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Sources of Euro Real Exchange Rate Fluctuations: What Is Behind the Euro Weakness in 1999-2000?

by

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Abstract

This paper analyzes the factors underlying the weakness of the euro. For this purpose, the framework advocated by Clarida and Gali (1994) is used. Within this model, three structural shocks drive the dynamics of the endogenous variables: aggregate supply shocks, aggregate spending shocks, and monetary shocks. Applying a structural VAR to data for the Euro-zone and the U.S. suggests that supply shocks are the most important factor explaining real exchange rate fluctuations in the sample from 1980 to 2000. However, historical decompositions reveal that fluctuations since the introduction of the euro in 1999 have been predominantly driven by demand shocks.

JEL classification: C32, F31, F41

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1. Introduction

Following its introduction, the euro has depreciated significantly against the U.S. dollar. To account for this development, competing explanations have been offered in public discourse as well as in the scientific community. One line of reasoning argues that supply conditions in Europe have been less favorable than in the U.S. Indeed, some commentators identify relatively unfavorable supply conditions in the Euro-zone compared to the U.S. as the main source of the depreciation of the European currency since its introduction in 1999 (Siebert 2000). In contrast, some authors blame a relative shortcoming of demand within the Euro-zone for the depreciation of the euro (Cohen and Loisel 2001). Yet another school of thought argues that diverging courses of monetary policy in Europe relative to the U.S. are responsible for the strong appreciation of the dollar against the euro (Spahn 2000).

This paper analyzes the recent development of the real euro/U.S.-Dollar exchange rate in terms of the open economy macroeconomic framework advocated by Clarida and Gali (1994).[1] This framework has been recently used also by Astley and Garratt (2000) for the analysis of Sterling real exchange rate fluctuations.[2] In this model, the real exchange rate of the euro is driven by aggregate supply shocks, aggregate spending shocks, and monetary shocks. To identify the relative importance of these structural shocks, the structural vector autoregressive (SVAR) technique pioneered by Blanchard

[1] It should be pointed out that our aim is to understand the sources of euro real exchange rate fluctuations and not to forecast this time series. For attempts to forecast the euro exchange rate see Meier (1999) and van Aarle et. al. (2000).

[2] Another application includes Funke (2000), who employs this framework to identify macroeconomic shocks in the Euro-zone relative to the United Kingdom.

and Quah (1989) is applied. For this purpose, aggregated quarterly data covering the time period from 1980 I to 2000 III are employed.[3]

We find that supply side shocks are the most important factor behind the dynamics of the real exchange rate for the whole sample period under investigation. Yet, historical decompositions reveal that the sharp depreciation of the euro vis-à-vis the U.S. dollar since the beginning of 1999 has been predominantly driven by demand shocks.

The paper is organized as follows; Section 2 gives a brief overview of the theoretical model. The empirical techniques are introduced in section 3. The fourth section discusses the empirical results. The last section offers conclusions for further research and economic policy.

2. Shocks and Exchange Rate Movements

An adequate set-up to understand the recent fluctuations of the euro/U.S. dollar exchange rate is the open economy model outlined by Clarida and Gali (1994)[4]. This model is a stochastic two-country version of the classic Dornbusch (1976) framework and captures the dynamics of output, prices, and the real exchange rate. While price rigidities characterize the short-run, in the long-run neutrality of money is presumed. The time series utilized in the model are Euro-zone data relative to the corresponding

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[3] This implies the use of an artificial time series for the Euro before 1999. In this paper, we refer to the paper by Clostermann and Schnatz (2000) and thank the authors for providing us with their data. As regards the other data used in the empirical analyses we refer to the data set provided by Coenen and Vega (1999) up to 1990. We thank these authors for providing us with their data. For the time period beginning in 1991 we use the official EUROSTAT data. The data are corrected for German unification.

[4] The presentation in this section draws also on Lane (2001), Astley and Garratt (2000) and Funke (2000).

US levels[5]. For example, real GDP is defined as $y_t \equiv y_t^{Euro\text{-}zone} - y_t^{US}$. The first equation of the framework is an IS equation:

$$y_t^d = \eta q_t - \sigma\left[i_t - E_t\left(p_{t+1} - p_t\right)\right] + d_t \quad (1)$$

In equation (1), y_t^d represents relative aggregate demand, d_t is a stochastic relative demand shock, and i_t is the difference between Euro-zone and U.S. nominal interest rates. The variable p_t denotes the relative price of output. The exchange rate is defined as the number of units of domestic currency required to purchase a unit of foreign currency, hence the real exchange is given by q_t = (euro/U.S.-dollar$_t$ - p_t) = (euro/U.S.-dollar$_t$ - $p_t^{Euro\text{-}zone}$ + p_t^{US}). An upward movement of the real exchange rate corresponds accordingly to a real depreciation of the euro. The term $E_t(p_{t+1} - p_t)$ is the relative inflation rate expected in period t for the next period. Greek letters denote the corresponding elasticities. The IS function given by equation (1) therefore states that the relative output in the Euro-area rises if the real exchange rate depreciates. The same holds also for a positive demand shock buffeting the euro area economy relative to the U.S. In contrast, relative output decreases if the real interest rate differential rises.

The second equation of the model is a LM equation, which describes the equilibrium in the money market. As can be seen from expression (2), real money demand is a positive function of relative output and is negatively related to the interest rate differential i_t.

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[5] All variables except interest rates are expressed in logarithms.

$$m_t^s - p_t = y_t - \lambda\, i_t \qquad (2)$$

The third equation of the model states that the condition of the uncovered interest parity holds:

$$i_t = E(s_{t+1} - s_t) \qquad (3)$$

where $E(s_{t+1} - s_t)$ denotes the expected change of the nominal exchange rate.

