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TRENDS IN EUROPEAN PRODUCTIVITY: Implications for Real Exchange Rates, Real Interest Rates and Inflation Differentials

by

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Editorial

On April 3 -4, 1998 the Oesterreichische Nationalbank hosted a joint Euroconference with the CEPR on „Real Exchange Rates: Recent Theories and Evidence". A number of papers presented at this conference is being made available to a broader audience in the Working Paper series of the Bank. This volume contains the first of these papers.

ABSTRACT

The price of home goods relative to traded goods has risen faster in countries like Belgium, Italy, and Spain than it has in Germany. The observed relative-price trends are in line with sectoral trends in relative labor productivity. A neoclassical model with marginal-cost pricing, long run labor mobility within each country, and long-run PPP in the traded sector can account for the observed trends. As long as the productivity trends continue, countries like Belgium, Italy and Spain will experience equilibrium real appreciations against Germany and will have lower equilibrium real interest rates compared to Germany. Convergence in national inflation rates would require nominal appreciations against the DM to avoid competitiveness problems. In a monetary union, the equilibrium real appreciations and real interest-rate differentials can only come out in inflation differentials. The implied inflation differentials are five to ten times larger than those implied by differences in productivity trends across US regions.

I. INTRODUCTION[1]

Inflation has fallen dramatically in most southern European countries over the last decade, but inflation in the home-good sector remains stubbornly higher than inflation in the traded-good sector. Table 1 reports the average annual growth rates of the relative prices of home goods (measured by the ratio of the price deflator for services to the price deflator for manufactured and agricultural products) in EC countries for which the requisite data are available.[2] The average differentials in sectoral inflation rates for Italy (3.0 percent) and Spain (2.5 percent) were five or six times larger than the differential for Germany (0.5 percent). What is probably less widely recognized is that the large differentials are not just a southern European phenomenon; the relative price of home goods in Belgium has increased even more sharply than the corresponding relative prices in Italy and Spain. What are the forces that are driving these relative price movements? What are their macroeconomic implications?

The existing literature's benchmark for explaining the observed trends in relative prices of home goods is the Balassa-Samuelson "productivity hypothesis."[3] According to this supply-side explanation, productivity gains in the traded sector have made traded goods cheaper to produce, and more so in the countries that have experienced sharper increases in the relative price of home goods. A number of recent studies also emphasize the role of sectoral changes in demand for explaining the observed movements in relative prices (and real exchange rates) in the EC.[4]

Besides supply and demand factors interacting in a competitive environment, departures from the competitive paradigm may account for the observed trends in the relative price of home goods. The potential role of non-competitive forces has been a focal point of policy-oriented discussions in Europe. Our summary rendition of these discussions is that the common market

forced the traded sector in each country to become more competitive; surplus labor shed by the traded sector was absorbed by government employment and by a service sector that was protected from competition by legislation, distribution networks, and tradition. Thus, according to this view, increases in the relative price of home goods were caused by excessive public-sector employment and by rents accruing to the protected home-good sector.[5]

As explained in Section II below, the hypothesis that (unobservable) supply and demand factors interacting in competitive markets account for observed trends in relative prices of home goods has a simple testable implication. For a class of technologies including Cobb-Douglas production functions, labor mobility (across sectors within each country) and marginal cost pricing imply that the relative price of home goods should be proportional to the ratio of average labor productivity in the traded and home-good sectors. That is, trends in any relevant supply and demand shocks should be summarized by trends in the average product of labor.[6]

Table 1 reports the average annual growth rates of the relevant measure of relative labor productivity. Abstracting from sampling variations and measurement errors (which are likely to be severe for productivity figures in the service sectors), the growth rates of relative productivity in Table 1 should equal the growth rates of relative prices if our hypothesis is true. Although the two growth rates differ quite a bit for some countries, the results clearly suggest that the countries with large sectoral inflation differentials (Belgium, Italy and Spain) are also the ones with large sectoral productivity differentials. Our more formal tests, reported in Section III below, confirm this impression. Specifically, the panel unit-root tests of Im, Pesaran and Shin (1995) suggest that the relative price and relative productivity series are nonstationary but the spread between the logarithms of the two series exhibits mean reversion. This suggests that a standard neoclassical model with long-run labor mobility and marginal-cost pricing can explain the long-run trends in relative

prices of home goods.[7]

Turning to the macroeconomic consequences of the observed trends in relative prices of home goods, one familiar implication pertains to movements in the real exchange rate (the relative price of the national outputs of two countries). The trend in the real exchange rate can be decomposed into two components: one reflecting the cross-country difference in the trends of relative prices of home goods, and the other reflecting the trend in the relative price of traded goods across the two countries.[8]

Short-run changes in the relative price of traded goods represent deviations from purchasing power parity (PPP) in the traded sector. Such changes may reflect either an equilibrium response to changes in supply and demand for traded goods or a disequilibrium phenomenon that causes international competitiveness problems. By contrast, changes in the real exchange rate that arise purely from trends in the relative prices of home goods have no direct implication for international competitiveness. Maintenance of PPP for traded goods only implies that countries with the relative price and productivity profile of Belgium, Italy or Spain must experience a trend real appreciation against countries with the German profile. Moreover, if the nominal exchange rate is fixed, this real appreciation must be reflected in higher inflation in the home-good sectors of countries like Belgium, Italy and Spain. Thus, if the relative price and productivity trends continue to hold after EMU, the equilibrium real appreciations against DM would have to come out in cross-country differences in national inflation rates.

