ASSESSING THE VOLATILITY OF THE EURO ON FOREIGN EXCHANGE MARKETS: FURTHER EMPIRICAL EVIDENCE AND POLICY IMPLICATIONS

1. Introduction and motivation

The positive and normative implications associated with nominal exchange rate volatility have received a considerable attention in the recent literature. These topics are addressed in two parallel strands of theoretical and empirical work:

1. Research exploring the welfare effects of exchange rate volatility in the context of dynamic stochastic general equilibrium (DSGE) models;
2. Research investigating the performance of alternative optimized monetary policy rules for open economies.

As regards the former line of research, Straub and Tchakarov (2004) show that, assuming habit persistence in the representative household's utility function, 'non-fundamental' exchange rate volatility (i.e. the fraction of volatility that cannot be accounted for by macroeconomic fundamentals) gives rise to significant welfare losses. The negative welfare effects induced by exchange rate volatility are confirmed in Bergin and Tchakarov (2003), using a very similar framework incorporating real and monetary shocks. Bergin *et al.* (2007), finally, document substantial welfare gains from nominal exchange rate stabilization, in a two-country model where one country cannot issue international debt denominated in its own currency.

Turning to the latter line of research, the debate about the relative advantages of monetary rules explicitly reacting to exchange rate movements dates back to Ball (1999) seminal paper. Although on a centralized microfounded welfare criterion these rules can approximate the first best equilibrium (Benigno and Benigno, 2001), the conclusions reached so far in the literature are remarkably mixed. In line with Ball (1999), Batini *et al.* (2003) find that adding a separate response to the current and lagged level of the real exchange rate generates marginal welfare improvements. Other authors express some skepticism towards policy rules leaning against the exchange rate wind, maintaining that a simple Taylor rule is robust to most model configurations (Taylor, 2001; Leitemo and Söderström, 2005). However, according to some recent contributions, while it is difficult to define a definitive ranking among alternative policy rules (Levieuge, 2006), assuming significant deviations from uncovered interest rate parity (UIP) is sufficient to establish a strong case for the adoption of monetary rules systematically reacting to exchange rate movements (Wollmershäuser, 2006).

The mixed results characterizing the literature on monetary policy rules for open economies seem fully reflected in the actual behavior of major inflation targeting Central Banks. Lubik and Schorfheide (2007) point out that while the monetary authorities of some countries (Canada, United Kingdom) explicitly include the nominal exchange rate in their policy rule, the opposite is true for other countries (Australia, New Zealand). Chada *et al.* (2004) document a significant, albeit quantitatively small, reaction of monetary policy to the real exchange rate (for the United States, the United Kingdom, and Japan), interpreting these results as an occasional response to large foreign exchange misalignments. Overall, these findings reiterate the variegated evidence produced in previous work on Central Banks behavior (Clarida *et al.,* 1998; Gerlach and Smets, 2000).

This paper relates to the different strands of literature surveyed above, providing a first assessment about the monetary policy of the European Central Bank (ECB) during the first years of the Eurosystem. The 'stability-oriented' approach of the ECB (ECB, 1999) corresponds to a flexible inflation targeting regime where monetary authorities are entirely focused on the pursuit of domestic goals. In this framework, although foreign exchange market developments are regularly monitored together with other macroeconomic indicators, the exchange rate does not explicitly enter the ECB policy reaction function. The basic issue addressed in this paper is whether this 'benign neglect' approach was appropriate, or whether the macroeconomic environment would have called for a systematic reaction to the dynamics of the Euro exchange rate.

This topic deserves a particular interest for a twofold order of reasons. First, as revealed by the above discussion, the ongoing debate on open-economy monetary rules is far from reaching some definitive conclusion, while the validity of any specific rule is strongly dependent on the nature of shocks hitting the economy and, more generally, on the degree of macroeconomic uncertainty implied by these shocks. Secondly, this topic has close connections with another relevant policy issue, concerning the link between monetary policy and domestic asset prices (i.e. stock and property prices). The dominant view in the literature is one of ‘benign neglect’, according to which the Central Bank should respond only to inflation in the price of goods, without pre-emptive monetary restrictions in an asset boom phase. However, in strict analogy with the literature on open-economy monetary rules, this ‘benign neglect’ approach is open to criticism, both on empirical (Cecchetti *et al.,* 2000) and on theoretical grounds (Bordo and Jeanne, 2002).

One profitable research strategy to assess the validity of the ECB ‘benign neglect’ approach is to apply various conditional volatility models to the dynamics of the Euro exchange rate. This analysis yields some interesting insights into the degree of ‘non-fundamental’ exchange rate volatility and the extent of UIP shocks, which represent two crucial elements in this kind of evaluation. A first step in this direction is taken in Tronzano (2008), where alternative volatility models are applied to U$/Euro data. The present paper extends the above analysis, focusing on another cross rate highly relevant in a policy-making perspective, namely the Yen/Euro exchange rate.

The paper is organized as follows. In the next section we estimate a wide class of conditional volatility models, starting with some standard specifications, and extending the analysis to allow for potential asymmetries and the effect of the conditional variance on the conditional mean process. Moreover, we investigate the robustness of our findings re-estimating some models on a restricted period. Section 3 provides a comprehensive evaluation of this empirical evidence, and discusses its policy implications in the light of the two parallel strands of literature outlined above. Section 4 concludes, summarizing the main results and pointing out some directions for future research.

2. Empirical evidence

2.1 Data Set and Preliminary Analysis

In order to preserve a substantial homogeneity with Tronzano (2008), we use weekly end-of-period data. Data cover the period from 01-01-1999 to 01-06-2007, yielding a sample of 440 observations. The nominal exchange rate is taken from Bloomberg (Bloomberg code: EURJPY), and is expressed as the number of Japanese Yen for one unit of the European currency.

Figure 1 and 2 plot, respectively, the log of the Yen/Euro nominal exchange rate [hereafter (S_t)] and the first difference of this series [hereafter (R_t) = (S_t) - (S_{t-1})].

FIGURE 1 - *Yen-Euro Nominal Exchange Rate (in logs)*

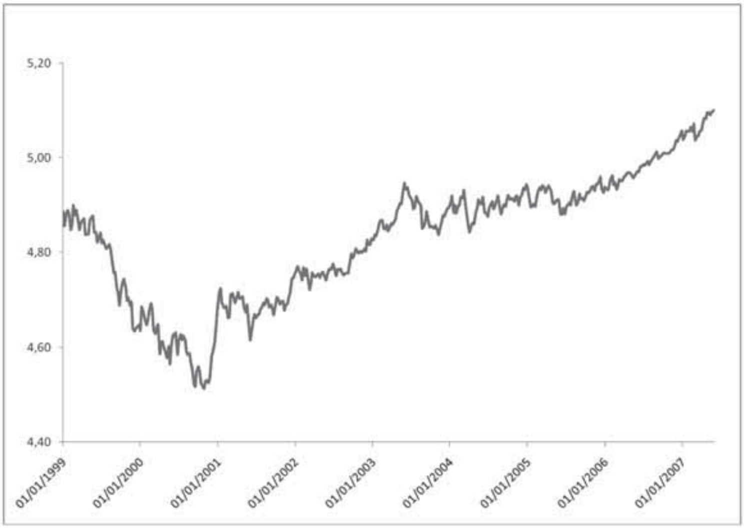
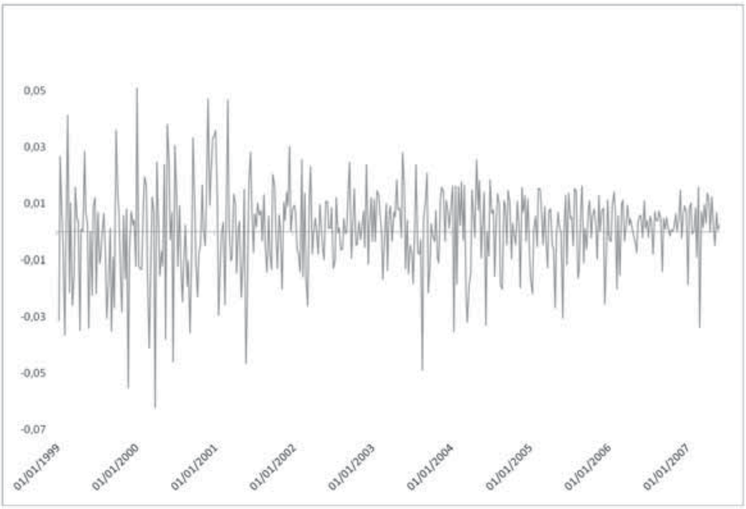