The fourth equation of the theoretical set-up models the relative price level for goods as a weighted average of the expected market-clearing price expected in *t-1* to prevail in *t*, which is denoted as $E_{t-1}p_t^*$, and the price that would actually clear the goods market in period *t*, p_t^*.

$$p_t = (1 - \Theta)E_{t-1}p_t^* + \Theta p_t^* \qquad (4)$$

The parameter Θ determines the degree of price flexibility; with $\Theta = 1$, prices are fully flexible, while with $\Theta = 0$ prices are predetermined for one period.

Clarida and Gali (1994) specify three stochastic random walk processes for the exogenous variables in the model. This assumption introduces three structural shocks: i) a relative supply shock (ε_s), ii) a relative non-monetary demand shock such as a change in government spending or in the propensity to consume (d_t), and, iii) a relative monetary shock (ε_m) capturing diverging courses of monetary policy as well as shocks to relative national demands for real money balances. Hence the following equations supplement the model:

$$y_t^s \quad = \quad y_{t-1}^s \quad + \quad \varepsilon_{s,t} \tag{5}$$

$$d_t \quad = \quad d_{t-1} \quad + \quad \delta_t \quad + \quad \gamma\delta_{t-1} \tag{6}$$

$$m_t \quad = \quad m_{t-1} \quad + \quad \varepsilon_{n,t} \tag{7}$$

The demand shock allows for a permanent and a transitory component. In case of the latter it is assumed that a fraction γ of a shock to relative demand in period *t* is reversed in *t+1*. It is furthermore assumed that the structural shocks ε_{st}, δ_t, ε_{nt} are orthogonal and independently distributed with zero mean.

With this set of equations at hand, Clarida and Gali (1994) consider two types of equilibria. First, they discuss the properties of a long-run rational expectations and flexible-price equilibrium. In the context of the equations outlined above this setting obtains if $\theta = 1$. Under this assumption, the authors derive a set of equations from the first-order conditions relating the equilibrium values of relative output, the relative price level, and the real exchange rate to the underlying structural shocks.[6] The results can be summarized in the following set of equations, where the upper case letter *e* denotes equilibrium values:

$$y_t^e \quad = \quad y_t^s \tag{8}$$

$$q_t^e = \frac{y_t^s - d_t}{\eta} + \frac{\sigma\gamma\delta_t}{\eta(\eta + \sigma)} \tag{9}$$

$$p_t^e = m_t - y_t^s + \frac{\lambda\gamma\delta_t}{(1+\lambda)(\eta + \sigma)} \tag{10}$$

A positive supply shock ε_s increases output in the long run, the real exchange depreciates and the price level is lowered. It is noteworthy that the supply shock is the only shock that has a permanent effect on the level of output. If the supply of domestic goods rises relative to domestic demand, this excess supply induces domestic producers to cut the price of their goods in order to increase demand for their exports. Hence, the domestic supply shock leads to a real depreciation. The reduction of the relative price level follows from the same line of reasoning since the producers will also reduce their domestic price. The demand shock d_t, in contrast, has no long-run effect on output since full price flexibility ensures that neutrality holds with respect to real activity. But the demand shock leads to a real appreciation; thereby conforming, for instance, with the intuition of Mundell/Fleming (Mundell 1962) models where, in conjunction with a flexible exchange rate regime and perfect capital mobility, the output effect of e.g. an expansionary shift in fiscal policy is eventually crowded out by a real appreciation of the domestic currency. However, the second term in (9)

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[6] For a formal derivation of these results see Clarida and Gali (1994), p. 25.

indicates that in the case in which the shock is partially reversed in the future ($g > 0$), the appreciation is dampened by the expectation of a real depreciation required by the future partial reversal of the shock. Regarding the price effects, the transitory component of the demand shock leads to a permanent increase of the relative price level, while the permanent component has no long-run effect on this variable. In the latter case the real appreciation of the domestic currency dampens inflation in the home country while inflation rises in the rest of the world due to the depreciation of the foreign currency and increased exports. Finally, the monetary shock has no long-run effects on output and on the real exchange rate but induces an equiproportional change of the relative price level. To summarize, this model has a triangular structure regarding the long-run effects of the shocks. This feature of the framework makes it very suitable for an empirical analysis employing long-run restrictions to recover the structural shocks hitting the economy.

The short-run effects of the shocks can be analyzed by considering the case $0 \leq \Theta \leq 1$, which introduces nominal rigidity into the model. Sluggish price adjustment implies that not only supply but also demand and monetary shocks have real effects. In particular, positive realizations of the two latter shocks tend to raise output in the short-run. Moreover, a positive monetary shock leads to a transitory depreciation of the real exchange rate, which is in line with the well-known Dornbusch (1976) overshooting model. Clarida and Gali (1994) show that if the overshooting condition holds in this model then the exchange rate will undershoot relative to its long-run level in response to supply and demand shocks. Finally, price stickiness implies also that output will reach its new long-run equilibrium in response to a supply shock only gradually. These results will turn out to be useful overidentifying restrictions in order to evaluate the empirical model presented in the remainder of this paper.

3. The empirical methods

To obtain insights into the relative importance of monetary, demand and supply shocks for the development of the euro, a structural vector autoregression (SVAR) is used to decompose the contributions of the underlying structural shocks to the variance of the currency's time series. The first step is to estimate a reduced form vector autoregressive (VAR) model. It contains the change of the relative output series (Δy_t), the change of the real exchange rate (Δq_t), and the inflation rate (Δp_t) as endogenous variables. All series are computed by taking the first–difference of the logarithm of the relative level variables. Let the vector of endogenous variables be defined by $X_t \equiv (\Delta y_t \quad \Delta q_t \quad \Delta p_t)'$. The reduced form representation of this trivariate system is then given as below:

$$X_t = A_0 + \sum_{i=1}^{p} A_i X_{t-i} + e_t \tag{11}$$

where A_0 is a (3×1) vector of constants, A_i are (3×3) matrices of coefficients and e_t represents a (3×1) disturbance vector. The system is consistently and asymptotically efficiently estimated by ordinary least squares. The lag length p of the system is determined by information criteria and additional tests on remaining autocorrelation of the residuals (Lütkepohl 1991).[7] Based on these considerations, 5 lags of the

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7 Detailed results are available from the authors upon request.

endogenous series have been included in the VAR. As regards the deterministic components of the VAR, a constant but no deterministic trend is included.