Table 2 reports the average annual appreciation rates of nominal exchange rates against DM and of two measures of "equilibrium" exchange rates based on PPP, one calculated from GDP deflators and the other from deflators for manufactured and agricultural products (which constitute the bulk of traded goods).[9] Although we acknowledge the familiar pitfalls of any attempt to infer

"equilibrium" exchange rates from measures based on price ratios, we find the results in Table 2 interesting in terms of their implications for whether or not certain currencies where „overvalued" relative to the DM at the time of the 1992 currency crisis.

Consider, in particular, the DM/Lira exchange rate. The Lira depreciated at an average annual rate of 6.8 percent against the DM from the end of 1973 to the end of 1991. This nominal depreciation was in line with the decrease in the price of German relative to Italian manufactured and agricultural products, at an average annual rate of 6.9 percent. These figures suggest that Italy did not experience a long-term loss of international competitiveness in the traded sector.

The nominal depreciation rate of the Lira, however, fell short of offsetting the differential between Italian and German inflation rates, which on average equaled 8.8 percent; a PPP calculation based on national price levels would lead to the impression that the Lira was grossly overvalued by the end of 1991. Our results suggest that such an impression would be unwarranted.[10] Changes in the DM/Lira real exchange rate were almost entirely attributable to changes in relative prices of home goods--which, in turn, reflected the trends in relative productivity. Figure 1 shows how closely the nominal DM/Lira exchange rate followed the PPP exchange rate for traded goods. Figure 2 shows how closely the relative price of home goods, in each country, followed relative productivity.

Besides Italy, the most interesting case reflected in Tables 1 and 2 is that of Belgium. How did Belgium manage to essentially maintain PPP in terms of GDP deflators against Germany, despite the fact that Belgium's relative productivity and relative price trends were even more pronounced than those of Italy and Spain? We suspect the answer may be that Belgian monetary policy has repressed the inflation that would naturally result from Belgian relative price and productivity trends. The low national inflation rate in Belgium led to an average decrease of about 1.8 percent

per annum in the price of Belgian tradeables relative to German tradeables.

Although we acknowledge (again) that international competitiveness issues are too complex to be gauged by looking at simple price ratios, our results (by themselves) suggest that the low national inflation rate in Belgium may have caused competitiveness problems for German firms. Figure 3 shows the divergence of the DM/Belgian franc nominal exchange rate from the PPP exchange rate for traded goods. Figure 4 shows the relationship between the relative price of home goods and relative productivity in Belgium.[11]

More generally, the figures in Table 2 suggest (not surprisingly) that PPP in the traded sector has held much better than PPP for national price levels for EC countries. Panel unit-root tests, reported in Section III below, confirm this impression. The tests find that deviations from PPP in the traded sector exhibit mean reversion; thus, the nonstationarity in real exchange rates is attributed to nonstationarity in relative prices of home goods.

Although a real-exchange-rate trend resulting purely from changes in the relative prices of home goods should not be interpreted as a cause or a manifestation of a change in international competitiveness, such a trend may be linked to other macroeconomic imbalances. In particular, such a trend would have implications for real interest rates.

Integration of financial and goods markets leads, in theory, to cross-country equalization of real interest rates expressed in units of traded goods. Thus, real interest rates measured in units of national outputs will be lower in countries where the relative price of home goods rises more rapidly. In a floating exchange-rate regime, this difference in equilibrium real interest rates may come out in a cross-country differential in nominal interest rates. But if nominal interest rates converge in a fixed-exchange-rate regime, cross-country differences in equilibrium real interest rates must be reflected in inflation differentials. In Section IV, we calculate the magnitudes of the implied

inflation differentials for EC countries and compare them to corresponding magnitudes for US regions.

In comparing our results to the findings of earlier studies, it should be kept in mind that we focus entirely on long-run trends in the data. Our findings should not be construed as contradictory to studies, such as Stockman and Tesar (1995), that work with detrended data or to regression equations and other approaches to explaining the variability in the data. For example, even setting aside differences in data sets, our claim that the trend in the DM/Lira real exchange rate is almost entirely attributable to trends in relative prices of home goods does not contradict Engel's (1995) finding that most of the variation in the real exchange rate for the US dollar is attributable to deviations from purchasing power parity in the traded sector.

The rest of the paper is organized as follows. In Section II, we present our analytical framework and briefly review the econometric approach we use. In Section III, we present our empirical results. In Section IV, we discuss the implications of our analysis for EMU. Section V contains a brief summary and some concluding remarks. The data are discussed in more detail in an appendix.

