_3$ is significantly positive and $\hat{\beta}_4$ is significantly negative. $\hat{\beta}_2 > 0$ suggests that relative acceleration of domestic income growth causes the exchange rate to depreciate. While this effect violates the prediction of the flexprice monetary model it does capture the induced trade balance deterioration that is typically postulated in Mundell-Fleming fixprice model. This particular transmission channel is entirely compatible with the operation of the present hybrid model. We can conclude, therefore, with some confidence, that the path of the D-E rate conforms remarkably well to the predictions of the hybrid monetary model.

The non-stationarity tests for cointegration regression residuals for the two sub-samples show that all the residual series follow an I(0) process. This result is consistent with the conjecture that the exchange rate and economic fundamentals are cointegrated in both subperiods.[8] Consequently, we estimate an ECM for both subperiods, and report the results in Tables 7 and 8.

TABLE 7: ECM Estimates for Sub-period 1994 - 1998

Estimates	Value	Std. Error	t value	Pr(>|t|)
$\hat{\lambda}_1^{\,1}$	-0.2080***	0.0659	-3.1566	0.0027
$\hat{\lambda}_2^{\,1}$	0.4334***	0.1229	3.5279	0.0009
$\hat{\lambda}_3^{\,1}$	0.0924	0.1138	0.8115	0.4208
$\hat{\lambda}_4^{\,1}$	1.1064	1.2274	0.9014	0.3715
$\hat{\lambda}_5^{\,1}$	2.3467**	1.1585	2.0256	0.0479
$\hat{\lambda}_6^{\,1}$	-0.0107*	0.0058	-1.8517	0.0697

Note: *, **, *** denote significance at the 10%, 5% and 1% levels

TABLE 8: ECM Estimates for Sub-period 1999 - 2003

Estimates	Value	Std. Error	t value	Pr(>|t|)
$\hat{\lambda}_1^{\,2}$	-0.1176**	0.0463	-2.5408	0.0141
$\hat{\lambda}_2^{\,2}$	0.3597***	0.1220	2.9474	0.0048
$\hat{\lambda}_3^{\,2}$	0.0043	0.1819	0.0237	0.9812
$\hat{\lambda}_4^{\,2}$	0.0404*	0.0217	1.8642	0.0681
$\hat{\lambda}_5^{\,2}$	1.9072	1.2132	1.5720	0.1221
$\hat{\lambda}_6^{\,2}$	0.0219	0.0171	1.2787	0.2068

Note: *, **, *** denote significance at the 10%, 5% and 1% levels

The ECM results do not show much difference in model fit between the two subperiods, nor are the parameter estimates particularly robust. There is a slight improvement in average significance of the estimates in the second subperiod. One reassuring finding of robustness is that both $\hat{\lambda}_1$ and $\hat{\lambda}_2$ (capturing the effects of the error correction term and the serial correlation in the exchange rate return, respectively) have the correct sign and are sufficiently significant in both sub-periods. This result provides some support for the use of the ECM in the entire observation period. It seems that other variables do not contribute much to the dynamics of the exchange rate return series after controlling for the disequilibrium error and serial correlation. This fact may reflect more on model implementation than on model selection. The data used for the first subperiod (leading up to stage 3 of the EMU) represent simple aggregates of the corresponding data for the EU member countries, which may have led to some distortion. The small sample size, particularly for the period

following the launch of the Euro, may inhibit the ability of the model to reveal the true features of parameters.

5. POLICY IMPLICATIONS FOR INTERNATIONALIZATION OF EURO

The empirical results in Section 4 indicate that economic fundamentals have influenced the path of the D-E rate, especially after the creation of the single currency on Jan 1, 1999. What are the implications of this finding for the design of the Euro exchange rate mechanism and, in general, for the international role of the Euro? Before answering this question, we briefly outline the advances the Euro has made in the international monetary system.