To investigate the stationarity properties of the time series in the model, we performed augmented Dickey and Fuller (1979) and KPSS (cf. Kwiatowski et. al. 1992) tests. All variables under investigation turned out to be integrated of order one.[8] We also tested for the cointegration rank of the system using the Johansen (1988) technique. At conventional significance levels it was not possible to reject the null hypothesis that there is one cointegration vector in the system, but the system specified in levels displayed strong signs of dynamic instability. Moreover, imposition of the rank restriction yielded theoretically implausible parameter estimates. Therefore, for the empirical analysis presented below, we prefer to use a model in first differences.

After estimating the vector autoregressive system given in equation (11), the next step is taken by transforming the system into its infinite vector moving average representation:[9]

$$X_t = \sum_{i=0}^{\infty} L^i B_i e_t \,, \tag{12}$$

where B_i denotes a (3×3) matrix comprised of the coefficients of the reduced system and L symbolizes the lag operator. For comparison, the moving average

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8 The results of the unit root and the cointegration tests are available from the authors upon request.

9 To simplify the following notation, the constant is suppressed.

representation of the underlying *structural* model, which has been derived in the theoretical section, is given by:

$$X_t = \sum_{i=0}^{\infty} C(L) L^i \varepsilon_t \tag{13}$$

where $C(L)$ are (3×3) matrices of the coefficients $c_{ij}(L)$ and $\varepsilon_t \equiv (\varepsilon_{s,t} \quad \varepsilon_{d,t} \quad \varepsilon_{n,t})'$ represent orthogonal serially uncorrelated structural shocks. The coefficients in C(L) show how the variables in X_t respond in time to the structural shocks hitting the economy. For this reason, these impulse response functions are useful tools to investigate the dynamic properties of the system. Regarding the links between the estimated reduced form system given by (12) and the theoretically motivated model given by (13), comparison of both shows that $e_0 = C(0)\varepsilon_0$ holds.[10] This implies that the impulse response functions *C(L)* are related to the estimated parameter matrices *B(L)* by *C(L)=B(L)C(0).* In other words, once one has identified the nine elements in C(0), it is possible to recover the structural parameters and the structural shocks from the estimated reduced form system. Three of the nine elements in *C(0)* are simply normalizations, another three parameters are determined by the assumption that the structural disturbances are orthogonal and the remaining three restrictions are derived from the theoretical model.

The first two theoretically motivated restrictions assume that monetary shocks can influence neither output nor the real exchange rate in the long run. The third restriction obtains by realizing that the relative demand shock is restricted to have no long-run effect on output. Thus, a triangular system regarding the long-run effects of the shocks in the tradition of Blanchard and Quah (1989) can be used to disentangle aggregate supply, demand and monetary shocks. The long–run neutrality restrictions imposed on the reduced form system can be summarized as follows:

$$\sum_{k=0}^{\infty} c_{12}(k) = 0 \ , \qquad \sum_{k=0}^{\infty} c_{13}(k) = 0 \ , \qquad \sum_{k=0}^{\infty} c_{23}(k) = 0 \tag{14}$$

where c_{ij} represent elements of the matrix *C(L)* introduced above.

To shed more light on the relative importance of the structural shocks for the dynamics of the endogenous variables we employ the historical decomposition technique.[11] The idea of this technique can be described as follows. Assume, that

$$X_t \quad = \quad C_D(L)D \quad + \quad C(L)e_t \tag{15}$$

is the moving average representation of the underlying structural model already described in equation (13). In (15) the matrix D contains the deterministic part of the model, which is here the constant present in all equations. The term $C_D(L)$ represents a polynomial matrix giving the effects of *D* on the variables in X_t. Hence, the dynamics of relative output, the real exchange rate and the relative price level can be expressed as the sum of the deterministic and the stochastic component of the model. The latter is attributed to the three structural shocks driving the model. The historical decomposition focuses on the effects of these shocks. Therefore, the deterministic part

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[10] Notice that $B_0 = I$.

[11] This technique has for example also been employed by King et al. (1991).

of the model, though important for other questions, can be omitted in the following. Then, for a particular period $t+j$ equation (15) can be written as:

$$X_{t+j} = \sum_{s=0}^{j-1} C_s e_{t+j-s} + \sum_{s=j}^{\infty} C_s e_{t+j-s} \tag{16}$$

with C denoting the impulse response to a structural innovation.

It is apparent here that the variable X_{t+j} is composed of two types of terms. The term on the far right contains the information that is available at time t . Based on this information the expected value of X_{t+j} can be computed, which is the so-called 'base projection' of X_{t+j} .[12] However, the base projection is unlikely to coincide with X_{t+j} , because in the time period from $t+1$ to $t+j$ 'new' structural innovations hit the system. By their very nature these shocks are unexpected, hence the first term on the right-hand side gives the forecast error of X_{t+j} . The historical decomposition is based on this part of the system, thereby allowing one to attribute the unexpected variation of X_{t+j} to individual structural innovations buffeting the economy, which is useful for exploring the sources of fluctuations.