II. ANALYTICAL FRAMEWORK

We begin with the link between the relative price of home goods and relative productivity in the traded and home-good sectors. The analytical framework we use is quite general. In each country, capital and labor are employed in the production of traded goods, X, and home goods, H. Competition implies that labor is paid the value of its marginal product, and labor mobility implies that the nominal wage rate, W, is equal in the two sectors.

$$\frac{\partial X / \partial L^X}{\partial H / \partial L^H} = \frac{W / P^X}{W / P^H} = \frac{P^H}{P^X} = Q$$

Equation (1) states the familiar condition that the relative price of home goods, which we denote as Q, is equal to the slope of the production possibility curve.

To measure the marginal products, we assume that the marginal product of labor is

$$\frac{\partial X / \partial L^X}{\partial H / \partial L^H} = \frac{\_ \ (X / L^X)}{y \ \ (H / L^H)}$$

proportional to the average product of labor in each sector.

With Cobb Douglas technologies, _ and y are the labor shares in value added in the traded and home-good sectors. But equation (2) will hold under assumptions that are much less restrictive than Cobb Douglas. Average and marginal products will be proportional if the production functions can

$$X = F(K^X)(L^X)^{-}, \quad H = G(K^H)(L^H)^{y}$$

be expressed as,

where F(.) and G(.) are arbitrary functions that may, for example, depend on inputs other than the firms' choices of labor and capital as in the endogenous growth literature.[12]

When average and marginal products are proportional, the relative price of home goods, Q,

$$Q = \frac{P^H}{P^X} = \frac{\_}{y} \ \frac{X / L^X}{H / L^H} = \frac{\_}{y} \ \frac{x}{h}$$

is proportional to the ratio of the average products of labor, x/h, in the two sectors:

Adding subscripts to denote country i at date t and taking logarithms, we get

$$\ln(Q_{i,t}) = \ln\left(\frac{-i}{y_i}\right) + \ln\left(\frac{x_{i,t}}{h_{i,t}}\right)$$

Although the model described above does not distinguish short-run and long-run fluctuations, in our empirical tests, we interpret equation (5) as a restriction on the long-run trends in the relative price of home goods and relative labor productivity in the two sectors. Thus, in Section III we test whether the spread between ln(Q) and ln(x/h) exhibits mean reversion.

The above relationship between relative prices of home goods and relative sectoral productivities should hold, for the class of production functions satisfying (3), as long as firms are competitive and labor is mobile across sectors (within each country) in the long run.[13] In particular, the relationship does not hinge on whether changes in these variables are in response to changes in underlying supply or demand conditions. After joining the common market, for example, expected future income may have increased in some countries, leading to higher aggregate demand. Since home goods cannot be imported, stronger demand may have increased their share in employment, reduced productivity, and raised the relative price of home goods. Similarly, as Froot and Rogoff (1991) point out, stronger government demand for home goods may have increased their relative price and lowered relative productivity.

We now turn to our decomposition of changes in the real exchange rate. Let $E_{i,t}$ be the nominal exchange rate of currency i, expressed in units of currency 1 (the reference currency) per unit of currency i. Using lower-case letters to denote the natural logarithms of the exchange-rate and price variables [e.g., $\ln(E_{i,t}) = e_{i,t}$, $\ln(P^X_{i,t}) = p^X_{i,t}$], define $d_{i,t}$ as the (percentage) deviation from PPP in the traded sector of country i.

$$d_{i,t} = e_{i,t} + p^{X}_{i,t} - p^{X}_{1,t}$$

To measure the national price level ($p_{i,t}$), we use a geometric average of the price of traded

$$p_{i,t} = g_{i,t}\, p^{H}_{i,t} + (1 - g_{i,t})\, p^{X}_{i,t} ,$$

and home goods in each country,

where $g_{i,t}$ is the share of home goods in nominal value added in country i at date t. The price index in (7) is a minor variation on the Cobb-Douglas price index routinely used in the literature. The only differences are that we define g as a value-added share rather than an expenditure share (because we work with production data) and that we don't assume that shares remain constant over time (because they change considerably in our data).

Let $z_{i,t}$ be the real exchange rate of country i at date t, expressed in units of the reference

$$z_{i,t} = e_{i,t} + p_{i,t} - p_{1,t}$$

country's national output per unit of country i's national output.

$$z_{i,t} = d_{i,t} + g_{i,t}\, q_{i,t} - g_{1,t}\, q_{1,t} ,$$

Using (6) and (7), we can rewrite (8) as

where q is the natural logarithm of the relative price of home goods defined in (1).

Using the operator D to calculate the cumulative change in a variable from the beginning to

$$\Delta z_i = \Delta d_i + [\, g_i \Delta q_i - g_1 \Delta q_1 \,] + [\, q_i \Delta g - q_1 \Delta g \,] + [\, (\Delta g)(\Delta q_i) - (\Delta g)(\Delta q_1) \,] ,$$

the end of our sample (or the average annual change over the sample period), we get:

where g_i, g_1, q_i and q_1 represent the values of the corresponding variables at the beginning of the sample period.