FIGURE 2 - *First-Differences of Log of Yen-Euro Exchange Rate*



The sharp depreciation of the Euro during the initial years of the new monetary regime is clearly apparent from Figure 1. This phase culminated in the last quarter of 2000, forcing the ECB to official intervention in support of the Euro. The remainder of the period is instead characterized by a prolonged weakness of the Japanese currency, reaching an all time low towards the end of the sample.

Joint inspection of Figures 1 and 2 suggests that (S_t) is integrated of order one [I(1)]. This hypothesis is strongly supported by various unit root tests (ADF, Phillips-Perron)[1]. The exchange rate return series (R_t) is therefore the focus of the econometric analysis performed in the next sections.

A closer inspection of the return series reveals a period of greater instability during the two initial years (1999-2000), when the Euro experienced a major weakness on currency markets. This turbulent phase may be ascribed to the higher uncertainty characterizing the beginning of the new regime, when agents were still doubtful about the effective degree of ECB credibility and the strength of its commitment to preserve price stability. This intuition finds actually strong support in some recent contributions[2].

Table 1 reports some descriptive statistics for (R_t).

TABLE 1 - *Descriptive Statistics for R_t*
Yen/Euro Exchange Rate
(Weekly Data: 01-01-1999/01-06-2007)

Maximum	0.0508
Minimum	-0.0622
Mean	0.487E-3
Stand. Dev.	0.0153
Skewness	-0.466
Kurtosis	4.586

[1] Formal results from the above tests, as well as from serial correlation tests on (R_t) and (R^2_t), and the detailed procedure to select the model for the conditional mean of returns are available from the author upon request.

[2] Analyzing the early years of operation of the Eurosystem through high-frequency data, Goldberg and Klein (2005) document a clear evolution of the market's perception of the policy stance of the ECB from a more tolerant to a more hawkish attitude towards inflation. Further evidence along these lines is provided in Breedon and Hume (2007), using survey data on inflation expectations for some major European economies.

This evidence is broadly in line with that reported in Tronzano (2008), both as regards the range of variations and as regards the standard deviation of exchange rate returns. Differently from the U$/Euro case, Yen/Euro returns display some positive excess kurtosis, suggesting that a t-distribution is likely to provide a better fit of the conditional distribution of residuals from volatility models.

The Ljung-Box test for serial correlation (up to the 40th order) allows to exclude any significant dependence in nominal exchange rate returns. The same test on the squared returns series (R^2_t) exceeds instead the 1% critical values at most lags, thus providing preliminary evidence about the existence of conditional heteroscedasticity (Hsieh, 1988; Baillie and Bollerslev, 1989).

In line with the preliminary results from the Ljung-Box test and with a large body of empirical evidence, a simple random walk model with drift ($R_t = c + \varepsilon_t$) provides the best characterization of the conditional mean return. This specification was chosen after a detailed comparison with alternative parametric formulations for the conditional mean, relying on the standard Akaike and Schwarz model selection criteria. Diagnostic tests on residuals allow to exclude the existence of serial correlation, while revealing significant departures from normality and strong Arch effects.

2.2 Standard Arch(q) and Garch(p,q) Models

In line with the above discussion, the following specification for the conditional mean return is assumed throughout the paper:

$$R_t = c + \varepsilon_t \ , \ \varepsilon_t \mid \Omega_{t-1} \sim D\ (0,\ h^2_t\ ) \qquad (1)$$

where c is a constant parameter, ε_t is a serially uncorrelated disturbance term, and $D(0,h^2_t)$ represents a distribution with mean zero and variance h^2_t .

The conditional variance can be expressed as:

$$h^2_t = \varpi + \sum_{i=1}^{q} \alpha_i \varepsilon^2_{t-i} + \sum_{i=1}^{p} \beta_i h^2_{t-i} \qquad (2)$$

where ϖ, α_1, ... α_q, β_1, ... β_p, are constant parameters, and the constraint $\sum_i \alpha_i + \sum_i \beta_i < 1$ is a necessary and sufficient condition for a finite unconditional variance to exist. Equation (2) nests the simpler Arch(q) specification (Engle, 1982), where coefficients β_1, ... β_p are jointly restricted to zero, with the more general Garch(p,q) model originally proposed in Bollerslev (1986).

These models were estimated using an iterative ML numerical optimization algorithm, where we fixed an upper limit of 50 iterations for convergence in order to exclude singularity problems. Moreover, in line with previous preliminary evidence, we assumed a t-distribution for the error term in equation (1) across alternative conditional variance specifications[3].

The selection between alternative models relied on conventional Akaike and Schwarz information criteria. In addition, a wide range of diagnostic tests on standardized residuals was implemented. These tests include the Ljiung-Box statistic for serial correlation in the levels and squares of standardized residuals, and further tests for mis-specification of the conditional variance function, allowing for a potentially asymmetric response of conditional volatility to past innovations.

Parameters estimates from standard Arch(q) and Garch(p,q) models are summarized in Table 2.

The first three rows contain the results from Arch(q) models, both in an unrestricted specification, allowing up to a maximum of six lags (q = 6), and in some restricted versions. The remaining rows contain the results from Garch(p,q) models, allowing for one lag in the impact of the conditional variance and preserving the same lag structure as regards the parameters of the moving average specification[4].

In the unrestricted Arch(q) specification, only two out of six parameters (α_5, α_6) turn out to be statistically different from zero, while their quantitative impact is very low. These modest Arch effects are corroborated by the remaining estimates referring to a semi-restricted and to a restricted specification (Table 2, second and third rows).

Turning to diagnostic tests (Table 3), the Jarque-Bera (1980) statistic strongly rejects the null of normally distributed residuals.

This does not invalidate the robustness of our empirical findings since all conditional volatility models have been estimated assuming a t-distribution.

---

[3] Preliminary LM tests on equation (1), based on the Engle (1982) statistic, pointed out that the bulk of Arch effects concentrates around the sixth lag. For this reason, a maximum of six lags (q = 6) was allowed when estimating the effects of past disturbances on conditional volatility.

[4] Some preliminary estimates pointed out that the optimal lag structure for the autoregressive component of the Garch specification may definitely be set to one (p = 1). All Garch models were estimated in various restricted versions in order to obtain convergence in the numerical optimization algorithm.

