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DOES THE EURO EXCHANGE RATE MATTER?

I wish to extend my warmest thanks to the Research Institute of the Finnish Economy, ETLA, for providing me with an encouraging environment at their offices. I started my research while working as the Acting Professor of Economics at the University of Lapland, and was able to finish it after I had started working as the Senior Assistant at the Åbo Akademi University in Turku.

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ABSTRACT: In this paper, we examine the relationship between the euro exchange rate and domestic inflation in the EMU area. This issue has gained importance as the euro has depreciated around 20 per cent during the first eighteen months of EMU, and is now a serious concern for the European Central Bank (ECB) since it threatens price stability in the EMU area. In the paper, we construct two simple models to illustrate the effect of the exchange rate on export demand, on the one hand, and on inflation rate, on the other hand. Export demand is explained by the exchange rate and by foreign demand, which is captured here by economic growth in the USA. The expected stimulating effect on exports from a depreciating currency does not show in the results. On the other hand, the positive effect of economic growth abroad, i.e., in the USA, shows clearly in the results. The inflation rate, in turn, is explained by the exchange rate, by domestic demand as reflected by industrial production, and by world commodity prices. The results for this equation show that a depreciation of the exchange rate clearly accelerates domestic inflation. An increase in world prices has the same effect, whereas domestic demand shows no clear effect on the inflation rate. This problem could be solved by using the output gap, instead. The most important contribution of the paper is that it applies basic models and, hence, serves as a good starting point for further research on exchange rate pass-through to domestic prices. The results indicate that the degree of pass-through could be much larger in EMU than is expected on basis of the degree of openness of the EMU economy. Thus, further research on this issue is evidently needed.

Key words: euro, exchange rate, inflation, export demand, monetary policy

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TIIVISTELMÄ: Työssä tarkastellaan valuuttakurssin merkitystä EMU-alueen inflaatiolle. Kysymys on keskeinen rahapolitiikan kannalta: euron noin 20 prosentin heikkeneminen puolentoista vuoden aikana on aiheuttanut EMU-alueen hintoihin voimakkaita nousupaineita. Euroopan keskuspankki (EKP) on joutunut antamaan valuuttakurssille inflaatiokehitystä ennakoivassa analyysissä keskeisen roolin. Valuuttakurssi vaikuttaa vientikysyntään aiheuttaen inflaatiopaineita kasvavan kokonaiskysynnän kautta. Toisaalta valuuttakurssi vaikuttaa suoraan kuluttajahintaindeksiin, kun tuontitavaroiden ja tuotantopanosten hinnat nousevat. Työssä rakennetaan kaksi yksinkertaista mallia, joissa kuvataan valuuttakurssin ja näiden muuttujien välistä yhteyttä. Vientikysyntää selitetään valuuttakurssin lisäksi ulkomaisella kysynnällä, mitä kuvaa Yhdysvaltojen tuotannon kasvu. Tulokset eivät osoita odotettua heikon valuutan ja kasvavan vientikysynnän yhteyttä. Sen sijaan Yhdysvaltojen talouden kasvu johtaa selkeästi lisääntyneeseen vientiin EMU-alueelta. Kuluttajahintojen muutosta puolestaan selitetään valuuttakurssil-la, kotimaisen tuotannon kasvulla kuvattuna teollisuustuotannolla sekä maailman markkinahin-noilla. Tämän yhtälön testitulokset näyttävät hyvin selkeän yhteyden heikon valuutan ja kiihtyvän inflaation välillä. Myös maailman markkinahintojen nousu nostaa kotimaisia hintoja. Sen sijaan kotimaisen tuotannon nousu ei näytä vaikuttavan inflaatioon. Tämä ongelma saattaisi ratketa käyttämällä selittäjänä tuotantokuilua. Työssä käytetyt perusmallit ja niillä saadut tulokset toimivat hyvänä lähtökohtana valuuttakurssin välittymistä analysoivalle jatkotutukimukselle. Saadut tulokset antavat viitteitä siitä, että valuuttakurssin välittyminen EMU-alueelle saattaa olla huomattavasti voimakkaampaa kuin voisi odottaa alueen avoimuuden perusteella. Tulosten tarkentaminen ja jatkotutkimus ovat tärkeitä, jotta valuuttakurssin merkitys inflaatiokehitykselle ja sitä kautta EKP:n rahapolitiikalle voidaan hahmottaa nykyistä tarkemmin.

Asiasanat: euro, valuuttkurssi, inflaatio, vientikysyntä, rahapolitiikka

1. INTRODUCTION

The main objective of the monetary policy of the European Central Bank (ECB) is to maintain price stability in the EMU area. This primary objective is written in the Maastricht Treaty (Article 105) in order to maximize, from an institutional point of view, the independence of the central bank. In practice, the ECB must conduct a transparent and determined monetary policy in order to establish credibility. Part of the strategy to achieve the goal of monetary policy is "a broadly based assessment of the outlook for future price developments and the risks to price stability in the euro area as a whole"[1]. One potential risk factor hampering the success of this strategy is the exchange rate.

The role of the euro exchange rate in the monetary policy making was described by the President of the ECB: "…the exchange rates affect the maintenance of price stability as they influence import prices and activity, and thereby consumer prices, in the euro erea. …they reflect market expectations about future economic developments and policies. …due consideration has to be given to the exchange rate of the euro against the background of the importance of the euro area in the international monetary and financial system. …the ECB monitors exchange rate movements on an ongoing basis within its broadly based assessment of the outlook for price developments. The euro exchange rate is an integral part of the broad range of variables used by the Eurosystem to take its monetary policy decisions. The exchange rate is also monitored as it may be a channel for monetary policy transmission." (Speech "The euro, the dollar and national economic policies: what room for manoeuvre?" given at the Euro J +80 conference on March 25, 1999 in Paris).