On the right-hand side of (10), the first term represents the contribution of deviations from PPP in the traded sector to the change in the real exchange rate; the following two bracketed terms respectively represent the contributions of changes in relative prices of home goods and of changes in the value-added shares of home goods. The last bracketed term is a second order interaction term involving changes in shares and changes in relative prices.

Turning to our empirical approach, most of the analysis in this paper is informal and self explanatory. The only formal tests reported in Section III below are based on the panel unit-root tests developed by Im, Pesaran and Shin (1995). Their unit-root test for a heterogeneous panel is based on the average over the N cross sections of the Augmented Dickey-Fuller t-ratio, $\bar{t}_N$.[14] Im,

$$\sqrt{N}\left(\frac{\bar{t}_N - a_T}{\sqrt{b_T}} \right)$$

Pesaran and Shin show that the statistic,

is distributed asymptotically as a standard normal. The mean and variance of $\bar{t}_N$, a_T and b_T depend only on the number of time-series observations T and the average lag length in the Augmented Dickey-Fuller regressions and are tabulated by Im, Pesaran, and Shin.[15] For a one-sided test of the unit-root null against the stationary alternative, the rejection region for the standard normal statistic is to the left of -1.645 using a test of size 0.05, and to the left of -1.282 using a test of size 0.10.

III. EMPIRICAL RESULTS

We first consider the stationarity properties of deviations from PPP in the traded sector, $d_{i,t}$ in Equation (6) above. Augmented Dickey-Fuller tests for individual countries (not reported) fail to reject the unit-root null in most cases. This is not surprising given the small number of time-series observations in our data. For the panel as a whole, however, the value of the Im, Pesaran, and Shin test statistic is -3.75. This finding strongly rejects the presence of a unit root in the deviations from PPP, and thus supports long-run PPP, in the traded sector.

For the panel data on relative prices of home goods, $\ln(Q_{i,t})$ above, the value of the Im, Pesaran and Shin statistic is positive (1.31). So, we fail to reject the hypothesis that relative prices are nonstationary. The value of the test statistic is also positive (1.88) for the relative productivity panel, $\ln(x_{i,t} / h_{i,t})$ above, again failing to reject nonstationarity.

If Equation (5) holds in the long run, the difference between the relative-price and relative-productivity series, $\ln(Q_{i,t}) - \ln(x_{i,t} / h_{i,t})$, should be stationary. The Im, Pesaran and Shin statistic for these series is -1.57, rejecting the unit-root null at the 10 percent significance level but not at the 5 percent level. For a larger panel of OECD countries, Canzoneri, Cumby and Diba (1996) find stronger evidence that the difference between the relative-price and relative-productivity series is stationary.[16] This stronger evidence (a test statistic of -4.11) was for a panel with more cross-sectional observations and with all the time series observations available for each country (except for the post-reunification German data). To see if the weaker rejections of the unit-root null for the present paper's data set arise from the smaller cross-sectional or time-series dimension, we maintain the time-series dimensions used by Canzoneri, Cumby and Diba (1996) but restrict the cross-sectional dimension to the EC countries listed in Table 1. The Im, Pesaran and Shin statistic for the resulting panel is -1.92, rejecting the unit-root null fairly strongly (although not as strongly as was

the case for the larger cross-section of OECD countries).

Overall, we consider the above findings quite favorable to the hypothesis that relative prices of home goods and relative sectoral productivities have the same stochastic trends. Thus, the long-run trends in relative prices can be attributed to underlying changes in supply and demand conditions interacting in a competitive neoclassical environment. As such, the departures from the competitive paradigm, which we identified as „policy-oriented" concerns in Section I above, are not needed to explain our data.

Moreover, the most notable discrepancies between relative price and productivity changes in Table 1 go the wrong way for some of the policy-oriented concerns, as we understand them. In particular, an increase in monopolistic markups in the home-good sector relative to the traded sector markup would imply that the relative price of home goods should grow more than relative productivity. The results in Table 1 suggest that the converse is true for Belgium, Italy, Spain and a number of other countries. Similarly, wage pressures in the home-good sector would not be a likely candidate for explaining the discrepancies between relative price and productivity growth in Table 1, while wage pressures in the traded sector could.

At a more fundamental level, however, the observed productivity trends themselves could reflect non-competitive forces. In particular, excessive growth in public-sector employment and/or inefficient protection of the home-good sector may have caused slower productivity growth in this sector in countries like Belgium, Italy and Spain, compared to Germany. Our analysis, based on macroeconomic aggregates, cannot determine the fundamental microeconomic causes of the observed productivity trends.