The historical decomposition presented below is computed by keeping the forecast horizon given by j fixed while the time index t moves from the beginning of the sample period to the end. A forecast horizon of two years (8 quarters) is chosen, since this horizon corresponds to a typical business cycle frequency. The effective sample period begins in 1981 III. To illustrate the procedure, in a first step t is set to 1981 III and the decomposition for $X_{1981III+8}$ is computed on the basis of the structural innovations hitting the economy between 1981 III and 1983:III. In the next step *t* is set to 1981:IV and the decomposition of $X_{1981IV+8}$ is obtained. This procedure is repeated until X_{t+8} reaches the end of the sample period. The variables in X_t are plotted as a function of each type of structural shock occurring in the time from *t-8* till *t.* The historical decomposition, therefore, shows how at each point in time the economy was influenced by the three types of structural shocks considered here. This allows in particular to distinguish the shocks responsible for recent movements of the euro.

4. Empirical Results

4.1 The Impulse Response Functions

Turning to our empirical results, figure 1 shows the accumulated impulse response functions of the time series under investigation following a one standard deviation shock. The responses cover a time span of 32 quarters. The solid lines represent the respective impulse response function; the dotted lines cover a 5%-95% error band.

Generally, our results are in line with the finding of Clarida and Gali (1994), Astley and Garratt (2000), and Funke (2000). Beginning with the effects of an aggregate supply shock, which are depicted in the first row of figure 1, it is apparent that a positive supply shock increases output permanently. As expected, the price level falls in the aftermath of such a shock. Thus, the long-run effects are in line with the theoretical

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[12] The effects of the deterministic components enter the base projection.

predictions.[13] Surprisingly, however, the response of the euro real exchange rate to a supply shock indicates an appreciation rather than a depreciation as the theoretical model outlined above would predict. Still, this result is in line with several other previous empirical findings. For example, Clarida and Gali (1994) report similar impulse response functions for the supply shock with respect to the U.S.-dollar/Pound Sterling and the U.S.-dollar/DM relationship. Noting that Germany has considerable weight in the euro area aggregate and that the euro/U.S.-dollar exchange rate broadly tracks the movements of the DM/U.S.-dollar exchange rate, it is probably not particularly surprising that we unearth a relationship for the euro area and the U.S. similar to the one found by Clarida and Gali for the United States and Germany. Also, Astley and Garratt (2000), who investigate the sources of Sterling real exchange rate fluctuations, report similar results for response of the Pound Sterling/U.S.-dollar exchange rate to a supply shock. Moreover, these results do not appear unreasonable from a theoretical perspective if one introduces into the analysis a non-tradable sector. In this case the Balassa-Samuelson effect suggests that the domestic currency appreciates in real terms if the supply shock raises productivity in the tradable but not in the non-tradable sector. The 'Dutch Disease' effect also suggests that a supply side shock like the discovery of natural gas reserves is associated with a real appreciation. Since the extension of the theoretical model in this direction would not invalidate the neutrality propositions we used to motivate our long-run identifying restrictions, we believe the empirical model applied here is not falsified by this particular impulse response function. Turning next to the profile of the adjustment process to the long-

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13 Since the SVAR methodology does not pin down the sign of the response to a structural shock, the relative consistency of the impulse response functions matters rather than their sign. For the supply shock this implies that prices have to move in the opposite direction as output, which is the case here. For an extensive discussion of this issue, see Astley and Garratt (2000), p. 502.

run equilibrium, output and prices take about 15 to 20 quarters to adjust, while the adjustment process of the real exchange rate is completed after about 10 quarters. It is also apparent that output and the real exchange rate initially undershoot their long-run level, which is again in line with the theoretical predictions in case of price stickiness.

With respect to a spending or IS shock, the results depicted in figure 1 fulfill the theoretical predictions considered above. The aggregate demand shock stimulates relative output for a period of about two years, consistent with a business cycle interpretation of short run fluctuations. As expected, the euro real exchange rate appreciates and the relative price level rises. The point estimate for the latter variable suggests that it rises permanently, but this effect is not significant. On the other hand it is clear that the real exchange rate appreciates permanently, reaching its new level after about two years. In this context it is noteworthy that the initial undershooting of the exchange rate is consistent with the theoretical predictions. The observation that the real exchange rate appreciates permanently while the long-run effect for the price level is not significant, suggests that the demand shocks are of a permanent nature. An example is a sustained change in the stance of fiscal policy, like the stepped-up military spending during the Reagan administration or the long-lasting increase of fiscal outlays in Germany following unification. Another important episode in Europe in this context was the run-up to the third phase of European Monetary Union, as many countries in Europe went through a phase of fiscal consolidation to meet the Maastricht criteria, which required in many cases a permanent reduction of structural deficits.

Finally, coming to the effects of a monetary shock, the last row in figure 1 shows that these lead to a transitory effect on relative output and the real exchange rate. Both effects last for approximately 10 to 15 quarters, which corresponds to conventional views about the effects of monetary shocks on those aggregates. In line with the theoretical model, in the long run a monetary shock has only an effect on the relative price level. The price response builds up gradually, pointing to substantial nominal rigidity in the short-run. If one computes from the real exchange rate and the price response the path of the nominal euro/U.S.-dollar exchange rate, it is apparent that the nominal rate overshoots its long-run level of depreciation considerably. This is in line with the prediction of the familiar Dornbusch (1976) model.

All in all, we conclude that the empirical estimates appear plausible and generally conform well to the theoretical predictions. Therefore, we can proceed now to discuss the sources of the fluctuations of the US$/euro real exchange rate. For this purpose we turn to the historical decomposition of this variable.

4.2 The Historical Decomposition

The historical decomposition of the euro real exchange rate is plotted in figure 2. A forecast horizon of two years has been used to focus on the role of recent shocks for the movements of the euro rate. The dotted line shows, for a given point in time *t,* the contribution of all three shocks together for the deviation of the real exchange rate from its base projection. The solid line shows the contribution of each individual type of shock to the fluctuations of the real euro exchange rate. It is useful in this context to recall that the base projection is defined as the real exchange rate one would have observed if no shocks had occurred in the preceding two years. Hence, the base projection represents on the one hand the effects of shocks having occurred more than two years ago, on the other hand it encompasses the effects of the deterministic part of the model. Regarding the latter component, the constant in the system models a deterministic trend in the levels of the time series included in the VAR, which implies that the real exchange rate of the euro depreciates each year by approximately 0.80 percent against the U.S.-dollar.