Thus, although the opinion of the ECB is that the importance of a certain movement in the euro exchange rate for domestic economic development is no longer as significant as it used to be, the concern about the exchange rate affecting price stability has been clearly expressed. This concern became increasingly pronounced

[1] The quote is from the first Monthly Bulletin of the ECB (January 1999). See that issue for a thorough description of the monetary policy strategy.

during February – July 2000, especially. To quote the statements given by the ECB[2] in connection with Council monetary policy decisions:

- February 3, interest rates were raised by 0.25 %, "The depreciation of the euro which we have witnessed is contributing to increases in import prices."
- March 16, interest rates were raised by 0.25 %, "…the downward movement of the exchange rate of the euro in the past are putting upward pressure on import costs and producer prices."
- April 27, interest rates were raised by 0.25 %, "…upside risks to price stability which…arise from…the present level of the exchange rate of the euro"
- June 8, interest rates were increased by 0.5 %, "…in a phase of strong growth upward risks to price stability currently relate mainly to the spillover of rising import prices to consumer prices, owing both to the lagged effects of the exchange rate depreciation and to rising oil prices."

Finally, in its recent meeting on July 6, the Council decided to maintain the interest rates at the prevailing level, but still expressed its concern about the exchange rate: "…the accumulated depreciation of the exchange rate of the euro remains a cause for concern and has to be taken into account in the assessment of the risks to price stability".

In this paper, we try to shed some light on the two empirical questions related to the effects of the exchange rate: First we analyze to which extent does the weakening (strengthening) of the euro exchange rate pass through to domestic consumer prices. Second we estimate to which extent does the depreciation (appreciation) of the euro add to aggregate demand in EMU through increased (decreased) export demand.

The paper is structured as follows. In section 2, we formulate a simple relationship between the exchange rate and domestic inflation, and test this relationship empirically. In section 3, we construct a model for the link between the exchange rate and exports, and test the model empirically. Finally, section 4 concludes with a summary and conclusions.

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[2] ECB Press Conferences, Introductory Statement on the respective day.

2. THE EFFECTS OF THE EXCHANGE RATE ON THE INFLATION RATE

In general, the exchange rate affects the real economy via two channels - direct and indirect. When the exchange rate depreciates, imported goods become more expensive for domestic consumers. Since the final target of monetary policy is measured with a consumer price index, import prices affect directly the final target of monetary policy. The indirect effects can be seen in the increasing the competitiveness of export goods increases in the international markets as they become cheaper relative to foreign goods. Thus, exports increase and that, in turn, adds to the aggregate demand in the economy. If the economy is already working at high levels of capacity utilization, then the injection coming from increased export production puts up inflationary pressures on the economy.[3] A third channel through which the exchange rate can affect the domestic economy comes through the financial markets. In general, as the exchange rate depreciates, the consequent loss of return has to be compensated for foreign investors in form of a higher interest rate. An increasing interest rate tends to slow down the inflationary effects of the exchange rate depreciation. However, since the ECB has only expressed its concern over the real effects of the depreciation of the euro, the financial markets are left outside the scope of the current paper.

2.1 Pass-through of the exchange rate to the price index

Exchange rate pass-through is often defined as the degree to which exchange rate changes are reflected in the destination currency prices of traded goods. As shown by surveys, the relationship between the exchange rate and domestic prices has been extensively studied: Goldberg & Knetter (1997) report nearly 700 entries in the EconLit database for empirical research on the law of one price, purchasing power parity, exchange rate pass-through, and pricing-to-market. Menon (1995) summarizes the empirical results of 43 empirical studies on exchange rate pass-through. The surveys of Menon (1995) and Goldberg & Knetter (1997) provide extensive analyses of the research on exchange-rate pass-through. Therefore, we will review the main approaches only briefly here.

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[3] Franzén & Andersson (1993) list three draw-backs of a depreciation: expectations of a higher inflation, higher import prices, and the threat of a knockout for import business firms.

In the early studies, the percentage change in the domestic currency price of the imported goods following an exchange rate change was derived being a function of the elasticities of demand and supply. Empirical studies that applied this approach often concluded that the larger less-open countries experienced much lower pass-through than the smaller more-open economies. Given this result and knowing that the share of exports to GDP in the EMU-area is only 14 per cent[4], we should expect that the euro exchange rate has little effect on domestic prices.

Another approach applies the traditional proposition of the law of one price. The price is thus determined by the domestic price levels in the competing countries, and by the exchange rate. As a formal expression, in competitive markets the law of one price is to hold:

$$P = P^* / S \qquad [2.1]$$

where P and P* are the domestic and foreign price levels, and S is the exchange rate defined as units of foreign currency per unit of domestic currency. The relative version of the law of one price, or the absolute purchasing power parity, expresses the same idea in terms of changes in the price levels or the exchange rate:

$$p = p^* - s \qquad [2.2]$$

where p and p* are the domestic and foreign inflation rates and s is the exchange rate change as logarithms observed during the period.

Thus, one might expect that a nominal depreciation of the importing country's currency should also lead to an equivalent increase in import prices denominated in the importing country's currency. A direct price effect comes from the fact that part of the goods consumed in a country are imported goods and do, therefore, count in the consumer price index. The indirect effect is caused by the increased production costs due to the risen price of imported goods that are used as input in domestic production. However, two conditions should be fulfilled for a complete pass-through to take

[4] Data for 1999 from the Monthly Bulletin of the ECB.

place. First, mark-ups of price over cost should be constant, and second, marginal costs should be constant[5].

In the literature referred to, the next step was to develop models that focused market structures and product characteristics. Pass-through then depends on whether exporters squeeze profit margins, or whether particular types of market organization always lead to only a limited response of prices to exchange rate changes. One of the central findings of these studies is that the lower the degree of substitutability between domestic and foreign goods, and the lower the degree of market integration, the greater the market power of sellers will be. Namely, the firm's mark-up on marginal cost in determining its price is an increasing function of its market share. Further, the market price depends on the sum of marginal costs of all firms in the market. Since a change in the exchange rate affects only foreign firms, there will be less than unity pass-through. Finally, the degree of pass-through is a decreasing function of the ratio of domestic to foreign firms.

As Menon (1995) summarizes, empirical tests of market structure have indicated that while the price response to a temporary appreciation could go either way, an appreciation viewed as permanent leads to foreign firms pricing very aggressively in the host country market in order to gain an increase in market share. This occurs because future market shares depend on current market shares, and any increase obtained from exploiting the appreciation will be of a relatively permanent nature. [6]

As Menon (1995) explains, according to hysteresis models, firms have adopted a wait and see approach as exchange rates have become more volatile because there are irretrievable sunk costs associated with entry-exit decisions in world markets. Firms are then less likely to enter a market following a temporary or a small exchange rate change. Similarly, they will be deterred from leaving the market. Thus, competition in the market will remain unchanged as long as exchange rate changes fluctuate within narrow limits, and this band is the greater the higher the costs associated with entry

[5] For a discussion, see Goldberg & Knetter (1997).