Slower (than German) productivity growth in the home-good sector, however, has not been the main source of the differentials in relative productivity growth reflected in Table 1.[17] In the case

of Italy and Germany, for example, about one-fifth of the observed differential in relative productivity growth comes from slower productivity growth in the Italian (relative to German) home-good productivity; the remaining four-fifths of the differential arise from more rapid productivity gains in Italian tradeables, compared to German tradeables. For Belgium (Spain) only about one-sixth (one-quarter) of the differential in relative productivity growth is attributed to slower (than German) productivity gains in the home-good sector. Overall, the more notable cross-country differences in relative productivity growth reflect productivity gains in the traded sector, which may reflect „catching up" with Germany and technology transfer after market liberalization.

We next consider the decomposition of real-exchange-rate changes. For each country, we calculate the average annual rate of real appreciation against Germany using (7) and (8) and the decomposition in (10). Table 3 contains the results. Note first that the average annual real appreciation rates calculated using our price index (7) are quite close to the real appreciation rates implied by adding the nominal appreciations and the inflation differentials for GDP deflators reported in Table 2. Thus, the fact that we work with a geometric price index and only use data for the manufacturing, agriculture and service sectors does not seem to skew our results.

Table 3 shows that all countries except Belgium experienced real appreciations against Germany. Most of these real appreciations, however, did not involve sizeable increases in prices of traded goods relative to German tradeables. The only notable exceptions were UK and Spain. In most cases, the contributions of changes in relative prices of home goods to real appreciations were larger than the contributions of deviations from PPP in the traded sector. For Belgium, the results confirm the impression discussed in Section I: the real appreciation against Germany caused by the rising relative price of home goods was (exactly) offset by the real depreciation in the traded sector.

Table 3 also shows that changes in value-added shares of home goods did not play any

significant role in observed real appreciations. The main reason behind this finding is reflected in Table 4. Although there is quite a bit of cross-country variation in the value-added shares at the beginning and at the end of our sample period, all the countries (including Germany) experienced roughly comparable increases in the share of home goods over the sample period. Thus, the average annual cross-country differences in changes of shares were negligible.

To summarize our empirical findings for the 1973-1991 period, both the formal unit-root tests and our casual discussion of the data lead us to conclude that deviations from PPP in the traded sector have not been an important source of long-run real appreciations against DM. By contrast, relative prices of home goods seem nonstationary and their contributions to real appreciations seem large for several countries. These relative price trends seem roughly to be in line with relative productivity trends. Before turning to the implications of these findings, we briefly comment on the robustness of the casual impressions based on Tables 1 and 2.

The general impression conveyed by Table 1–that growth rates of relative prices of home goods are roughly in line with growth rates of sectoral relative productivities–is not very sensitive to our decision to drop observations before 1973 and after 1991. Since the theoretical relationship between relative prices and productivities is not logically related to the exchange-rate regime, we report the results using all available data (described in the data appendix) in Table 5. The general impression is much the same as the one conveyed by Table 1. The figures for Germany in Table 5, however, deserve the following brief comment.

The OECD has continued to publish data for former West Germany after reunification. These data points (particularly the ones for 1992 and 1993) are the main reason for the discrepancy between the growth rates of relative productivity and relative price of home goods in Table 5. According to OECD data, German productivity in the traded sector relative to the home-good

sector fell by 1.0 percent in 1992, and by another 2.8 percent in 1993; the relative price of home goods rose by 2.1 percent in 1992, and by 2.8 percent in 1993 (at a considerably faster rate than what the data for earlier years suggest). These figures make us suspicious about the quality of German data for 1992 and 1993.[18]

By contrast, the general impression conveyed by Table 2–that long-run PPP held reasonably well in the traded sector for most countries–is quite sensitive to our decision to ignore exchange-rate changes before the end of 1973 and after the end of 1991. The DM appreciated sharply against other currencies during 1973. This appreciation, however, was presumably attributable to undervaluation of DM before the advent of generalized floating in early 1973. The DM also appreciated sharply against several currencies during 1992 and 1993.

In particular, the nominal DM appreciation against the Lira over the two years was more than 26 percent. By contrast, if we believe the OECD figures, the price of Italian tradeables relative to German tradebles fell by 1.3 percent in 1992, and rose only 2.6 percent in 1993. These changes were large enough to have a noticeable effect on average annual growth rates. Between the end of 1973 and the end of 1993, Italian tradeables became cheaper relative to German tradeables at an average annual rate of 1.2 percent.

Overall, however, the short span of our data and doubts about the quality of our data for Germany preclude a meaningful extension of our analysis to the post 1991 period. In the following section, therefore, we take the trends we found in our data for 1973-1991 as long-run stylized facts, and discuss their macroeconomic implications for a (hypothetical) currency union.

IV. IMPLICATIONS FOR EMU

The preceding discussion leads us to consider the implications of a simple analytical

framework in which value-added shares are constant, long-run PPP holds in the traded sector, and the long-run trend in the relative price of home goods coincides with the long-run trend in sectoral relative productivity. In this stylized framework, (5) and (10) link the equilibrium real appreciation

$$\Delta z_i = g_i \Delta q_i - g_1 \Delta q_1 = g_i [\Delta \ln(x_i) - \Delta \ln(h_i)] - g_1 [\Delta \ln(x_1) - \Delta \ln(h_1)]$$

rate to changes in relative productivity.