While the discussion of the historical decomposition could proceed in terms of the supply, demand and monetary shocks identified by the model, this would probably not be particularly informative as this tells the story of the euro in a rather abstract way. To provide a more intuitive understanding of the sources of the euro fluctuations, an effort is made to interpret the structural shocks in the light of the economic circumstances and events characterizing the sample period under investigation. For this purpose, figure 3 plots a number of time series we deem useful to illustrate some of the economic forces that the SVAR model may have identified as shocks.[14] This discussion can of course not claim to be exhaustive, but we hope to point to some important factors determining the U.S.-dollar/euro exchange rate.

4.2.1 Real Exchange Rate Fluctuations Due to Aggregate Supply Shocks

Beginning with the role of the aggregate supply shocks, in the first panel of figure 2 it is apparent that these shocks account for most of the variation of the real euro

[14] All time series are obtained from the OECD Economic Outlook, with the exception of the oil and the share price indices, which are from Datastream.

exchange rate in the sample period.[15] In this context it is useful to recall that the empirical model identifies those shocks as supply shocks which in the long run lead to a divergence of relative output levels. In other words, the shocks here have to change the output potential of one country relative to the other. If one models the production potential with the help of a production function, it becomes clear that a change of the potential implies either that more factors of production have become available or that the production process has become more efficient. An example for the former case is a change in labor supply, which for instance could be due to demographic factors. Regarding the efficiency of the economy, technological developments are of course important, but also other factors like the tax system may be significant, as the latter affects incentives to work and to invest.

Coming to the historical decomposition, the discussion will focus on the broad movements of the euro real exchange rate. It is apparent from figure 2 that in the early eighties the euro depreciated, suggesting that supply conditions in the U.S. improved relative to those in the euro area. The effects of the tax reforms implemented by the Reagan administration might have played a role here, which boosted tax incentives for investment projects. In the second half of the eighties, the relative supply conditions improved in Europe, leading to a real appreciation of the euro. This may reflect the moderating influence of persistently high unemployment rates on wage aspirations in Europe, whereas unemployment in the United States began to decline already in the early eighties, reducing the need for sustained wage restraint in the second half of the

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[15] This also holds if one computes forecast error variance decompositions for other horizons than two years. For horizons longer than one year, the supply shocks account for approximately 2/3 of the forecast error variance, while the demand shocks account for the rest. The monetary policy shocks

decade. The diverging paths of unemployment in the two economies are depicted in the first panel of figure 3. Wage moderation is likely to increase the profitability of investment projects and to reduce the structural unemployment rate in the long run, inducing a rise in effective labor supply. Thus, the wage setting process is an important factor for supply conditions and hence for the path of the real exchange rate. In figure 3 the difference between productivity growth and real wage gains serves as a proxy for wage restraint. The second panel in figure 3 plots the difference between the respective wage restraint series for Europe and America. An upward movement of this index indicates a higher degree of wage restraint in the European economies relative to the United States. This measure shows clearly that European trade unions reduced their wage aspirations in the middle of the eighties relative to their U.S. counterparts for a number of years. But as unemployment rates finally began to decline in Europe, the incentives for maintaining modest wage settlements apparently receded, and in the last two years of the decade relative supply conditions deteriorated again, leading to a real depreciation of the euro. Coming to the development of the real exchange rate in the 1990s, the real appreciation of the euro during the course of the year 1990 is clearly attributed to a supply side shock occurring in Europe relative to the United States. It is likely that this reflects an upward jump of the European production potential following unification as the formerly East German labor supply and capital stock was added to the German economy. To illustrate the effect of unification on the European production potential, the third panel in figure 3 plots the difference between the European and American potential growth rates of output as calculated by the OECD;

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only play a role at extremely short horizons, where they account for at most 20 percent of the forecast error variance.

the effect of unification is noticeable.[16] However, the integration of the additional labor supply into the production process proved difficult, as wage aspirations exceeded productivity. This is clearly visible in the second panel of figure 3. Not surprisingly, relative supply conditions in Europe were weak in the following years, inducing a real depreciation of the euro. Strongly rising unemployment rates in the period from 1991 till 1994 induced a return to a policy of wage restraint and relative supply conditions in Europe recovered in 1994 and 1995, bringing about a recovery of the euro. In the second half of the nineties, the strength of the U.S. dollar relative to the euro suggests that the supply side conditions have been more favorable in the USA. This is surprising, because unions in Europe maintained a policy of wage restraint, relative to their U.S. counterparts. Since this period coincides with the so-called 'New Economy' in the United States, it is possible that productivity gains related to the information technology investment boom have dominated the relative supply side conditions, leading to a strong U.S. dollar.