TABLE 2 - *Arch(q) and Garch(p,q) Models*
Yen/Euro Exchange Rate; Weekly Data (01-01-1999/01-06-2007)

Model	c	ϖ	α_1	α_2	α_3	α_4	α_5	α_6	β_1	$\Sigma (\alpha_i + \beta_i)$	AIC	SBC
Arch(6)	0.0018 (3.24)	0.769E-4 (13.0)	0.125 (1.45)	0.110 (1.33)	0.117 (1.73)	0.0386 (0.63)	0.184 (1.94)	0.212 (2.21)	-	0.786	1223.8	1207.5
Arch (6) (SR)	0.0018 (2.91)	0.151E-3 (25.1)	-	-	-	-	0.20 (2.16)	0.215 (2.19)	-	0.415	1219.8	1211.6
Arch (5) (R)	0.0017 (2.70)	0.197E-3 (3.39)	-	-	-	-	0.215 (2.12)	-	-	0.215	1218.9	1212.7
Garch (1,3) (R)	0.0018 (3.03)	0.106E-5 (0.13)	-	-	0.054 (2.14)	-	-	-	0.939 (46.9)	0.993	1243.5	1235.3
Garch (1,4) (R)	0.0018 (3.08)	0.108E-5 (0.172)	-	-	-	0.056 (2.47)	-	-	0.936 (45.9)	0.992	1240.0	1231.8
Garch (1,5) (R)	0.0019 (2.22)	0.114E-5 (0.03)	-	-	-	-	0.063 (0.43)	-	0.930	0.993	1240.2	1232.0
Garch (1,6) (R)	0.0018 (3.14)	0.131E-5 (0.22)	-	-	-	-	-	0.055 (2.59)	0.935	0.990	1236.0	1227.8

The coefficients reported in this table refer to equations (1) and (2) defined in section 2.2. t-statistics are in parentheses below parameters estimates. In the first column of this table an (R) heading means that, in the corresponding model, the lag structure for α_i coefficients has been restricted to the highest lag in order to obtain convergence in the numerical optimization algorithm. In a similar vein, an (SR) heading stands for 'semi-restricted' meaning that, in the corresponding model, some α_i lags have been set to zero in order to obtain convergence. In the last two columns, AIC indicates the value of the Akaike Information Criterion, while SBC refers to the value of the Schwarz Bayesian Criterion.

TABLE 3 - *Diagnostic Tests on Standardized Residuals from Arch(q) and Garch(p,q) Models Yen/Euro Exchange Rate; Weekly Data (01-01-1999/01-06-2007)*

Model	Jarque Bera	Q(10)	Q(40)	Q(80)	$Q^2(10)$	$Q^2(40)$	$Q^2(80)$	Sign Bias Test	Neg. Size Bias Test	Pos. Size Bias Test	F test	TR^2 test
Arch(6)	76.97^{**}	9.58	36.67	94.75	6.20	56.28^{*}	88.75	-0.463	0.610	-0.350	0.423	1.278
Arch (6) (SR)	62.43^{**}	10.55	40.02	101.7^{*}	14.91	113.8^{**}	166.2^{**}	-0.466	-0.750	0.817	0.618	1.866
Arch (5) (R)	67.75^{**}	14.88	43.05	113.2^{*}	20.3^{*}	65.99^{**}	139.3^{*}	-0.569	-0.735	0.676	0.569	1.717
Garch (1,3) (R)	52.60^{**}	7.94	30.54	76.70	6.71	21.26	36.84	-0.438	0.202	0.089	0.277	0.839
Garch (1,4) (R)	46.91^{**}	7.83	30.69	77.08	6.21	20.40	35.85	-0.440	0.229	0.143	0.327	0.989
Garch (1,5) (R)	57.44^{**}	7.94	30.96	77.98	5.07	20.73	36.61	-0.518	0.250	0.069	0.373	1.127
Garch (1,6) (R)	49.53^{**}	8.00	30.70	75.76	6.30	21.09	37.37	-0.454	0.242	0.065	0.303	0.916

See Table 2 for the definitions of alternative models. One (two) asterisks indicate significance at the 5% (1%) level. JB stand for the Jarque-Bera (1980) test of normality of regression residuals. Q(n) and $Q^2(n)$ denote the Ljung-Box test for serial correlation of order (n) applied, respectively, to standardized residuals and to squared standardized residuals. The Sign Bias Test examines whether negative and positive shocks have an asymmetric effect on volatility, while the Negative (Positive) Size Bias Test examine potential asymmetric influences associated with negative (positive) large and small innovations. These tests can be carried out either separately or assessing the joint restrictions associated with them (as in the last two columns of this table headed 'F-test' and 'TR^2-test'). See Engle and Ng (1993), section 2, for further technical details.

In the case of Arch(q) models, however, there is some evidence of conditional variance mis-specification. Most of them (Arch(6)[SR]; Arch(5)[R]) exhibit significant serial dependence in standardized residuals at higher lags. Moreover, although there is no evidence of neglected asymmetries in the conditional variance, the Ljung-Box test for serial correlation on squared standardized residuals is highly significant in most cases, pointing out that these models are unable to appropriately fit the heteroscedasticity present in the data.

Focusing on Garch(p,q) models, the modest influence of Arch effects is confirmed across all specifications. The impact of the lagged conditional variance is instead significant and very high since the β_1 parameter is estimated above 0.9. A further distinguishing feature is that Garch models fully overcome mis-specifications problems. As shown in Table 3, none of them suffers from residual serial correlation, while the remaining tests exclude the existence of asymmetric effects in the reaction of the conditional variance to different kinds of shocks.

Standard Garch models are therefore clearly superior to their Arch counterparts. This result displays a close analogy with the evidence achieved in Tronzano (2008), with one important qualification. The degree of volatility persistence for the U$/Euro exchange rate is rather low, whereas the Yen/Euro exhibits a notably higher degree of volatility persistence, with current shocks apparently exerting a permanent effect on predictable volatility[5].

These results would therefore seem to conform to the limiting integrated Garch (IGarch) case, where the unconditional variance of ε_t is infinite so that neither ε_t nor ε^2_t satisfy the definition of a covariance-stationary process (Hamilton, 1994, pp. 665-674). The above evidence, however, needs to be interpreted with great caution. We recall, at this purpose, that preliminary data inspection pointed out an initial period (1999-2000) of very high instability of the Yen/Euro return series. The robustness of these results needs therefore to be assessed in various directions, included the possibility of an upward bias in the estimated degree of volatility persistence as a result of the very high instability characterizing the start of the European Monetary Union.

This topic will be addressed in more detail in section 2.4, replicating our Garch estimates on a restricted sample (2001-2007).

---

[5] As shown in Table 2, the sum of estimated α_i and β_i coefficients is never significantly different from one. This result is strongly supported by a Wald test on the alternative Garch specifications appearing in this table.

2.3 Alternative Conditional Volatility Models

This section extends the analysis to an alternative class of conditional volatility models. More specifically, we focus on the Exponential Garch model both in its standard specification [Egarch(p,q)], originally developed in Nelson (1991), and in a modified version incorporating the effect of the conditional variance on conditional mean returns [Egarch(M)(p,q)].

The rationale for this econometric investigation is twofold. First, since the Egarch(p,q) model incorporates potential asymmetries in the conditional variance, we assess the robustness of previous empirical findings. Moreover, focusing on the Exponential Garch-in-Mean specification [Egarch(M)(p,q)], allows to investigate the existence of a significant risk premium component. As underlined before, this issue has relevant policy implications, since the existence of significant departures from UIP would establish a strong case for the adoption of monetary rules systematically reacting to exchange rate movements.