[6] The question of the effects of temporary versus permanent exchange rate changes is also discussed in Goldberg & Knetter (1997).

and exit. This will result in a lower rate of pass-through, as firms fight to either stay in the market or deter entry.

2.2 The model for the exchange rate and inflation

For the purpose of this paper, we want to concentrate on the international pressure on the target of the ECB, which is the inflation rate. Our intention is not to create an extensive economy-wide model for the inflation rate[7]. Inflation is most often monitored by means of an indicator that is a representative measure of the general price level[8]. The ECB has adopted the so called Harmonized Index of Consumer Prices (HICP) as the indicator of inflation in the EMU area. The HICP covers a broad range of goods and services that are purchased by consumers. Since part of the expenditure on consumption is always spent on imported goods, changes in import prices are expected to affect the consumer price index, too. There is no calculation of the shares of imported and domestic goods in the HICP, but Table 4.1 presents the weights of different main items in the basket.

Thus, we explain the domestic inflation rate with three components: the nominal exchange rate, domestic production, and world export prices. The depreciation of the nominal exchange rate is expected to accelerate domestic inflation. Domestic production, in this case described with industrial production, reflects domestic demand

Table 4.1 Weights for harmonized index of consumer prices 1996=100 (Source: Tilastokeskus)

Food and non-alcoholic beverages 19.1 %	Furnishing, household equipment and routine maintenance of the house 5.8 %	Culture and recreation 12.2 %
Alcoholic beverages and tobacco 7.8 %	Health and medical care 1.6 %	Education 0.2 %
Clothing and fottwear 5.7 %	Transport 16.5 %	Hotels, cafes and restaurants 8.1 %
Housing, heat and light 16.7 %	Communications 2.6 %	Miscellaneous goods and services 3.8 %

[7] For example, the domestic money supply or the interest rate, or government expenditure, could have been included in order to be more complete. However, we use data for the 1990s – a time when EMU did not exist yet but the current EMU countries conducted national monetary policies, and national fiscal policies. Thus, the aggregation of these individual domestic economic policies would have been to flurry to give sufficiently accurate information on the development of the inflation.

[8] For a presentation of different indicators of inflation, see Andersen (1995).

pressure. A high production rate is expected to imply high capacity utilization and, thus, to add to the rate of inflation. Finally, world export prices are included in order to capture the competitive pressure in the international markets. The higher the prices in the world markets are, the better the domestic firms can raise their prices without losing market shares.

To summarize this, we can write the inflation rate as

$$\pi = \pi (S, Y, WP^*) \qquad [2.3]$$

where S is the nominal exchange rate[9], Y is domestic production and WP* stands for world export prices. Or, as an ordinary least-squares (OLS) regression equation[10]

$$p_t = \alpha + \beta_1 s_t + \beta_2 y_t + \beta_3 wp_t^* + \varepsilon_\tau \qquad [2.4]$$

where the symbols are as above but are the first differences of the logarithms of the time series, and ε is the error term. In order to capture some dynamics of the pass-through process, we added one lag to the variables[11].

2.3 Empirical tests for inflation

The regression equations given in the previous section were tested through the period of January 1991- March 2000. Because too few observations exist for the EMU era, we have to extend our sample to the time prior to EMU. Although the available EMU-wide aggregates cover the entire 1990s, we cannot just put an equal sign between the pre- and post-EMU eras. However, until enough time has lapsed, we must accept this weakness in the empirical work that we do concerning EMU. It is, however, important

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[9] We ran tests also for the real effective exchange rate but the main results were not qualitatively different from those obtained with the nominal exchange rate. Since the nominal exchange rate dominates the short-term variability of the real exchange rate, we chose to use the former.

[10] As reported by Menon (1995), most previous studies have employed OLS to estimate pass-through. He also points out that very little attention has been paid to the time series properties of the data. If OLS is used to estimate a regression using non-stationary data, then the problem of spurious regressions becomes a concern. Menon (1995) briefly discusses the solutions to this problem (p. 223). In our study, we have done the standard tests for stationarity and Dickey-Fuller cointegration tests. The results are available on request from the author.

[11] Even more lags were added, but that did not improve the results.

to put an effort to carefully follow the development of the parameters in the post-EMU era, but we must, for the time being, remember to be careful with the results that we obtain. Thus, here we have used data[12] collected from the Main Economic Indicators of the OECD for the euro zone and the USA, but remind the reader of the problem described above.

Table 2.1 Regression results for equation [2.4].

Dependent Variable: PEMU
Method: Least Squares
Date: 06/29/00 Time: 11:39
Sample: 1991:02 2000:02
Included observations: 109

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.005712	0.007720	-0.739802	0.4611
USDEUR	-0.551816	0.317439	-1.738336	0.0851
EPROD	-1.671327	0.957853	-1.744868	0.0839
WPX	0.758380	0.211484	**3.585991**	0.0005

R-squared	0.137992	Mean dependent var	-0.005889
Adjusted R-squared	0.113363	S.D. dependent var	0.083874
S.E. of regression	0.078977	Akaike info criterion	-2.203324
Sum squared resid	0.654916	Schwarz criterion	-2.104559
Log likelihood	124.0812	F-statistic	5.602860
Durbin-Watson stat	1.831443	Prob(F-statistic)	0.001328

Table 2.2 Regression results for equation [2.4] but with lagged explanatory variables.