4.2.2 Real Exchange Rate Fluctuations Due to Aggregate Demand Shocks

The role of the relative demand shocks for the euro is depicted in the second panel of figure 2. It is apparent that their role for movements of the real exchange rate is generally much smaller than that of the aggregate supply shocks. In contrast to the former, the demand shocks identified here do not lead to a long-run divergence of relative output levels, since a shock to demand in one country induces eventually offsetting changes in external and internal demand due to exchange rate and price level

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16 As German unification took place officially only in late 1990, the statistics report the jump of the

responses. In general, demand conditions are likely to be affected when the propensity to consume of either the government or of private households changes.[17] The role of fiscal policy in this context has been discussed above already. The consumption decision of private households is probably a function of their income and perceived wealth. While income and wealth are mostly determined on the supply side of the economy, there are also some demand side factors, which are potentially relevant. An exogenous terms-of-trade shock like a transitory rise in oil prices, for instance, redistributes income throughout the world. Due to the transitory nature of the shock it is likely that adjustment costs prevent a supply side response to higher oil prices, so that in the framework employed here the shock is identified as a relative demand shock, reflecting the income effects of the change in the terms of trade.[18] A plot of oil prices is provided in the fourth panel of figure 3. Apparently oil prices have fluctuated during most of the sample period around a constant mean of approximately 20 U.S. dollar per barrel, which suggests that market participants are likely to perceive a substantial part of changes in oil prices as being transitory. The substantial improvement of relative demand conditions in Europe beginning in late 1985, which is visible in the historical decomposition as a marked real appreciation of the euro, may therefore reflect to some extent the sharp drop in world oil prices occurring in the fourth quarter of 1985. Because Europe imports most of its oil, while the United States

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growth rate in 1991 if annual data is used.

[17] An exogenous change in the propensity to invest is likely to act as a supply shock since it changes the production potential of the economy. Nevertheless, this does not imply that, for example, improved demand conditions may not trigger a temporary increase in investment. But as the demand shock subsides investors are likely to realise that their capital stock is larger than warranted under normal demand conditions and subsequently investment activity is going to slow down until the capital stock will reach again its optimal size.

[18] If the shock were permanent, it would be classified as a supply shock, since it affects the production potential of an economy. It is likely that a permanent increase in oil prices would have more impact on the U.S. economy, since it is more energy intensive.

are at the same time a major oil producer, the lower oil price was equivalent to a major income transfer to the European economies, while the corresponding effect for the US economy was smaller. In a similar vein, the drop in oil prices following the Asian crisis during late 1997 and 1998 is likely to have contributed to the slight real appreciation of the euro in 1998, while the strong rebound of oil prices since the summer of 1999 is presumably a factor behind the real depreciation in the last two years.[19]

Another factor influencing demand conditions is the valuation of assets in equity and property markets, since these affect the wealth of households. It is important to distinguish between movements of asset market valuations driven by fundamentals, which have their origin on the supply side of the economy, and those not justified by those. Considering a bubble in the stock market as an example for the latter case, rising prices for equities induce households to overestimate their wealth, which stimulates their consumption demand, but eventually the bubble bursts. Such a bubble qualifies as a demand shock, as it only affects the demand side of the economy.[20] It is interesting that the strong real appreciation of the euro in the middle of the eighties also coincides with a strong performance of the German equity market relative to the U.S. market. This can be seen in the fifth panel of figure 3, which plots the German DAX 30 stock market index against the Standard & Poor 500 index.[21] In the second half of the nineties both continents experienced an unprecedented stock market boom. Recent corrections in stock market indices show that some part of this boom was not

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[19] The discussion refers here to the transitory components of these changes in oil prices.

[20] Such a bubble may also trigger increased investment and hence a rise in the capital stock. But the capital stock rises only temporary, as has been pointed out above.

sustainable, suggesting that part of the previous gains did not reflect fundamentals. Since investment in equities plays a larger role for households in the United States than for those in Europe, it is probable that this development accounts for a noticeable part of the divergence in demand conditions in this period and hence for the relative strength of the U.S. dollar in recent years.

Another potentially important demand factor is fiscal policy. The fiscal expansion during the first years of the Reagan administration probably accounts to some degree for the strength of the U.S. dollar in the early eighties. The sixth plot in figure 3 employs as a measure of the fiscal stance the change of the government deficit relative to GDP. The relative fiscal stance is computed as the difference between the respective European and the American measure of fiscal policy. If this index moves upwards, this indicates that fiscal policy in Europe is becoming tight relative to US fiscal policy. Such an episode is clearly visible in the early years of the eighties, but in the remainder of the decade the policy stance in the economies differed by much less. Coming to the nineties, during 1990 till 1992 fiscal policy was loose in both continents, hence the relative stance changed little. In America the recession was probably an important factor, while in Europe the fiscal costs associated with German unification played a role. In the following years, the fiscal stance in Europe remained relatively loose, while policy in the United States embarked on a course of steady budgetary consolidation. This induced a small real depreciation of the dollar until 1996, when European governments also began to consolidate more forcefully in order to comply with the Maastricht fiscal criteria. In subsequent years, the relative fiscal stance remained fairly

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21 It is recognized here, of course, that the German stock market index is an imperfect proxy for the developments in European equity markets, but a long time series for a corresponding euro area

constant, as governments in Europe and the United States continued to consolidate their budgets with equal vigor.

4.2.3 Real Exchange Rate Fluctuations Due to Monetary Shocks

A striking result of the historical decomposition of monetary shocks shown in the third panel of figure 2 is that these shocks played almost no role for the changes of the real exchange rate. Some episodes, which are generally deemed to have been important, are indeed visible, like the EMS crisis in 1992. Another example is the tight Federal Reserve policy between 1988 and 1990, which was followed by substantial interest rate cuts. More recently, the interest rate reductions in the United States in response to the Asian and Russian crises are clearly discernible in the historical decomposition, while European policy makers acted less vigorously. But the effects of these episodes hardly mattered for the real exchange rate.

It would be premature to conclude from the finding that monetary policy shocks do not account for a noticeable part of exchange rate fluctuations that interest rates in general and interest rate differentials in particular do not matter. In contrast, it has become apparent in section 2 that the underlying theoretical model assigns a central role to the interest rate differential in modeling the exchange rate. But for the analysis at hand the crucial point is that interest rates are endogenous variables, which do not only respond to exogenous monetary policy disturbances but also, in a systematic way, to demand and supply conditions.

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aggregate was not available.