In the standard Egarch(p,q) model the conditional variance function takes the following exponential form:

$$\log(h^2_t) = \varpi + \sum_{i=1}^{q}\alpha_i\left[\frac{\varepsilon_{t-i}}{h_{t-i}}\right] + \sum_{i=1}^{q}\alpha_i^{*}\left[\frac{|\varepsilon_{t-i}|}{h_{t-i}} - \mu\right] + \sum_{i=1}^{p}\phi_i \log(h^2_{t-i}) \qquad (3)$$

where, as before, h^2_t represents the conditional variance associated with equation (1), ε_t is a serially uncorrelated disturbance term, ϖ, α_i, α^*_i, ϕ_i, are constant parameters, and $\mu = E\left[\left|\frac{\varepsilon_t}{h_t}\right|\right]$ depends on the density function assumed for the standardized disturbances.

The logarithmic specification of the Egarch(p,q) model ensures that the estimated conditional variance is strictly positive, while the persistence of shocks is now given by $\sum_i \phi_i$[6]. The α_i parameters capture potential asymmetric effects on the conditional variance; thus if $\sum_i \alpha_i$ is negative (as widely documented for stock prices data), positive return shocks generate less volatility than negative return shocks. The α^*_i coefficients, finally, capture the volatility clustering typical of financial data, with large positive values of these parameters indicating that large (small) unexpected changes tend to be followed by further large (small) changes in the return series.

[6] Thus, for this process to be stable, it is required that $\sum_i \phi_i < 1$.

The Exponential Garch-in-Mean specification [Egarch(M)(p,q)] preserves the same functional form described above [eq.(3)], but modifies equation (1) allowing the conditional mean return to be influenced by the conditional variance process:

$$R_t = c + \lambda\, h^2_t + \varepsilon_t \qquad (1)'$$

This specification has close connections with the finance literature, since one important class of asset pricing models predicts an increase in the expected rate of return in response to an increase in the predictable variance of the return (Merton, 1980). In this perspective, the λ parameter in equation (1)' provides a measure of the risk-return tradeoff. This specification is interesting in the present context because, if the above parameter is statistically significant, the (λh^2_t) term may be interpreted as a time-varying risk premium.

Table 4 summarizes our new empirical evidence.

The upper section of this table reports the estimates relative to the standard Egarch(p,q) model, while the results obtained from the Exponential Garch-in-Mean specification are displayed in the lower section. A preliminary investigation selected a maximum of six lags for the influence of the moving average components (α_i and α^*_i parameters), and one single lag for the effect of the past conditional variance on predictable volatility (ϕ_i parameters). Moreover, all the estimates appearing in Table 4 refer to restricted models, since various trials with unrestricted specifications failed to reach convergence. The conditional mean constant (not shown in the table) is always significant and, in line with our previous results, oscillates around 0.002-0.004, reflecting a tendential depreciation of the Japanese currency during the period considered (see Figure 1).

Focusing on the standard Egarch(p,q) model, in all restricted specifications the α_i coefficients are never significantly different from zero. These results corroborate the evidence discussed in section 2.2, pointing out that the symmetry on the conditional variance structure implied by the Garch (p,q) model is consistent with data.

The α^*_i coefficients are always significant and oscillate between 0.11 and 0.13 across alternative lag specifications. This supports a significant degree of volatility clustering, although the intensity of this effect appears relatively lower than that documented for other exchange rates (see, e.g. Maneschiöld, 2004; McMillan and Speight, 2001).

The degree of persistence of shocks to the conditional variance is again very high, with estimates of the ϕ_1 coefficient never significantly different from one. This replicates our previous evidence and, as discussed before, calls for a supplementary empirical investigation.

TABLE 4 - *Egarch(p,q) and Egarch(M)(p,q) Models*
Yen/Euro Exchange Rate; Weekly Data (01-01-1999/01-06-2007)

Model	λ	α_3	α_4	α_5	α_6	α^*_3	α^*_4	α^*_5	α^*_6	ϕ_1	AIC	SBC
Egarch (1,3) (R)	-	0.017 (0.48)	-	-	-	0.128 (2.73)	-	-	-	0.996 (122.2)	1241.3	1231.1
Egarch (1,4) (R)	-	-	0.011 (0.34)	-	-	-	0.121 (2.79)	-	-	0.996 (127.6)	1237.8	1227.6
Egarch (1,5) (R)	-	-	-	-0.006 (-0.21)	-	-	-	0.109 (2.70)	-	0.994 (127.8)	1238.1	1227.9
Egarch (1,6) (R)	-	-	-	-	0.96E-3 (0.03)	-	-	-	0.107 (2.87)	0.994 (131.0)	1234.1	1223.9
Egarch (M)(1,3)(R)	-10.7 (-1.43)	0.015 (0.46)	-	-	-	0.127 (2.78)				0.993 (129.3)	1242.5	1230.2
Egarch (M)(1,4)(R)	-11.6 (-2.20)	-	0.011 (0.38)	-	-	-	0.126 (2.97)	-	-	0.993 (111.3)	1239.2	1226.9
Egarch (M)(1,5)(R)	-10.3 (-1.74)	-	-	-0.001 (0.05)	-	-	-	0.114 (3.04)	-	0.994 (174.3)	1239.0	1226.8

The coefficients reported in this table refer to equations (1)' and (3) defined in section 2.3. t-statistics are in parentheses below parameters estimates. The estimated constant terms, both in the conditional mean equation (c) and in the conditional variance equation (ϖ), are omitted in order to save space. The (R) heading means that, in the corresponding model, the lag structure for α_i and α^*_i coefficients has been restricted to the highest lag in order to obtain convergence in the numerical optimization algorithm. In the last two columns, AIC indicates the value of the Akaike Information Criterion, while SBC refers to the value of the Schwarz Bayesian Criterion.

Turning to the Exponential Garch-in-Mean model, the most relevant result is that we do not find any significant influence of the predictable variance on the expected rate of return of the Yen/Euro exchange rate. As shown in the first column of Table 4, the λ coefficient is wrongly signed and not statistically significant in all Egarch(M)(p,q) specifications. This evidence strongly rejects the existence of a significant risk premium component affecting the evolution of the Yen/Euro exchange rate during the period examined. The other parameters estimates, finally, do not display any relevant change with respect to the standard specification.

On the whole, these empirical findings imply that the standard Garch(p,q) model provides an adequate description of the stochastic process driving Yen/Euro volatility[7]. A latter important result is that the Egarch(M)(p,q) specification allows to exclude the existence of significant departures from the UIP arbitrage equilibrium condition on the Yen/Euro foreign exchange market.

2.4 Further Evidence on the Degree of Volatility Persistence

According to previous estimates, the conditional volatility process driving the Yen/Euro exchange rate would seem to conform to the limiting integrated Garch (IGarch) case. Although our empirical evidence is apparently consistent with an IGarch process, this result needs to be interpreted with great caution, since many recent contributions dealing with foreign exchange markets have documented how spurious IGarch effects may arise as a consequence of unaccounted structural breaks in the conditional volatility process.

Using daily returns for the DM/U$ and Yen/U$ exchange rates, Morana (2002) shows how IGarch effects can arise as an artifact of an unaccounted structural change, when the data generating process is characterized by a time varying conditional variance with switching heteroscedasticity. In a similar vein, the Monte Carlo simulations performed in Caporale *et al.* (2003) show how the presence of structural breaks can result in spuriously high estimates of the degree of persistence of shocks to the conditional variance.