Dependent Variable: PEMU
Method: Least Squares
Date: 06/29/00 Time: 11:38
Sample(adjusted): 1991:03 2000:02
Included observations: 108 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.009924	0.008060	-1.231286	0.2210
USDEUR(-1)	-0.751035	0.332981	**-2.255489**	0.0262
EPROD(-1)	0.978544	1.005411	0.973278	0.3327
WPX(-1)	0.254907	0.221653	1.150029	0.2528

R-squared	0.064611	Mean dependent var	-0.006647
Adjusted R-squared	0.037628	S.D. dependent var	0.083889
S.E. of regression	0.082295	Akaike info criterion	-2.120675
Sum squared resid	0.704340	Schwarz criterion	-2.021337
Log likelihood	118.5164	F-statistic	2.394547
Durbin-Watson stat	1.835902	Prob(F-statistic)	0.072555

The results for the regression equation [2.4] are presented in Table 2.1. The only significant variable is the world export prices: when world export prices rise, the

[12] A more detailed description of the data is given in the Appendix.

domestic inflation rate accelerates. The exchange rate appears with a negative sign, which is as expected, but it is insignificant. Hence, we ran the regression also with lagged variables in order to grasp price stickiness. We obtained significant coefficients only for explanatory variables with one lag. These results are presented in Table 2.2. Now the exchange rate is the only significant variable: when the domestic currency depreciates, domestic inflation accelerates.

The results for a regression with the current and lagged values of the explanatory variables are presented in Table 2.3. The F test for the coefficients of the exchange rate is 4.057, which lets us state that the exchange rate does significantly affect the domestic inflation rate. If we summarize the effects of the lagged and current exchange rate, we see that within one month, a one unit depreciation of the euro leads to an acceleration of the domestic inflation rate by 1.097 units. Thus, there seems to be a complete pass-through within only a short period of time. Changes in world export prices also seem to have a great impact on domestic prices: the results indicate that over four fifth or the price changes are immediately transmitted to domestic prices.

Table 2.3 Regression results for equation [2.4] but with the nominal exchange rate lagged with one period.

Dependent Variable: PEMU
Method: Least Squares
Date: 08/16/00 Time: 09:57
Sample(adjusted): 1991:03 2000:02
Included observations: 108 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.010082	0.007752	-1.300456	0.1964
USDEUR	-0.487808	0.345130	-1.413401	0.1606
USDEUR(-1)	-0.609516	0.334290	-1.823311	0.0712
EPROD	-1.152860	0.978220	-1.178528	0.2414
EPROD(-1)	0.225560	0.969760	0.232594	0.8165
WPX	0.914415	0.230030	**3.975201**	0.0001
WPX(-1)	0.128902	0.224718	0.573617	0.5675

R-squared	0.207515	Mean dependent var	-0.006647
Adjusted R-squared	0.160437	S.D. dependent var	0.083889
S.E. of regression	0.076865	Akaike info criterion	-2.230908
Sum squared resid	0.596734	Schwarz criterion	-2.057067
Log likelihood	127.4691	F-statistic	4.407864
Durbin-Watson stat	1.827058	Prob(F-statistic)	0.000535

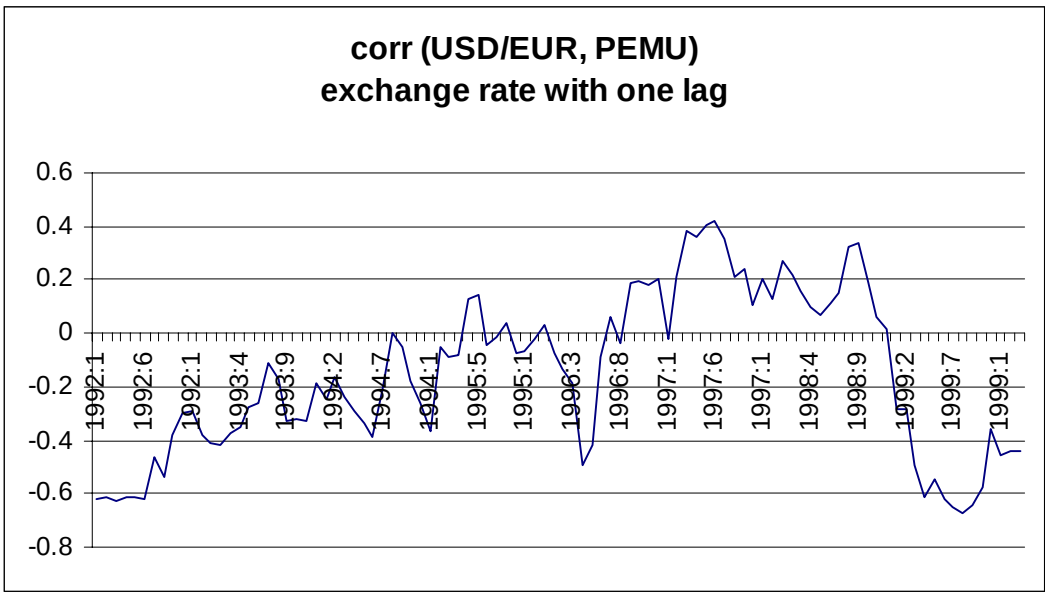
Compared to the results of the other studies that we have referred to earlier in this paper, the figures describing the effect of the exchange rate on domestic inflation seem quite large. If we accept Germany as the substitute for EMU in earlier studies, we can do a careful comparison. In the survey of Menon (1995), only three studies report pass-through results for Germany. Kreinin (1977) analyzed the consumer price index and found a pass-through of 60 per cent. Spitaeller (1980) obtained a 73 per cent pass-through for traded goods prices. Feinberg (1986) reports a pass-through of 24 per cent on industry level.

In a recent study, Ayub (1996) finds a pass-through of 89 per cent for a panel of 28 countries. He studies the sample period 1980-90 for 28 OECD countries. He points out that there is a variety of theoretical models explaining inflation but no single approach that could entirely and solely explain inflation. Therefore, as many empirical studies of inflation have done, he adopts a general approach and combines various factors that can be shown, theoretically, to affect inflation. He constructs a simple linear regression equation in which he includes the money supply, the exchange rate, industrial production, the current account and the government deficit as explanatory variables. He then excludes non-significant variables ending up in a model, where inflation is explained simply by the depreciation of the exchange rate or, in a competing model, by industrial production, the current account and the money supply. After comparing these two final models, he concludes that the rate of depreciation as a single explanatory variable is the best model when explaining inflation, whereas the other model with more variables is a better model for forecasting inflation.