As regards this point, it is important to emphasisz that the monetary shocks shown in the last panel of the historical decomposition only capture the non-systematic part of policy actions. It is likely that the systematic component of policy is much more important for interest rate movements, but this part of monetary policy enters the impulse response functions giving the response of the system to demand and supply shocks. After all, impulse response functions show how the economy reacts to these shocks, which includes the reaction of the central bank. To summarize, tracking interest rate movements to account for exchange rate fluctuations is useful in the sense that one can produce a close fit, but it is not helpful if one wishes to understand the forces driving the exchange rate (and, for that matter, the interest rate differential).[22] This paper is interested in the latter question as it attempts to discriminate between the competing explanations for the weakness of the euro advanced in the introduction.

4.2.4 Factors Underlying the Weakness of the Euro in the Period from 1999 to 2000

The weakness of the euro since its inception in January 1999 has come as a surprise for many observers. The historical decomposition presented here allows some insight into the factors which may have been responsible for this development. Regarding the role of relative supply shocks, the first panel in figure 2 clearly shows that these have not been a significant factor in the recent past. Given the strong performance of the U.S.

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[22] A similar line of thought holds for capital flows, which are also often presumed to be important determinants of the real exchange rate. Again, these are likely to respond endogenously to developments on the supply, demand and monetary side of an economy.

economy in recent years, which is often attributed to the New Economy, this finding could imply on the one hand that the New Economy has also arrived in Europe. On the other hand, however, this could also suggest that the impressive productivity gains in America in recent years did not have their origins in supply side developments but were more of a demand driven, cyclical nature. The development in the relative demand conditions suggests that the latter argument may have some substance, as it is apparent from the historical decomposition that relative demand shocks account indeed for most of the real depreciation of the euro in the years 1999 and 2000. Two factors have been identified in the preceding discussion, which may play a role here. First, the strong rise in oil prices since summer 1999 is equivalent to a noticeable transfer of income from the European economies to the oil exporting countries. The United States are probably less affected, as they are themselves a major oil producer. Such a worsening of relative demand conditions in Europe is likely to induce a weakening of its currency. The second factor is the stock market boom. Even though equity markets in the last two years have performed strongly in both economies, the income effects are likely to be stronger in the USA. Hence this development corresponds to a positive demand shock benefiting in particular the US economy and therefore also the U.S. dollar. Compared to the demand shocks, the effects of the monetary policy shocks on the real exchange rate are small. To the extent that they matter, the changes in the relative stance of monetary policy have supported the real value of the euro. In particular, the interest rate hike in late 1999 appears to have had this effect.

5. Conclusion

We have discussed to what extent the development of the euro/U.S.-Dollar can be attributed to exogenous shocks such as supply disturbances, non-monetary demand shocks and monetary shocks. To identify these structural shocks empirically, restrictions were obtained from the model advanced by Clarida and Gali (1994). The application of a structural VAR to aggregated quarterly data for the Euro-zone covering the time period from 1980 to 2000 has led to the conclusion that supply side shocks were the most important factor influencing the dynamics of the real exchange rate over the entire sample under investigation. However, a historical decomposition of exchange rate movements also showed that the depreciation of the euro since the beginning of 1999 can be best understood in terms of relative non-monetary demand shocks. In particular, differences regarding wealth effects appear to be relevant for the recent weakness of the exchange rate. Another factor is the income effect of the recent oil price shock, which affects Europe more severely than the U.S. economy. In this respect, it is interesting that the impulse response analysis reveals that it takes up to two years until a relative demand shock has reached its maximum effect on the real exchange rate. So, even if the stock market boom in both continents has come to an end and oil prices have declined again, due to the gradual response of the real exchange rate some time may elapse before the euro will regain previous strength.

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Figure 1: Responses of Relative Output, the Real Exchange Rate, and the Relative Price Level to Structural Shocks