[7] A further indication in this direction is provided by the values of the Akaike and Schwarz Information Criteria, which turn out to be systematically lower than those recorded in Table 2 for Garch(p,q) models with identical lag structures.

These results must be seriously taken into account in the context of the present paper. As underlined in section 2.1, the Yen/Euro return series exhibits a substantial instability during the two initial years of our sample period (1999-2000), most likely as a consequence of the higher uncertainty characterizing the beginning of the new monetary regime. The IGarch evidence documented in sections 2.2-2.3 might therefore result from an unaccounted structural break in the stochastic process driving conditional volatility. In other words, in close similarity with the IGarch evidence discussed in Morana (2002) and Caporale *et al.* (2003), the estimated degree of persistence might actually suffer from an upward bias generated by a switch in the conditional volatility from a turbulent initial phase (1999-2000) to a more tranquil period in subsequent years[8].

The present section addresses the above topic re-estimating the set of Garch(p,q) models selected in section 2.2 on a restricted sample which excludes the two initial years of the European Monetary Union. Our exclusive focus on Garch(p,q) models is motivated by the fact that, as shown before, this specification provides the best description of the stochastic process driving Yen/Euro volatility.

Table 5 summarizes our new results, focusing on a sample extending from 05/01/2001 to 01/06/2007.

The constant term in the conditional mean equation is basically unaffected whereas, differently from our previous results, the moving average components in the conditional variance equation (α_i parameters) are now always insignificantly different from zero. The influence of the lagged conditional variance (β_1 parameter) remains statistically significant across alternative lag structures, but its quantitative impact appears now lower with respect to the estimates obtained from the full sample.

These new results document a relatively high degree of persistence in the conditional variance, since the estimated sum of α_i and β_i coefficients is always close to 0.97[9]. However, in sharp contrast with the

---

[8] Note that, apart from the interpretation of IGarch effects discussed above, the empirical literature supports the existence of significant changes in the persistence of volatility shocks on major foreign exchange markets. Beine and Laurent (2000), for instance, document a relevant decrease in the long run persistence of volatility shocks on the DM/U$ exchange rate since the Louvre Agreement in February 1987, while emphasizing the role of the EMS as a potential source for similar decreases relative to other currencies.

[9] The half-life of shocks to the conditional variance is given by $-\log(2)/\log(\rho)$,

TABLE 5 - *Garch(p,q) Models Excluding the First Two Years of EMU Yen/Euro Exchange Rate; Weekly Data (05-01-2001- 01-06-2007)*

Model	c	ϖ	α_3	α_4	α_5	β_1	$\Sigma (\alpha_i + \beta_i)$	Wald Test	AIC	SBC
Garch (1,3) (R)	0.0013 (2.00)	0.382E-5 (0.29)	0.049 (1.01)	-	-	0.923 (19.7)	0.972	19.80 [0.000]	991.3	985.6
Garch (1,4) (R)	0.0013 (2.10)	0.395E-5 (0.19)	-	0.061 (0.635)	-	0.910 (10.0)	0.971	10.19 [0.001]	988.8	983.0
Garch (1,5) (R)	0.0014 (2.25)	0.436E-5 (0.50)	-	-	0.076 (1.44)	0.894 (18.2)	0.970	9.84 [0.002]	985.6	979.8

See Table 2 for the definitions of alternative Garch(p,q) models. The column labelled 'Wald Test' reports the Wald statistics testing the restriction $\alpha_i + \beta_1 = 1$ in the corresponding Garch(p,q) models. This statistics is distributed χ^2 (1). Marginal significance levels are in square brackets beside the value of the Wald test.

empirical evidence of section 2.2, this value is now significantly lower than one, implying that the effects of current shocks on predictable volatility are gradually absorbed over time. The existence of a limiting IGarch (p,q) process in the Yen/Euro conditional volatility is actually strongly rejected by data, since a Wald test consistently rejects the restriction that $\Sigma\ (\alpha_i + \beta_i) = 1$ in all alternative specifications at very high significance levels (see Table 5, eighth column).

Overall, the evidence obtained in the present section is therefore fully consistent with that put forward in Morana (2002) and Caporale *et al.* (2003). In line with this empirical literature, we have documented how the existence of a structural break in the stochastic process driving Yen/Euro volatility may actually generate an upward bias in the estimated degree of persistence of shocks to the conditional variance.

The exclusion of an unstable process for the Yen/Euro conditional variance has far-reaching policy implications which will be discussed in more detail in the next section.

3. Overall evaluation of empirical findings and policy implications

The empirical evidence achieved in the preceding sections may be summarized as follows:

1. The standard Garch(p,q) models provide an adequate description of the Yen/Euro conditional volatility process. Although the degree of persistence in conditional volatility is relatively high, the existence of an explosive process can be safely ruled out allowing for a structural break occurring after the first two years of the European Monetary Union.
2. Alternative conditional volatility models strongly reject the existence of asymmetric effects on the conditional variance induced by different kinds of shocks. Moreover, when these models are estimated according to a Garch-in-Mean specification, there is no evidence of a significant influence of the predictable variance on conditional mean returns.

---

where ρ indicates the sum of estimated coefficients in the conditional variance equation [$\rho = \Sigma\ (\alpha_i + \beta_i)$]. Therefore, the estimates reported in Table 5 imply that current shocks to the conditional variance are half-absorbed in about 22-23 periods. Since we use weekly data, this corresponds approximately to 5 - 6 months.

The present section provides an overall evaluation of these results, in order to assess whether the ECB 'benign neglect' approach towards foreign exchange market developments was appropriate, or whether the macroeconomic environment would have called for a more systematic reaction to exchange rate dynamics.

In line with the introductory remarks put forward in section 1, the policy implications of our empirical evidence may be properly discussed in the light of two parallel strands of literature. The former concerns the welfare effects associated with nominal exchange rate volatility, while the latter concerns the performance of optimized monetary policy rules in open economies.

3.1 Welfare Effects of Nominal Exchange Rate Volatility

In the literature addressing the welfare effects of nominal exchange rate volatility surveyed in section 1, the contribution of Straub and Tchakarov (2004) is particularly relevant from the perspective of the present analysis.

Straub and Tchakarov (2004) outline a two-country open economy model with imperfect competition and sticky prices. The model is solved by a second-order accurate solution, while utility is computed as a function of consumption and leisure. The most important result is that, assuming habit persistence in the utility function, 'non-fundamental' exchange rate volatility generates significant welfare losses, amounting approximately to 4% in terms of steady-state consumption.

Straub and Tchakarov (2004) provides a useful framework of reference for a twofold order of reasons.

First, the assumption that households act to smooth changes in consumption, which is crucial in generating large welfare losses from nominal exchange rate volatility, represents a structural feature of the Euro area economy. Actually, as pointed out in some recent econometric evidence, aggregate consumption in the Euro area is not purely forward-looking but exhibits a relevant degree of habit persistence[10]. Thus, if our empirical findings would support the

[10] Smet and Wouters (2003) estimate a dynamic stochastic general equilibrium model for the Euro area, using data for seven key macroeconomic variables over the period 1980-1999. According to their results, the habit persistence parameter amounts to 0.573 and is highly significant (see *ibid*., table 1, pp. 1142-1143).

existence of a large component of 'non-fundamental' exchange rate volatility, this would clearly involve a negative verdict against the ECB 'benign neglect' approach towards foreign exchange markets.