The internationalization of the Euro can be approached from the alternative perspectives of the private and the official uses of the currency. First, the Euro has been used increasingly by private agents across the world, especially in international debt and bank transactions. The share of Euro-denominated debt has kept pace with the growth of debt markets while USD-denominated debt has contracted. The share of Euro-denominated bonds issued by non-residents has increased from less than 20 per cent prior to the launch of the Euro[9] to more than 30 per cent by mid-2003.[10] Meanwhile, the Bank of International Settlements (2003) estimates that total Euro-denominated cross-border claims of banks have increased by approximately 75 per cent between 2001 and 2003 while the corresponding dollar-denominated claims remained nearly constant. The modest abatement in the private use of the Euro as vehicle currency may reflect the fact that intra-European trade no longer requires the use of a vehicle currency.

Secondly, the US dollar has remained the principal reserve currency since the advent of the Euro. It accounted, in 2002, for 70 and 60 per cent of total reserves held by developed and developing countries, respectively. However, indications of a compositional change in the reserve portfolios of developing countries in favour of the Euro are already evident. Click (2006) shows that at the end of 2004 the Euro accounted for about one-third of total foreign reserves of East Asian countries, and that this ratio is increasing.[11] Nearly 50% of flow changes, i.e. of the stock increase of international reserves, in the region consist of Euro since 1999. This portfolio substitution is quantitatively significant because developing countries are the majority holders of international reserves. It should also be noted that the retention of U.S. dollar-denominated reserve holdings may reflect more on the increasing international indebtedness of the U.S. and the exchange rate objectives of the rest of the world than on underlying portfolio preferences. Central banks, especially in Asia[12], may have sought to prevent appreciation of their domestic currencies against the dollar in order to protect their US export markets. Progressive exploitation of the export opportunities afforded by the Euro area is likely to erode the pivotal trade role of the USD and change the portfolio preferences of central bankers in favour of other currencies including the Euro.

Another possible explanation of the relative prominence of US dollar reserves is that the creation of the Euro has obviated the need for European countries to hold reserves of the former European national currencies. Lastly, the Euro is catching up with the U.S. dollar as the popular international currency anchor.[13] Further expansion of the EU is likely to consolidate the position of the Euro as prospective member countries seek to enhance their financial credentials by pegging to the Euro.

In short, the Euro has made significant headway as an international currency since its recent creation. As illustrated by the past experience of the Japanese Yen and German Mark, sustained stability of the exchange rate and a sound domestic economy can greatly promote the internationalization of a currency. Our hybrid monetary model indicates a cointegration relationship between the D-E rate and economic fundamentals with a prominent role for the money supply and interest rates. Hence, our results imply that the ECB can influence the D-E rate by adjusting money supply or changing interest rates. While observers generally agree that the ECB should treat exchange rates with benign neglect,[14] the fact remains that the Bank should monitor exchange rate developments. Persistent deviation of the exchange rate from its long-run equilibrium is likely to affect adversely the economic performance of the Euro area and the credibility of the ECB, with prejudicial consequences for the international role of the Euro.

However, in reality, the ECB has been pursuing a “two-pillars” strategy[15] to achieve its primary task of keeping the inflation rate below 2 per cent per annum. The first pillar represents setting a fixed monetary growth rate,[16] and the second pillar refers to a broad assessment of other variables which the ECB deems significant.[17] This approach presents significant challenges. Specific monetary growth targets may be incompatible with the optimal conduct of monetary policy (De Grauwe, 2002 and Fritz, 2002). At the same time, the pursuit of internal price stability clearly constrains opportunities for active exchange rate management. Therefore, it would be a remarkable achievement for European monetary authority to implement well-designed policies aiming at strong economic growth and moderate inflation within Euroland without compromising the stability of Dollar/Euro exchange rate.

6. CONCLUSION

This study sets out to track the evolution of the Dollar/Euro exchange rate and the implications of the advent of the Euro currency for monetary policy in the Euro area and for international monetary arrangements. The key motivation of this exercise is to test the traditional monetary model of exchange rate determination in the novel setting by the launch of the Euro.