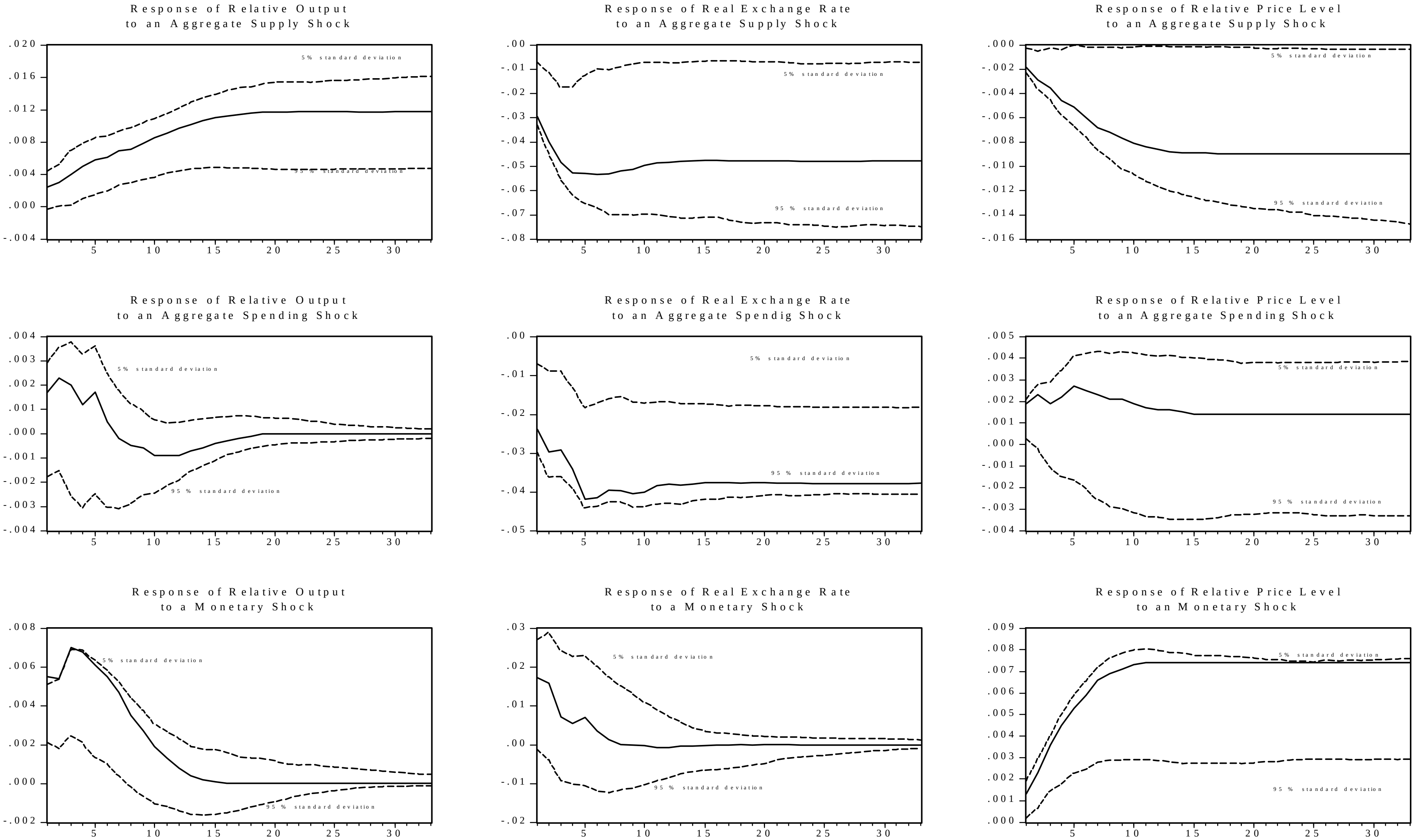

Figure 2: Historical Decomposition of the Real Euro/U.S.-dollar Exchange Rate (Forecasting Horizon: 2 Years)

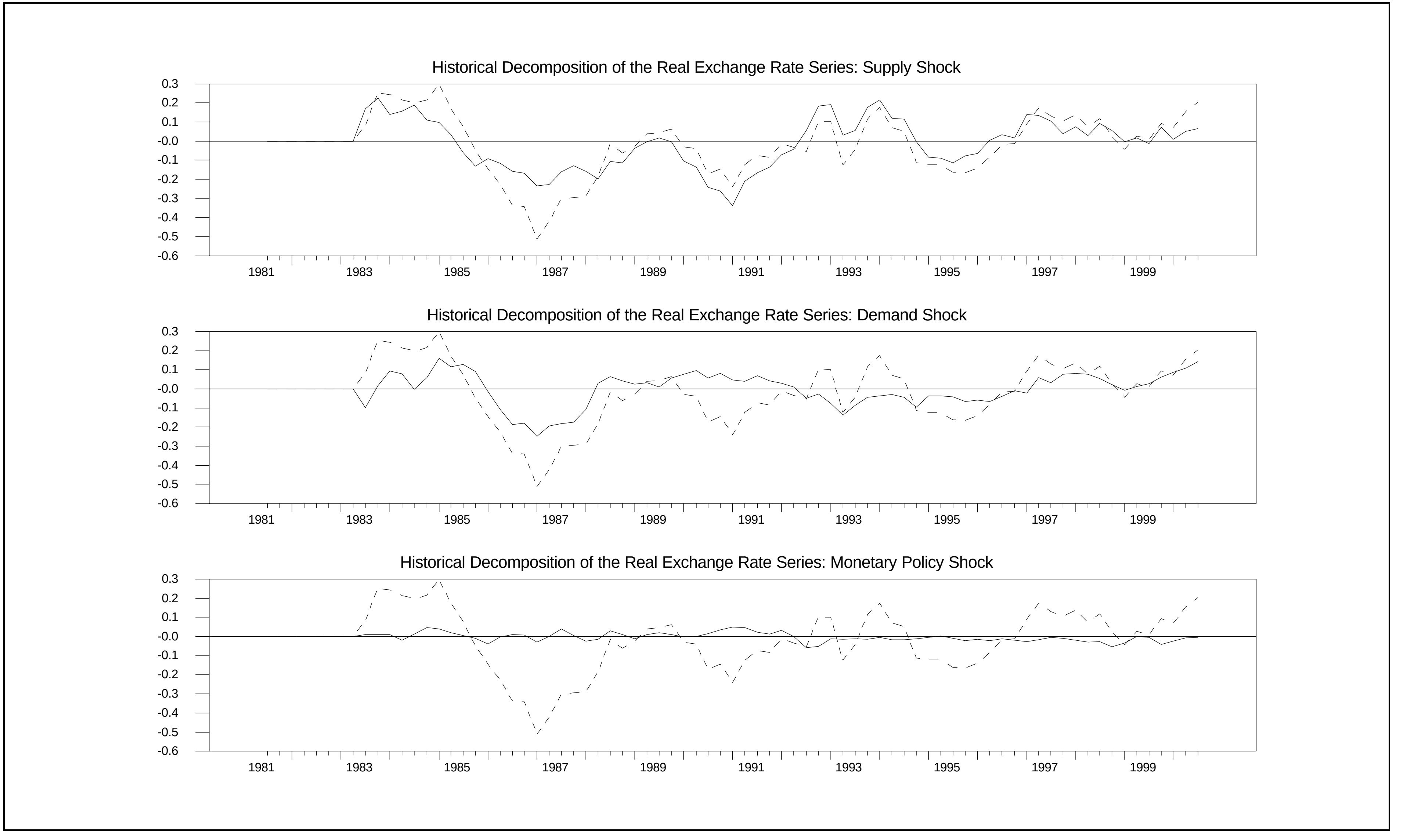

Figure 3: Factors Contributing to Aggregate Supply and Demand Conditions