A further reason why Straub and Tchakarov (2004) represents an important reference is related to the empirical methodology of this paper, which applies a Garch-Svar approach in order to measure the conditional variance of the exchange rate and to analyze its effect on the conditional mean of other macroeconomic variables. A distinguishing feature of this approach is that the structural identification of exchange rate shocks is performed in the context of a multivariate framework[11]. The Garch estimates obtained by these authors may thus be interpreted as the fraction of volatility that cannot be accounted for by the volatility of other macroeconomic fundamentals included in the Var.

The conditional volatility estimates obtained in the present paper do not allow to pinpoint the component of 'non-fundamental' exchange rate volatility, since our empirical investigation relies on a standard univariate Garch approach which does not incorporate the influence of other macroeconomic variables[12]. However, as the following discussion will reveal, the results achieved in Straub and Tchakarov (2004) represent a useful benchmark of comparison for a comprehensive evaluation of our results.

Consider the plot of the conditional variance obtained from our Garch (1,3) restricted model , reproduced in Figure 3[13].

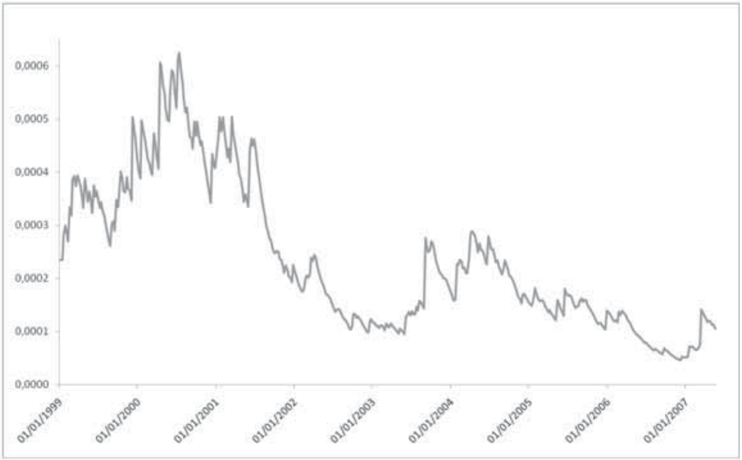
A structural break in the Yen/Euro conditional volatility process is clearly apparent from the above figure, reiterating the validity of the arguments put forward in section 2.4. More specifically, Figure 3 shows a very turbulent initial period, culminating with a peak in conditional volatility at 0.00063 during the second half of 2000. This unstable phase is followed by a period of steadily lower and tendentially declining volatility, reaching an all time low towards the end of the sample.

[11] See Straub and Tchakarov (2004), section 2, for a more detailed and technical presentation about the Garch-Svar model and the related procedure to identify exchange rate shocks.

[12] The short sample period (1999-2007) considered in our analysis precludes the implementation of a Garch-Svar methodology, which would require the use of monthly data for various macroeconomic variables.

[13] We focus on Garch(p,q) models since, as underlined before, they provide the best description of the Yen/Euro conditional volatility process. Alternative lag structures for this class of models generate almost identical patterns in the estimated conditional variance.

FIGURE 3 - *Conditional Variance from Garch (1,3)-[R] Model*



A comparison of the above figure with the empirical evidence obtained in Straub and Tchakarov (2004) is highly revealing. These authors use monthly data for three major bilateral rates against the U$ (DM, British Pound, Canadian Dollar) on a large sample (1974-2002). The plots of these conditional variances document, for all exchange rates, various peaks oscillating on average around 0.0026[14]. There is therefore a large quantitative difference between the peak volatility values reported in Straub and Tchakarov (2004) and those obtained in the present paper: the former are actually more than four times larger than the latter. Note, moreover, that an even greater discrepancy emerges if instead of focusing on peak volatility values we consider the estimates of time-varying volatilities excluding more turbulent periods. The average value obtained in Straub and Tchakarov (2004), for all bilateral rates against the U$, amounts approximately to 0.001 excluding the more unstable periods. The corresponding value obtained in the present paper, excluding the two more turbulent years characterizing the beginning of EMU (1999-

[14] The DM/U$ exchange rate exhibits various volatility peaks around 0.0028 during the first half of the 80's. Analogous values are recorded for the Pound/U$ during the 1992 EMS crisis (0.0032) and for the Canadian Dollar/U$ (0.0020) both during the 80's and in 1998. See Straub and Tchakarov (2004), Figures 1, 4, and 6 for details.

2000), amounts instead only to 0.00015, thus yielding a ratio which is now larger than six between the above estimates.

These huge quantitative discrepancies are even more impressive if the following features are taken into account:

1. The estimates obtained by Straub and Tchakarov (2004) refer exclusively to the 'non-fundamental' component of nominal exchange rate volatility whereas, as underlined above, our approach provides a quantitative assessment about overall conditional volatility;
2. Straub and Tchakarov (2004) use monthly data, which should in principle smooth out the main short-run exchange rate fluctuations, whereas the present paper relies on data sampled at a higher (i.e. weekly) frequency.

Taken as a whole, these considerations imply that the component of 'non-fundamental' volatility in the Yen/Euro exchange rate was at best negligible, if not completely absent, during the first years of the Eurosystem. Although our approach cannot detect the precise dimension of this component, the above conclusion is strongly supported by a comparison of our results with those relative to other major exchange rates, pointing out a huge and persistent gap in conditional volatility estimates.

This conclusion has clear-cut implications when evaluating the monetary policy strategy followed by the ECB since the beginning of the Eurosystem. As underlined above, the Euro area might potentially suffer from relevant welfare losses arising from 'excessive' exchange rate variations, since aggregate consumption in this area is characterized by a substantial backward-looking component. However, since the above discussion excludes a significant component of 'non-fundamental' exchange rate volatility and documents a steady decrease in the Yen/Euro conditional variance, we can safely rule out the existence of relevant welfare losses arising from the above channel. The analysis carried out in the present section provides therefore full support to the 'benign neglect' attitude towards foreign exchange market developments expressed by the ECB in recent years.

3.2 Optimal Monetary Rules for Open Economies

We now evaluate some results obtained in this paper in the light of the literature on optimal monetary policy rules for open economies. The conclusions reached so far in this literature are highly controversial: while some authors document marginal welfare improvements from policy rules systematically reacting to exchange rate movements, others establish a stronger case for the adoption of such rules. Two recent contributions in this literature, namely Wollmershäuser (2006) and Levieuge (2006), are particularly relevant from the perspective of our empirical investigation.

Wollmershäuser (2006) analyses the macroeconomic consequences of a high degree of exchange rate uncertainty. After calibrating a New-Keynesian open-economy model, the performance of alternative monetary rules is compared in a context where UIP does not hold, either as a consequence of persistent movements in the exchange rate risk premium or because agents expectations are not fully rational. Differently from other contributions, the main conclusion is that exchange rate-based rules outperform simpler policy rules.

The case for a monetary policy incorporating a systematic feedback to exchange rate movements, advocated in the above paper, hinges crucially on the existence of significant departures from the UIP condition which introduce a substantial uncertainty from international financial markets. Under such circumstances, the exchange rate appears as an own source of shocks, and exchange rate dynamics is subject to high instability since it is no more fully determined by the policy instrument controlled by the Central Bank.

Although the above scenario is theoretically appealing, and may lead to policy prescriptions departing from standard Taylor rules, the empirical evidence achieved in the present paper is clearly at odds with such an unstable environment.

As underlined in the previous section, the component of 'non-fundamental' exchange rate volatility was at best negligible, if not completely absent, during the first years of the Eurosystem. Thus, differently from Wollmershäuser (2006) theoretical model, we can exclude the occurrence of large structural shocks originating from the foreign exchange market.