According to the market structure approach, a relatively high value for pass-through reflects low degree of substitutability between imported and domestic goods, and / or a relatively low degree of market integration. One interpretation is that there are very many foreign firms as compared to domestic firms in the European traded sector. More information on the EMU market structure would be needed in order to be able to confirm these eventual connections, as suggested also by Goldberg & Knetter (1997). Qualitatively, however, the results of the current study support the view that a depreciation of the euro does threaten price stability in EMU.

In his study of the impact of exchange rates and import prices on domestic producer and consumer prices in selected industrialized countries for the period of 1976-98, McCarthy (1999) reports a pass-through of less than 25 per cent. His empirical model is a vector autoregression system incorporating a distribution chain of pricing. In his model, inflation at different distribution stages – import, producer, and consumer – is comprised of expected inflation, domestic supply and demand shocks, and external exchange rate shock. The key finding of his empirical tests is that the effect of external factors on domestic inflation is quite modest. However, in the period of strong disinflation during 1996-98, external factors seem to have a sizeable disinflationary effect. He concludes that much of the decline in inflation during this decade has come from other, presumably more permanent factors, indicating that central banks have been successful in reducing inflation trends and expectations.

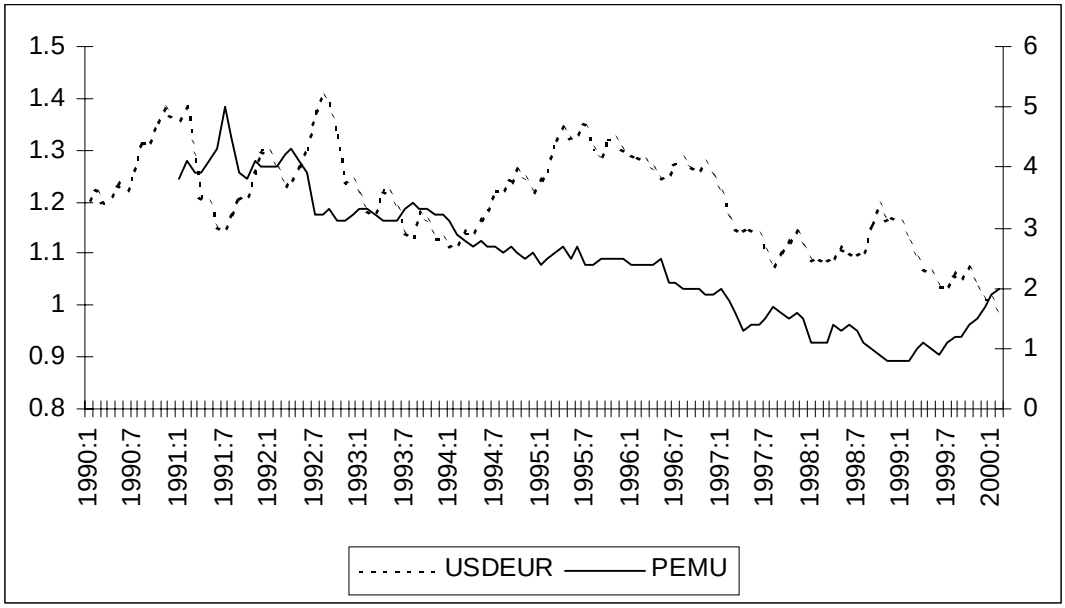
Figure 2.1 Correlation between the euro exchange rate and the inflation rate in EMU.



In order to gain more information about the role of the exchange rate for the inflation process, we analyzed the relationship between these two variables more closely. Following Nilsson & Nilsson (1993), we calculated the correlation between the inflation rate and the exchange rate for up to 4 months' time lag. Instead of using one single correlation coefficient for the entire period, we calculated the correlation coefficient for 12 months at a time. This "window" was then slided forward month by month throughout the whole period. As a result, we obtained a graph presenting the

correlation coefficient for the last 12 months for 97 months between January, 1992 and February, 2000. Figure 2.1 shows how the degree of correlation has changed during the period. We only present the most stable relationship between the variables, which is the one between the current inflation rate change and the exchange rate change with one lag. As we see, the correlation coefficient has not been very stable. For most of the time, it carries the correct sign: depreciation of the euro (or Ecu prior to EMU) is associated with acceleration of the inflation rate. However, during late 1996 through early 1999 the relationship is positive. This has to do with the strong anti-inflationary process that was going on in the EU[13] as the countries pressed down their inflation levels in order to fulfill the EMU convergence criterium: the inflation rate had to be no higher than the average of the three lowest inflation rates plus two percentage points. At the same time, the dollar appreciated vis-à-vis the European currencies. This is seen in Figure 2.2 where the exchange rate and the consumer price

Figure 2.2 The USD/EUR exchange rate (left-hand axis) and the EMU consumer price index (right-hand axis).



[13] This view is explicitly presented also in McCarthy (1999). He argues that when discussing the influence of exchange rates on domestic inflation, greater global integration and competition are given as reasons for a greater pass-through. On the other hand, central banks have been more concerned with price stability during the last two decades. This would imply that monetary authorities may have counteracted the inflationary impact of these external shocks, reducing the measured pass-through over time. He investigates this empirically, and finds out that the external factors do not appear to have become more important in explaining consumer price fluctuations. His results suggest that the exchange rate and import prices have not assumed a bigger role in domestic consumer price disinflation process during 1996-99.

index are plotted as levels. The figure also shows that after EMU was started, the euro began to depreciate and the inflation rate to increase. This indicates that exchange rate changes of the euro do affect inflation in EMU. However, there is no stable relationship, yet. As we can read from Figure 2.1, a one percent depreciation of the euro can be associated with an acceleration of the inflation rate of anything between zero and 0.67 per cent. In the lack of time series data, we cannot conclude if the correlation has stabilized at the level of the most recent observations, which lie slightly above 0.4 per cent.

3. THE EFFECT OF THE EXCHANGE RATE ON EXPORT DEMAND

A standard textbook model for the demand of exports is that exports of the home country depend on the real exchange rate and on the import demand of the foreign country. The real exchange rate measures the competitiveness of domestic products in the international markets: the lower the price of the goods relative to the exports of other countries as expressed in the same currency, the greater the demand for them is. In terms of equation [2.2], the competitiveness of domestic goods in the international markets is poor if $p > p^* - s$. Now, if the domestic currency depreciates, s gets a smaller value. The price differential is eroded and the competitiveness of domestic goods is improved.