We employ the hybrid monetary model to examine the evolution of the D-E rate using cointegration and ECM techniques. Our results indicate that the D-E rate is cointegrated with fundamental

economic variables, inferring not to reject the conjecture that movements in the D-E rate conform to the generic characteristics of the hybrid monetary model. In addition, our results reveal that both short-run (price stickiness) and long-run (secular growth) fundamentals affect the exchange rate path and our findings support a relatively broad-based policy approach to promote collective economic interest of the EU-zone. To the extent that such policies succeed in strengthening and stabilizing the Euro-zone economy, these policies are likely to buttress and possibly accelerate the internationalization of the Euro.

The Euro has been playing an increasingly important role in the global monetary system displacing. This may be an immediate consequence of the greater integration of financial markets in the Euro area following the adoption of the single currency. Since this institutional change is unlikely to be unwound, the Euro may well consolidate its prominent position in the financing area. In a parallel development, public use of the Euro has expanded as developing countries progressively diversify their portfolios to increase the share of Euros in their currency reserves. At the same time, we find that the Euro has yet to rival the Dollar in other functions. This persistence conforms to the stylized fact that the structure of international currencies tends to resist change unless dramatic shocks shake the existing system.[18]

Finally, economic considerations influence the shape of the evolution of the international role of the Euro. Political developments in the Euro area and in the U.S. may well carry potentially important consequences for their international roles. For example, Rogoff (2005) noted that “the euro has taken on a political role in European economic integration far beyond its economic role”. Eichengreen (2005) also hinted at the crucial importance of political integration within Europe for the advancement of the Euro currency. Lastly, albeit observing uniform monetary policy, EU countries can, contingent on economic status, pursue their own specific fiscal policies which may affect the effectiveness of common monetary policies. Therefore, further consolidation and expansion of the international role of the Euro largely hinges on the successful reconciliation of common monetary policy and diverse fiscal policies of the EU countries.

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NOTES

[1] See, for example, Bergsten (1997), Mundell (1998) and Portes and Rey (1998).

[2] The Maastricht Treaty of 1991 identified three stages towards achieving Economic and Monetary Union (EMU) of EU member states, and finally towards the establishment of a European Central Bank.

[3] For a more thorough discussion of the models of exchange rate determination, refer to Taylor (1995).

[4] Reference is Hamilton (1994)

[5] Monthly real GDP is interpolated from quarterly data.

[6] For example, see Frankel and Rose (1995) and references therein.

[7] We omit reporting the unit root test results to save space. The test results are available from the authors.

[8] We omit reporting the unit root test results to save space. The test results are available from the authors.

[9] Euro-denominated bonds issued prior to the creation of the Euro refer to bonds denominated by predecessor currencies of the Euro.

[10] See "Review of the International Role of Euro," *ECB*, December 2003.

[11] At the end of 2004, Japan, China and South Korea held 44% of the total world foreign reserves. Later figures could be substantially bigger in view of China's significant build up of foreign reserves.

[12] See IMF *World Economic Outlook*, September 2003, Figure 1.14.

[13] Despite figures showing that the Euro is an increasingly popular choice for currency pegs, many countries are careful to limit the extent of exchange rate fluctuations against the dollar for trade considerations (see McKinnon, 2005 for discussions especially about Asian countries) .

[14] See, for instance, Alesina and Barro (2001) and Fritz (2002).

[15] See Hartmann and Issing (2002) for a more detailed discussion and analysis of the two-pillar strategy.

[16] Announcement of a quantitative reference value of 4.5% for the growth of the broad monetary aggregate M3.

[17] Hartmann and Issing (2002) list these variables as including the exchange rate, wages, the yield curve, measures of real activity, business and consumer surveys etc. Also included are the ECB's staff macroeconomic projections and other organisation's forecasts.

[18] See, for example, Salvatore (2005).