A further strong support against the existence of a high degree of exchange rate uncertainty comes from the estimates of alternative conditional volatility models performed in section 2.3. As documented in this section, alternative Garch-in-mean specifications were consistently rejected by data, since we did not find any significant influence of the predictable variance on conditional mean returns. These results exclude the existence of a significant time-varying risk premium component on the Yen/Euro foreign exchange market, thus ruling out the occurrence of large and persistent deviations from the UIP condition.

On the whole, this empirical evidence stands in sharp contrast with the main assumptions underlying Wollmershäuser (2006) theoretical model. The main message conveyed by the above discussion is therefore that, according to our empirical findings, a monetary policy rule incorporating an explicit reaction to exchange rate dynamics would have not generated significant welfare gains during the first years of the Eurosystem.

A further interesting benchmark of comparison is provided by the simulations of alternative monetary rules performed in Levieuge (2006). This paper compares the welfare effects of a simple Taylor rule and alternative rules reacting in various ways to exchange rate dynamics. This contribution is relevant in our perspective because the underlying macroeconomic model incorporates both inertial and forward-looking components, and parameters are calibrated in order to reproduce the main structural features of the Euro area. The main result is that, although optimized monetary policy rules reacting to exchange rate movements yield a better macroeconomic performance, this result is not robust to uncertainty about the equilibrium value of the exchange rate.

Since the basic point raised in Levieuge (2006) is related to the long run equilibrium value of the nominal exchange rate (and not to the uncertainty associated with exchange rate volatility), a critical assessment of our empirical findings may simply rely, in this case, on a visual inspection of Figure 1. As shown in this figure, the Euro underwent a sharp depreciation during the first two years of the European Monetary Union, while the rest of the period displays a steady weakness of the Japanese currency. Overall, the pattern of this nominal exchange rate is highly erratic and, most importantly, does not exhibit any significant mean reverting tendency towards some long run equilibrium value. Given this very unstable scenario, it is hard to maintain that the ECB could conjecture an exact equilibrium value for the Yen/Euro exchange rate. The case study addressed in the present paper conforms therefore to a situation of major uncertainty which, in line with Levieuge (2006), establishes a strong case for the adoption of simple Taylor rules.

To sum up, the critical assessment of our results in the light of the recent literature on optimal monetary rules confirms the main policy implication achieved in the previous section, providing further support to the validity of the monetary strategy implemented by the ECB since the official launch of the Euro in 1999.

4. Concluding remarks

Recent research in the field of dynamic stochastic general equilibrium models has pointed out that 'non-fundamental' exchange rate volatility can give rise to significant welfare losses. Moreover, although the adoption of simple Taylor rules in open economies seems to perform relatively well, some authors have outlined circumstances under which monetary policy rules systematically reacting to exchange rate dynamics yield better welfare results.

Motivated by the above developments in the literature, this paper provides a first assessment about the monetary policy followed by the ECB since the inception of the European Monetary Union. The ECB policy strategy corresponds to a flexible inflation targeting regime, where monetary authorities are entirely focused on the pursuit of domestic goals. The core issue addressed in this paper is whether this 'benign neglect' approach towards foreign exchange market developments was appropriate, or whether the macroeconomic environment would have called for a systematic reaction to the dynamics of the Euro exchange rate.

Our empirical investigation extends the analysis performed in Tronzano (2008) (which examines the U$/Euro exchange rate), to another bilateral rate highly relevant in a policy-making perspective, namely the Yen/Euro exchange rate. We apply a wide range of conditional volatility models to a sample of weekly data ranging from 1999 to 2007.

The main results may be summarized as follows. Arch(q) models suffer from mis-specification problems, whereas standard Garch(p,q) models provide an adequate description of the Yen/Euro conditional volatility process. This latter class of models passes all conventional diagnostic tests, and allows to exclude the existence of potential asymmetries in the conditional variance equation. Alternative conditional volatility models provide further support to the above findings, while a Garch-in-mean specification does not reveal any significant influence of the predictable variance on conditional mean returns. Finally, although the degree of persistence in conditional volatility is relatively high, the existence of an explosive process can be safely ruled out, allowing for one structural break occurring after the first two years of the European Monetary Union.

A critical evaluation of this empirical evidence on the basis of the two strands of literature outlined above provides clear-cut policy implications which, in close similarity with Tronzano (2008), emphasize the validity of the strategy followed by the ECB since the beginning of the Eurosystem.

Focusing on the literature addressing the welfare effects of nominal exchange rate volatility, we document very large discrepancies between our conditional volatility estimates and those obtained for other major bilateral rates. More specifically, our estimates are about four times lower than those reported in the above literature if we consider peak volatility values, and about six times lower if a similar comparison is done excluding all more turbulent periods. This implies that the component of 'non-fundamental' volatility in the Yen/Euro exchange rate was at best negligible, if not completely absent, during the period considered, thus providing full support to the 'benign neglect' attitude towards foreign exchange market developments expressed by the ECB in recent years.

This policy implication receives further strong support when our results are evaluated from the perspective of the current debate on optimal monetary policy rules in open economies. One relevant point raised in this strand of literature is that, in a very unstable environment where UIP does not hold, monetary policy rules systematically reacting to exchange rate movements outperform simpler Taylor rules. Another relevant point is that the superiority of exchange rate based monetary rules hinges crucially on the absence of uncertainty about the equilibrium value of the nominal exchange rate.

Although these critical remarks are intuitively appealing, both of them are irrelevant in the light of the empirical findings documented in the present paper. As regards the former point, we observe that all Garch-in-mean models consistently rejected the existence of a time-varying risk premium on the Yen/Euro foreign exchange market, thus excluding the occurrence of large and persistent departures from the UIP arbitrage condition. As regards the latter point, a simple visual inspection of nominal exchange rate dynamics reveals a highly erratic pattern with no mean-reverting tendency, thus suggesting that it would have been quite difficult to conjecture an exact long run equilibrium value for the Yen/Euro rate.

To sum up, our empirical findings underline the importance of including the exchange rate as a relevant variable in the policy-maker's information set, but exclude substantial welfare gains from a policy rule incorporating a systematic reaction to exchange rate dynamics. Thus, in line with the main conclusion achieved in Tronzano (2008), this paper provides a favourable evaluation about the monetary policy of the ECB, which only occasionally intervened to stabilize foreign exchange markets while systematically reacting to inflation and output developments in the Euro area.

Although our empirical findings are quite robust, as they corroborate previous evidence focusing on another relevant Euro bilateral rate, the topics addressed in the present paper could benefit from some extensions of the analysis in a multivariate setting.

We envisage, at this purpose, two main directions of research. The former involves the implementation of a Garch-Svar approach, along the lines of Straub and Tchakarov (2004), which would allow to better pinpoint the 'non-fundamental' volatility components in a system including various bilateral cross rates against the Euro. A latter promising line of research is represented by a generalization of the Dynamic Conditional Correlation (DCC) model of Engle (2002) in a multivariate Garch framework. A DCC-Garch approach would yield additional relevant insights into the volatility spillovers and the patterns of conditional correlations on the Euro currency markets, thus further sharpening our assessment about the monetary policy strategy followed by the ECB.

MARCO TRONZANO

Università degli Studi di Genova, Dipartimento di Economia e Metodi Quantitativi, Genova, Italia

REFERENCES

Baillie, R.T. and T. Bollerslev (1989), "The Message in Daily Exchange Rates: A Conditional-Variance Tale", *Journal of Business and Economic Statistics*, 7(3), 60-68.