Thus, according to the idea of purchasing power parity, if the firm faces increasing returns to scale, then a depreciation of the domestic currency stimulates foreign demand, and the marginal cost diminishes as the production volumes grow.

The second determinant of the export demand is the foreign demand for exports. As the income in a country increases, then part of this increase in directed to consumption, and part of it is saved. Of the share of the income increase that is used for consumption, one part goes to the purchases of domestic goods, while the rest is spent on foreign goods. The size of the share that is used for consumption of foreign goods, i e imports, depends on the marginal rate to import. Formally expressed, let us derive the export demand within a simple two-country model as follows. Let us write the equilibrium conditions in countries 1 and 2 as

$$Y_1 = C_1 + I_1 + G_1 + (X_1 - M_1) \quad [3.1]$$

$$Y_2 = C_2 + I_2 + G_2 + (X_2 - M_2) \quad [3.2]$$

where Y stands for national income, C for consumption, I for investment, G for government expenditure, X for exports and M for imports. The subscripts refer to country 1 and country 2 respectively. Let us further denote the consumption and income functions as

$$C_1 = C_{a1} + (1 - s_1)Y_1 \quad [3.3]$$

$$M_1 = Ma_1 + m_1 Y_1 \quad [3.4]$$

$$C_2 = C_{a2} + (1 - s_2)Y_2 \quad [3.5]$$

$$M_2 = Ma_2 + m_2 Y_2 \quad [3.6]$$

where s is the marginal propensity to save and m is the marginal propensity to import in country 1 and in country 2, respectively. C_a and M_a stand for autonomous consumption and imports. Noting that in equilibrium, income equals expenditure, we can insert expressions [3.3] –[3.6] into [3.1] and [3.2] and obtain, denoting expenditure with E

$$(s_1 + m_1)\, Y_1 - m_1\, Y_1 = E_1 \quad [3.7]$$

$$-m_2\, Y_2 + (s_2 + m_2)\, Y_2 = E_2 \quad [3.8]$$

We next examine the effect of a change in autonomous spending in country 1 on the level of net exports in respective countries. For country 1 the level of net exports is

$$NX_1 = X_1 - M_1 \quad [3.9]$$

Consequently, the change in net exports is

$$dNX_1 / dE_1 = (dX_1 - dM_1) / dE_1$$

However, from the import function we know that

$$dM_1 / dE_1 = m_1 \, dY_1 / dE_1 \qquad [3.10]$$

$$dM_2 / dE_1 = m_2 \, dY_2 / dE_1 \qquad [3.11]$$

so that using these results together with the multipliers, we obtain the change in country 2's net exports

$$dNX_1 / dE_1 = -m_1 \, s_2 / D < 0 \qquad [3.12]$$

where $D = (s_1 + m_1)(s_2 + m_2) - m_1 \, m_2$

Since this expression is negative, it is evident that country 1's net exports decline while country 2's net exports must increase. Thus, an increase in the income of the foreign country is partly spilled over to the domestic country in form of an increase in export demand.

3.1 The model for the exchange rate and exports

Following the theory of export demand, we construct a simple model to be tested empirically. Let us express the demand for exports as the following function:[14]

$$X = \xi \, (Y^*, Q) \qquad [3.13]$$

[14] Alexius (1993) defines the export volume as a function of the relative price between domestic and foreign goods, the foreign demand, and possibly domestic demand. She argues that a certain share of the exchange rate change spills over into a relative price change between domestic and foreign goods, and a share of that is added to the profit margins of the firms. How firms choose to divide the change in the exchange rate between profit margins and relative prices depends on the demand position, capacity utilization, the market structures in the various export markets, and the expected future development of the exchange rate. Low foreign demand, low capacity utilization, and an expectation that the change in the exchange rate is permanent increases the propensity of firms to make use of a relative price change rather than changing their profit margins. A depreciation of the domestic currency means that domestic goods become less expensive relative to foreign goods. How much the export volume changes, depends then on the price elasticity of exports.
In his paper, Hansson (1993) solves the demand and price equations simultaneously. The estimates with this simultaneous equation system show that, quantitatively, an interest rate decrease of on e percentage point has the same effect on demand after one year as a depreciation of the currency by 2-4 per cent. In the period within which the domestic currency is depreciated, the effect on demand is negative. The author explains this so that the depreciation has an immediate pass-through on inflation. Inflation in turn has a restraining effect on demand, while the positive demand effect from the depreciation comes only after one quarter. All in all, the author concludes that the weakening of the exchange rate means a very significant demand stimulus for the economy.

where X stands for exports and Q is the real effective exchange rate defined as Q = P* / SP. The partial derivatives are as follows:

$\delta X/\delta Q < 0$; $\delta X/\delta Y^* > 0$

For the empirical part, we formulate this as the following regression equation:

$$x_t = \alpha + \beta_1 q_t + \beta_2 y_t^* + \varepsilon_t \qquad [3.14a]$$

where the symbols are the same as above but for natural logarithms, α is the constant and β are the respective coefficients, and ε is the error term.[15] The expectation then is that $\beta_1 < 0$ and $\beta_2 > 0$. We also replace the real effective exchange rate with the nominal exchange rate, s:

$$x_t = \alpha + \beta_1 s_t + \beta_2 y_t^* + \varepsilon_t \qquad [3.14b]$$

Then expected signs for the coefficients remain the same, $\beta_1 < 0$ and $\beta_2 > 0$. Finally, we replace the real effective exchange rate with the nominal exchange rate and add the price differential to the equation, and adhere the coefficient β_3 to the price differential:

$$x_t = \alpha + \beta_1 s_t + \beta_2 y_t^* + \beta_3 (p-p^*)_t + \varepsilon_t \qquad [3.14c]$$

The expectation of β_1 and β_2 remain unchanged, and β_3 is expected to be positive.

3.2 Empirical tests for export demand

The data is described in the Appendix. The results for equations [3.14a-c] are presented in Tables 3.1- 3.3. Table 3.1 gives the effects of the real effective exchange rate[16] and the US production on EMU exports; Table 3.2 reports the results when we

[15] E g Fountas & Aristotelous (1999) use a similar export equation. They analyze the effect of exchange rate volatility on export volumes.