In long-run equilibrium, countries with relative productivity trends like those of Belgium, Italy and Spain should experience real appreciations against countries like Germany.

Real interest parity implies that these equilibrium real appreciations must be matched by differentials in real interest rates. Countries like Belgium, Italy and Spain have lower equilibrium real interest rates than countries like Germany. A mechanical intuition for this result can be gained by noting that, with integration of financial and goods markets, real interest rates expressed in units of traded goods must equalize across countries. Thus, real interest rates measured in units of national outputs must be lower in countries where the relative price of home goods rises more rapidly.

In a floating exchange-rate regime, the equilibrium real appreciations and real interest-rate differentials may be reflected in nominal appreciations and in cross-country differentials in nominal interest rates. In a currency union, however, the real appreciations and real interest rate differentials must be reflected in cross-country inflation differentials. Countries like Belgium, Italy and Spain must have higher national inflation rates than countries like Germany.

We obviously don't know whether the relative productivity trends reflected in Table 1 will continue under EMU. To the extent that the trends arise from „catching up" with German technology in the traded sector, the observed trends should cease to hold once the catching up is

complete. But cross-country differences in levels of technology are not easily measured. So we don't know how much „catching up" remains to be done in the future.

Table 6 reports the magnitudes of implied inflation differentials with Germany assuming that the relative productivity trends in Table 1 and the 1991 value-added shares in Table 4 continue to hold. That is, we use the values in Tables 1 and 4 to calculate the right-hand side of (12). Based on these calculations, all the countries are expected to have higher inflation rates than Germany; the largest differentials are for Belgium (2.4 percent per annum) and Italy (2 percent per annum).

These implied inflation differentials have at least two implications: one concerning national monetary policies and one concerning inflation targets in hypothetical monetary unions. Suppose (national) monetary authorities aim to remove any inflation differentials with Germany. If exchange rates are flexible, a nominal appreciation relative to the DM will be required to accommodate the more rapid productivity growth in the traded sector (relative to Germany) while maintaining PPP for traded goods. If, however, exchange rates are fixed and central banks seek to suppress any inflation differentials, the more rapid productivity growth in the traded sector (relative to Germany) must result in a decline in the price of traded goods (relative to Germany). National authorities may therefore either seek to remove inflation differentials or to fix the exchange rate. But attempting to do both leads to potential competitiveness problems.

Table 6 also reports the implied inflation differentials against two hypothetical currency unions. Our „large union" consists of Austria, Belgium, Finland, France, Germany, Italy and Spain. Our „small union" consists of Austria, Belgium, Finland, France and Germany. The inflation rate used for each „union" is a weighted average of the inflation rates implied by productivity trends and value-added shares in its „member" countries, using 1991 GDP figures in US dollars as weights. The member countries whose regional inflation rates would be very close to the overall inflation rate in

the „large union„are Austria, Finland and France. Regional inflation rates in Belgium and Italy would be higher by 1.4 and 1.0 percentage points, respectively.

The regional inflation rate for Germany, in the thought experiment of Table 6, would be one percentage point below the rate for the „large union„as a whole. This observation suggests that inflation targets for such a „union„should be contemplated carefully. If, for example, the „union„ policy is to hold inflation constant in Germany, then the inflation target for the „union„should be one percentage point above the inflation rate that prevailed in Germany before EMU. If the „union„ is to have an inflation target equal to the German target before EMU, then regional inflation in Germany will have to fall by one percentage point after EMU.

The „small union„which excludes Italy and Spain, would still have an inflation differential of 0.6 percentage points with Germany, in the thought experiment of Table 6. Similar calculations (not reported in the Table) for an even smaller union consisting only of Austria, France and Germany would imply that the inflation rate in such a „union„would be about 0.5 percentage points above the regional inflation rate in Germany.

Are the inflation differentials, implied by productivity trends, across EC countries large? To set a benchmark for comparison, Table 7 reports the relevant figures for eight regions in the United States; the regions correspond to aggregations used by Bayoumi and Eichengreen (1993).[19] We report the average growth rates of relative sectoral labor productivity (x/h) from 1977 to 1992, the share of the home-good sector in nominal value-added (g) in 1990, and the implied inflation differentials between various regions and the Mideast. Compared to our earlier results for the EC, there is considerably less variation in relative productivity growth across US regions, and the implied differentials in regional inflation are only about a fifth the size of the differentials for EC countries. The eight regions that make up the US are clearly more homogeneous than the countries that may be

included in EMU, in terms of relative productivity trends.

V. SUMMARY AND CONCLUSIONS

Both our casual evidence (based on average annual growth rates) and our formal unit-root tests (for the panel of EC countries with available data) suggest that trends in relative prices of home goods can be attributed to trends in sectoral relative productivities. These findings suggest that the rapid increases in relative prices of home goods in countries like Belgium, Italy and Spain are in line with the predictions of a simple neoclassical model with marginal-cost pricing and long-run labor mobility across sectors within each country. As such, departures from the competitive paradigm are not necessary for explaining our data.