Ball, L. (1999), *Policy Rules for Open Economies*, in: J.B. Taylor (Ed.), "Monetary Policy Rules", University of Chicago Press: Chicago.

Batini, N., R. Harrison and S.P. Millard (2003), "Monetary Policy Rules for an Open Economy", *Journal of Economic Dynamics and Control*, 27(11-12), 2059-2094.

Beine, M. and S. Laurent (2000), "La persistance des chocs de volatilité sur le marché des changes s'est-elle modifiée depuis le début des années 1980?", *Revue Économique*, 51(3), 703-711.

Benigno, G. and P. Benigno (2001), "Monetary Policy Rules and the Exchange Rate", CEPR Discussion Paper No. 2807.

Bergin, P.R. and I. Tchakarov (2003), "Does Exchange Rate Risk Matter for Welfare?", NBER Working Paper No. 9900.

Bergin, P.R., H. Shin and I. Tchakarov (2007), "Does Exchange Rate Variability Matter for Welfare? A Quantitative Investigation of Stabilization Policies", *European Economic Review*, 51(4), 1041-1058.

Bollerslev, T. (1986), "Generalized Autoregressive Conditional Heteroscedasticity", *Journal of Econometrics*, 31(3), 307-327.

Bordo, M.D. and O. Jeanne (2002), "Monetary Policy and Asset Prices: Does 'Benign Neglect' Make Sense?", *International Finance*, 5(2), 139-164.

Breedon, F. and M. Hume (2007), "Does the European Central Bank Have a Credibility Problem?", *Economics Letters*, 95(3), 438-442.

Caporale, G.M., N. Pittis and N. Spagnolo (2003), "IGARCH Models and Structural Breaks", *Applied Economics Letters*, 10(12), 765-768.

Cecchetti, S.B., H. Genberg, J. Lipsky and S. Wadhwami (2000), Asset Prices and Central Bank Policy, International Centre for Monetary and Banking Studies: London.

Chada, J.S., L. Sarno and G. Valente (2004), "Monetary Policy Rules, Asset Prices, and Exchange Rates", *IMF Staff Papers*, 51(3), 529-552.

Clarida, R., J. Galí, and M. Gertler (1998), "Monetary Policy Rules in Practice: Some International Evidence", *European Economic Review*, 42(6), 1033-1067.

European Central Bank (1999), "The Stability-Oriented Monetary Policy of the Eurosystem", *Monthly Bulletin*, January, 39-50.

Engle, R.F. (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of U.K. Inflation", *Econometrica*, 50(4), 987-1008.

Engle, R. (2002), "Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroscedasticity Models", *Journal of Business & Economic Statistics*, 20(3), 339-350.

Engle, R. and V. Ng (1993), "Measuring and Testing the Impact of News on Volatility", *Journal of Finance*, 48(5), 1749-1778.

Gerlach, S. and F. Smets (2000), "MCIs and Monetary Policy", *European Economic Review*, 44(9), 1677-1700.

Goldberg, L.S. and M.W. Klein (2005), "Establishing Credibility: Evolving Perceptions of the European Central Bank", NBER Working Paper No. 11792.

Hamilton, J.D. (1994), "Time Series Analysis", Princeton University Press: Princeton.

Hsieh, D.A. (1988), "The Statistical Properties of Daily Foreign Exchange Rates: 1974-1983", *Journal of International Economics*, 24(1-2), 129-145.

Jarque, C.M. and A.K. Bera (1980), "Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals" *Economics Letters*, 6(3), 255-259.

Leitemo, K. and U. Söderström (2005), "Simple Monetary Policy Rules and Exchange Rate Uncertainty", *Journal of International Money and Finance*, 24(3), 481-507.

Levieuge, G. (2006), "Règle de Taylor *vs* Règle-ICM – Application à la Zone Euro", *Revue Économique*, 57(1), 85-121.

Lubik, T.A. and F. Schorfheide (2007), "Do Central Banks Respond to Exchange Rate Movements? A Structural Investigation", *Journal of Monetary Economics*, 54(4), 1069-1087.

Maneschiöld, P.O. (2004), "Modelling Exchange Rate Volatility: Evidence from Sweden", *Economia Internazionale/International Economics*, 57(2), 145-172.

McMillan, D.G. and A.E. Speight (2001), "Nonlinearities in the Black Market Zloty-Dollar Exchange Rate: Some Further Evidence", *Applied Financial Economics*, 11(2), 209-220.

Merton, R.C. (1980), "On Estimating the Expected Return on a Market: An Exploratory Investigation", *Journal of Financial Economics*, 8(4), 323-361.

Morana, C. (2002), "IGARCH Effects: An Interpretation", *Applied Economics Letters*, 9(11), 745-748.

Nelson, D.B. (1991), "Conditional Heteroscedasticity in Asset Returns: A New Approach", *Econometrica*, 59(2), 347-370.

Smets, F. and R. Wouters (2003), "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area", *Journal of the European Economic Association*, 1(5), 1123-1175.

Straub, R. and I. Tchakarov (2004), "Non-Fundamental Exchange Rate Volatility and Welfare", ECB Working Paper No. 328.

Taylor, J.B. (2001), "The Role of the Exchange Rate in Monetary Policy Rules", *American Economic Review*, 91(2), 263-267.

Tronzano, M. (2008), "The Volatility of the Euro/Dollar Exchange Rate: Empirical Evidence and Policy Implications", *Economia Internazionale/ International Economics*, 61(2-3), 569-596.

Wollmershäuser, T. (2006), "Should Central Banks React to Exchange Rate Movements? An Analysis of the Robustness of Simple Policy Rules under Exchange Rate Uncertainty", *Journal of Macroeconomics*, 28(3), 493-519.

ABSTRACT

This paper assesses the validity of the ECB 'benign neglect' approach towards foreign exchange markets. I extend the analysis performed in Tronzano (2008) on the U$/Euro rate, applying a wide range of conditional volatility models to Yen/Euro data from 1999 to 2007. An overall evaluation of results, in the light of the literature on the welfare effects of nominal exchange rate volatility and optimal rules for open economies, reveals that the ECB inward-oriented approach was fully appropriate. In line with Tronzano (2008), this paper excludes therefore substantial welfare gains from a policy incorporating a systematic reaction to exchange rate dynamics.

Keywords: Exchange Rate Volatility, Garch Models, Monetary Policy Rules, ECB, Yen/Euro Exchange Rate

JEL Classification: E52, F31

RIASSUNTO

La volatilità dell'euro sui mercati valutari: ulteriori evidenze empiriche ed implicazioni di politica economica

L'articolo discute la validitá dell'approccio di *benign neglect* della BCE nei confronti del mercato valutario. A tal fine, l'analisi condotta in Tronzano (2008) sul cambio Dollaro/Euro viene estesa al cambio Yen/Euro applicando diversi modelli di volatilità condizionale per il periodo 1999-2007. Una valutazione complessiva dei risultati, alla luce della letteratura sugli effetti di *welfare* della volatilità del cambio nominale e sulle regole di politica monetaria per un'economia aperta, conferma la validità dell'approccio adottato dalla BCE. In linea con le conclusioni ottenute in Tronzano (2008), questo lavoro esclude quindi l'esistenza di significativi guadagni in termini di benessere derivanti da una politica monetaria che incorpori una reazione sistematica alle variazioni del tasso di cambio.