[16] The method to calculate the effective exchange rates of the euro is described in the April 2000 number of the Monthly Bulletin of the ECB.

Table 3.1 Regression results for equation [3.14a].

Dependent Variable: XTOT
Method: Least Squares
Date: 06/27/00 Time: 11:09
Sample(adjusted): 1991:02 2000:02
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001239	0.003289	0.376718	0.7071
EFEUR	1.173705	0.179512	**6.538309**	0.0000
YUSA	1.035511	0.582888	1.776520	0.0785

R-squared	0.300620	Mean dependent var	0.002454
Adjusted R-squared	0.287424	S.D. dependent var	0.031608
S.E. of regression	0.026682	Akaike info criterion	-4.382544
Sum squared resid	0.075462	Schwarz criterion	-4.308471
Log likelihood	241.8487	F-statistic	22.78139
Durbin-Watson stat	2.541245	Prob(F-statistic)	0.000000

Table 3.2 Regression results for equation [3.14b].

Dependent Variable: XTOT
Method: Least Squares
Date: 06/27/00 Time: 11:12
Sample(adjusted): 1991:02 2000:02
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000800	0.002872	0.278590	0.7811
USDEUR	0.876521	0.093548	**9.369775**	0.0000
YUSA	1.211899	0.511227	**2.370569**	0.0196

R-squared	0.463177	Mean dependent var	0.002454
Adjusted R-squared	0.453048	S.D. dependent var	0.031608
S.E. of regression	0.023376	Akaike info criterion	-4.647070
Sum squared resid	0.057923	Schwarz criterion	-4.572996
Log likelihood	256.2653	F-statistic	45.72893
Durbin-Watson stat	2.884599	Prob(F-statistic)	0.000000

use the nominal exchange rate instead; and finally Table 3.3 presents the results for the nominal exchange rate, US production and the price differential.

We see that qualitatively, the effects of the exchange rate and the foreign production are the same in all variations of our equation. The results of equation [3.14a] show that a depreciation of the real exchange rate has a significant, positive effect on exports. The effect of foreign production is also positive, but insignificant. If we replace the real exchange rate with the nominal exchange rate, both coefficients remain positive and are now both significant. Also, the explanatory power of the regression improves.

The highest explanatory power is given by the regression of equation [18c]. Here the coefficients for the nominal exchange rate and foreign production are positive as

Table 3.3 Regression results for equation [3.14c].

Dependent Variable: XTOT
Method: Least Squares
Date: 07/06/00 Time: 13:55
Sample(adjusted): 1991:02 2000:02
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000753	0.002873	0.262068	0.7938
USDEUR	0.888120	0.094317	**9.416304**	0.0000
YUSA	1.238870	0.512080	**2.419291**	0.0173
PERO	-0.021959	0.022470	-0.977289	0.3307

R-squared	0.468016	Mean dependent var	0.002454
Adjusted R-squared	0.452816	S.D. dependent var	0.031608
S.E. of regression	0.023381	Akaike info criterion	-4.637776
Sum squared resid	0.057401	Schwarz criterion	-4.539011
Log likelihood	256.7588	F-statistic	30.79140
Durbin-Watson stat	2.864565	Prob(F-statistic)	0.000000

before, and significant. The coefficient for the inflation differential is negative but insignificant.

In sum, economic growth in the USA has clearly stimulated EMU exports. The puzzling result is, however, the highly significant coefficient for the exchange rate. Irrespective of whether we use the effective real exchange rate or the nominal exchange rate, the coefficient shows the wrong sign and is significant: whenever the euro depreciates, EMU exports shrink. We might explain this phenomenon by considering pricing behavior of exporters. According to the traditional view, trade in manufactured goods between developed countries is mainly invoiced in the exporter's currency[17]. In that case an increase in EMU exports that are invoiced in euros, the demand for euros goes up in the international markets while the supply of dollars increases. As a consequence, the relative price of the currencies should get up in favor of the euro. Thus, it would seem that an appreciation of the euro is connected with an increase in EMU exports.[18] However, knowing how small trade flows are as

[17] See e g Friberg(1998), pp. 61-62.

[18] In addition, there is an opposite view to the pricing behavior of firms. According to a recent study by Friberg (1998), price-setting in the importer's currency is a way to stabilize demand. Starting from the view that the task of the firm is to maximize profits, the author shows that when using the importer's currency, exchange rate uncertainty does not influence prices and hence traded quantities. On the contrary, if the firm uses its own currency, by setting a higher price to compensate for risk the exporter lowers the demand elasticity, thereby reducing the sensitivity of profits to exchange rate surprises. Traded quantities will thus be lower on average. Thus, given this argument, EMU exporters should invoice in dollars. Then an increase in EMU exports and, consequently, the demand for dollars should lead to a depreciation of the euro. In the regression, we should expect to see a negative coefficient for the exchange rate.

compared to financial flows, this explanation is questionable. We ran Granger causality tests to shed some more light on this issue, and as we see from Table 3.2, EMU exports do not explain the USD/EUR exchange rate. We can reject the hypothesis that the exchange rate would not affect EMU exports, and we cannot reject the hypothesis that exports do not affect the exchange rate. Hence, we have to seek another explanation. An important role is certainly played by the phenomenon of exchange rate pass-through, that was discussed in section xx. Low pass-through would make it possible for trade flows to remain relatively insensitive to exchange rate changes, despite the demand being highly elastic. As Menon (1995) notes, if there are significant lags in the transmission of exchange rate changes to prices which are coupled with the subsequent lag in the quantity-response to the relative price change, then the overall balance of payments adjustment process could be severely retarded. [19]

Table 3.2 Causality tests for the euro exchange rate and EMU exports

Pairwise Granger Causality Tests
Date: 06/27/00 Time: 11:26
Sample: 1991:02 2000:03
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Probability
USDEUR does not Granger Cause XTOT	103	3.59563	0.00306
XTOT does not Granger Cause USDEUR		0.54289	0.77426
YUSA does not Granger Cause XTOT	103	2.86409	0.01339
XTOT does not Granger Cause YUSA		0.87791	0.51449
YUSA does not Granger Cause USDEUR	104	1.21854	0.30409
USDEUR does not Granger Cause YUSA		1.09498	0.37150