In particular, our results do not support the view that observed increases in relative prices of home goods reflect wage pressures in the home-good sector or rising monopolistic markups for home goods, relative to markups for traded goods. We cannot rule out the possibility that the observed relative productivity trends themselves partly reflect inefficient protection and growth of employment in the home-good sector. Productivity in this sector has grown more rapidly in Germany than it has in other EC countries. Cross-country differences in home-goods productivity, however, have been relatively small in magnitude.

The more noticeable cross-country differentials in relative productivity growth arise from cross-country differences in traded-sector productivity gains. Thus, we think that rapid increases in relative prices of home goods in southern European countries and Belgium are largely due to productivity gains in their traded sectors, and fundamentally should not be a cause for concern.

In terms of their contributions to observed trends in real exchange rates, cross-country differences in growth rates of relative prices of home goods have generally played a more important

role than deviations from PPP in the traded sector. Indeed, our unit-root test for the panel of EC countries as a whole suggests that deviations from PPP in the traded sector exhibit mean reversion. This finding implies that stochastic trends in real exchange rates are entirely attributable to trends in relative prices of home goods.

If the trends in prices and productivity continue, and if long-run PPP continues to hold for traded goods, then countries like Belgium, Italy and Spain should continue to experience real appreciations against Germany. After EMU, these real appreciations can only come out as regional (or national) inflation differentials and regional real-interest-rate differentials. These differentials may be as large as 2 or 2.5%, which is on the order of five to ten times the size of differentials observed across regions in the US. Does this mean that the EU is a less natural candidate for monetary union than the US? Let us consider the real-interest-rate differentials and the inflation differentials separately.

The real-interest-rate differentials we expect to see (across countries in Europe or regions in the US) will be the natural consequences of differences in regional productivity trends; in particular, we would expect to see the same real-interest-rate differentials across Europe no matter what monetary arrangements -- EMU, ERM, managed float -- the EU ultimately chooses. These differentials reflect basic microeconomic forces at work, and in particular they do not imply regional differences in macroeconomic policy. We see no reason, on these grounds anyway, to say that the EU is a less natural candidate for monetary union than the US.

On the other hand, regional differences in productivity imply regional differences in inflation within the EMU, with the associated regional differences in „shoe leather„ costs. If differences of 2 or 2.5% are deemed to be important, then the EU may not be a natural candidate for a monetary union. In any case, regional differences in inflation should be taken into account

when choosing an overall inflation target for the union. Our calculations suggest that if the goal is to keep regional inflation in Germany constant, then the union target should be 1% higher than the old German target if both Spain and Italy are admitted to the union, and 0.5% higher if they are not.

With flexible exchange rates, national monetary policies could overcome the differences in productivity and make inflation rates converge. The required changes in the relative price of home goods would still have to occur in each country. This would mean that prices of traded goods in countries like Spain and Italy would have to fall relative to prices of traded goods in Germany, but nominal appreciations of the Peseta and the Lira would preserve long-run PPP in the traded sector. Even with fixed exchange rates, monetary policy may be able to make inflation rates converge in the short run, but only at the expense of breaking PPP in the traded sector and creating competitiveness problems for Germany.

This reasoning suggests that the inflation convergence criteria written into the Maastricht Treaty were misguided. It also suggests that countries (like the UK and Greece) that do not join EMU in the first wave should not be held to both exchange-rate and inflation criteria for their eventual qualification. One or the other would suffice as a measure of monetary convergence without creating competitiveness problems associated with differences in productivity trends.

APPENDIX: THE DATA

Nominal exchange rates are end-of-year figures from International Financial Statistics (line ae). GDP deflators are from the same source. For Belgium, Denmark, Great Britain, Finland, France, Germany, Italy and Sweden, sectoral price and productivity data come from the OECD International Sectoral Database, 1995. For Austria and Spain, they come from national statistics. (Francisco de Castro of the Bank of Spain collected and documented the data.) These sources provide annual data on nominal and real value added and number of employees. Sectoral prices are implicit deflators.

Traded goods consist of the "manufacturing" and "agriculture, hunting forestry and fishing" sectors. Home goods consist of the "wholesale and retail trade, restaurants and hotels", "transport, storage and communication", "finance, insurance, real estate and business services", "community social and personal services", "non-market services" sectors. "Non-market services" include the "producers of government services" and "other producers" subsectors.

The productivity data allow us to begin in 1960 for Germany and Finland, in 1964 for Spain, in 1967 for Denmark, and in 1970 for the remainder of the countries. The data end in 1993 for all countries except Austria and Spain (both 1992), Great Britain (1991), and Belgium (1990).

Data consistency is always an issue. We are aware of these anomalies in the OECD data: (1) The German market services employment figures do not include the "real estate and business services" sector; value-added figures do. (2) The Italian, British and Belgian value-added and employment figures do not include "real estate and business services" sector. (3) British value-added and employment figures consist of the "producers of government services" sector.