We should also consider the effect of different kinds of lags. One type of lag is the recognition of changing competitive conditions. Another one is a lag in forming new business connections and placing new orders. A third kind of a lag is between placing new orders and their impact on trade and payment flows. Replacement lags in using up inventories and wearing out existing machinery before placing new orders are a fourth kind of lags. Finally, we can recognize production lags involved in increasing the output of commodities for which demand has increased. Since our data consists of monthly observations, such lags are bound to occur. Hence, the wrong sign that we

[19] If there is hysteresis and heavy sunk costs are associated with entry-exit decisions, competition in the market can remain unchanged. As Menon (1995) explains, this will also lead to a lower pass-through, as firms accept lower margins to stay, or deter entry. However, since the degree of pass-through seemed to be quite high in the EMU area, hysteresis does not appear as a likely explanation.

get for the exchange rate might simply be the well-known J-curve effect. Traditionally, the J-curve effect has been related to the behavior of the trade balance after a depreciation of a currency. The first effect of a depreciation is an increase in import expenditures, since the volume is unchanged owing to prior commitments while the home currency price of imports has risen. As time passes, the quantity adjustment period becomes relevant, whereby import volume is depressed while exports become more attractive to foreign buyers. Hence, for a depreciation to take effect, time is required for the pricing mechanism to induce changes in the volume of exports. Our time interval of one month between the observations is obviously too short for firms to react.

4. SUMMARY OF RESULTS

Thus far, we have made two different observations. First we have seen that there is a negative relationship between the exchange rate and domestic inflation in the EMU area. A depreciation of the euro threatens price stability through putting upward pressure on prices. However, due to lack of time series data, we cannot judge the size of this effect. The evidence suggests that the effect of the exchange rate on prices could be larger than we would expect on the basis of the degree of openness of the EMU economy.

The second observation we have done is that there seems to be a positive effect between the exchange rate and exports: a depreciation of the euro depresses exports. This result contradicts with theory, but could be explained by factors related to the degree of pass-through, to market structure, or to firms' behavior.[20]

[20] Although the demand effect of the exchange rate seems to be hard to model on exports, the stimulating effect of a depreciation is shown in literature applying the concept of the monetary conditions indicator (MCI). An MCI for a given country is a weighted average of a short-term interest rate and an exchange rate, expressed as deviations from their values in the base year. The weights represent the relative effect of the interest rate and the exchange rate on economic growth. Interest rates reflect the pressure stemming from domestic market whereas the exchange rate reflects pressure stemming from abroad. These are the two channels through which monetary policy operates in a flexible exchange rate regime. An increase of the domestic interest rate or an appreciation of the currency depresses growth, and vice versa. In the recent empirical articles, Peeters (1999) uses the NiGEM and Euromoney macro models and reports that the absolute effect on EMU GDP following the exchange rate depreciation of the euro is smaller than for each of the individual countries. However, the influence of exchange rate fluctuations on GDP cannot be neglected. Mayes & Virén (2000) report for EMU that the exchange rate channel could be a more

Given the simplicity of the test presented in the current study, we may conclude that further research is needed in analyzing the role of the euro for EMU inflation. This study as well as some earlier studies indicates that the exchange rate seems to be much more crucial for the inflation rate than was expected prior to EMU. Contrary to the expectation expressed by the ECB in the very beginning of the EMU process, from price stability in the EMU area does not follow a strong euro. Instead, the US dollar seems to have reacted to the positive economic development in the USA. As the US dollar has appreciated, the euro has, by definition, depreciated and created a surprisingly large pressure on domestic prices in EMU. As a consequence, the ECB has to pay great attention to the external value of the euro. Thus, monetary policy is strongly affected by external economic developments. Further research is needed to analyze the relative importance of the external factors versus internal economic developments for monetary policy decisions.

The evidence in the current study and the earlier studies referred to seem to be sufficient for a consensus on that a stronger monetary policy reaction to exchange rate changes is called for than could be judged on the basis of the share of foreign trade to EMU GDP. The role of the euro for domestic price stability in EMU has been more pronounced than the ECB expected. In addition, the domestic price stability has not resulted in exchange rate stability. This suggests a world economy set-up where the USA is the leader and EMU is a follower. The Federal Reserve conducts its stability oriented monetary policy based on domestic economic developments. The US dollar is valued in the foreign exchange markets on the basis of the growth prospects in the USA and of expectations concerning the policy actions of the Federal Reserve. If the euro exchange rate is transmitted to domestic prices as strongly as empirical results seem to indicate, the ECB has to react to the exchange rate. Now, if the exchange rate depreciates at the same time as the domestic economy would call for an easy monetary policy, the ECB faces a difficult situation. Either it has to accept a higher inflation rate due to the exchange rate depreciation, or it endangers a domestic upswing. This conclusion stresses the need for further research not only on the role of the euro for the monetary policy of EMU, but also on the interaction – spill-over effects of monetary policy and transmission of shocks - between the USA and EMU.

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important channel compared to interest rates than might be expected from the size of EMU's

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APPENDIX

Data description

The data was collected from the Main Economic Indicators of the OECD (except the world export prices). The period covered was January, 1990 – March, 2000. For EMU, we used the aggregates constructed for the current euro zone. In those series, data prior to January 1999 have been compiled by the OECD from national series and converted using the prevailing ECU exchange rates. All regression series are first differences of the logs of the original monthly observations.

Exchange rate USD/EUR (USDEUR)

End-of-period spot exchange rate.

Prices (PEMU, PUSA)

Seasonally adjusted consumer price indices for all items in EMU and in the USA respectively.

Production (YUSA, EPROD)

Seasonally adjusted index of industry production excluding construction for the USA and EMU.

Exports (XTOT)

Monthly average of the value of exports (f.o.b.) including internal trade in USD. Data for exports valued in EUR, and data for exports excluding internal trade, was available only quarterly and only from 1995 onwards.

World Export Prices (WPX)

Monthly index for USD-based total world commodity prices, published by the HWWA in “World Commodity Price Indices”.

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