Data for the United States come from the Regional Projections data of the Commerce Department's Bureau of Economic Analysis. Regional inflation rates are derived from regional Gross

State Product (GSP) deflators; deflators are not available for traded and home goods at a sectoral level. This represents another slight inconsistency with the OECD data which are measured according to value added rather than final product.

REFERENCES

Asea, Patrick K. and Max Corden (1994), "The Balassa-Samuelson Model: An Overview," Review of International Economics, 2 (October): 244-267.

Balassa, Bela (1964), "The Purchasing Power Parity Doctrine: A Reappraisal," Journal of Political Economy, 72 (December): 584-596.

Bayoumi, Tamim and Barry Eichengreen (1993), "Shocking Aspects of European Monetary Integration," in Francisco Torres and Francesco Giavazzi (eds), Adjustment and Growth in the European Monetary Union, Cambridge University Press.

Canzoneri, Matthew B., Robert E. Cumby and Behzad Diba (1996), „Relative Labor Productivity and the Real Exchange Rate in the Long Run: Evidence for a Panel of OECD Countries, „NBER Working Paper no. 5676, forthcoming in Journal of International Economics.

Canzoneri, Matthew B., Behzad Diba and Gwen Eudey (1996), „Trends in European Productivity and Real Exchange Rates: Implications for the Maastricht Convergence Criteria and for Inflation Targets after EMU, „CEPR Discussion Paper no. 1417.

De Gregorio, Jose, Alberto Giovannini and Thomas Krueger (1994), "The Behavior of Nontradable Goods Prices in Europe: Evidence and Interpretation," Review of International Economics, 2: 284-305.

De Gregorio, Jose, Alberto Giovannini and Holger Wolf (1993), "International Evidence on Tradables and Nontradables Inflation," European Economic Review, 38: 1225-1244.

Engel, Charles (1995), „Accounting for U.S. Real Exchange Rate Changes, „NBER Working Paper no. 5394.

Froot, Kenneth, and Kenneth Rogoff (1991), "The EMS, the EMU and the Transition to a Common Currency," NBER Macroeconomics Annual, 6: 269-317.

Froot, Kenneth, and Kenneth Rogoff (1995), "Perspectives on PPP and Long-Run Real Exchange Rates," in Gene Grossman and Kenneth Rogoff (eds.) Handbook of International Economics, Volume 3, North Holland Press.

Hall, Alastair (1994), „Testing for a Unit Root in Time Series with Pretest Data-Based Model Selection, „Journal of Business and Economic Statistics, 12: 461-470.

Im, Kyungso, M. Hashem Pesaran and Yongcheol Shin (1995), „Testing for Unit Roots in Heterogeneous Panels, „ Working Paper, Department of Applied Economics, University of Cambridge.

Marston, Richard (1987), "Real Exchange Rates and Productivity Growth in the United States and Japan," in Sven Arndt and J. David Richardson (eds), Real-Financial Linkages Among Open Economies, MIT Press.

Micossi, Stefano, and Gian Maria Milesi-Ferretti (1994), "Real Exchange Rates and the Prices of Nontradable Goods," IMF working paper.

Ng, Serena and Pierre Perron (1995), „Unit Root Tests in ARMA Models with Data-Dependent Methods for the Selection of the Truncation Lag, „Journal of the American Statistical Association, 90: 268-281.

Rebelo, Sergio (1993), "Inflation in Fixed Exchange Rate Regimes: the Recent Portuguese Experience," in Francisco Torres and Francesco Giavazzi (eds), Adjustment and Growth in the European Monetary Union, Cambridge University Press.

Samuelson, Paul (1964), "Theoretical Notes on Trade Problems," Review of Economics and Statistics, 46 (May): 145-154.

Stockman, Alan, and Linda Tesar (1995), "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," American Economic Review, March: 168-185.

TABLE 1
Percentage Growth Rates of Relative Prices and Productivities
Average Annual Rates over 1973-1991

	Relative Price	Relative Productivity
Austria	2.1	2.1
Belgium	3.1	3.8
Denmark	1.2	1.7
Finland	2.1	1.7
France	1.6	1.8
Germany	0.5	0.4
Italy	3.0	3.2
Spain	2.5	2.7
Sweden	1.1	1.5
United Kingdom	1.3	2.2

Notes: The relative price series for each country is the ratio of the price deflator for services to the price deflator for manufacturing and agriculture. The relative productivity series is the ratio of the average product of labor in manufacturing and agriculture to the average product of labor in the service sector. The last observation for Belgium is 1990.

TABLE 2
Percentage Nominal Appreciations against DM
and Inflation Differentials with Germany
Average Annual Rates over 1973-1991

	Nominal Appreciation	National Inflation Differential	Traded-Sector Inflation differential
Austria	0.2	1.0	0.1
Belgium	-1.8	1.7	0.0
Denmark	-2.9	3.4	2.8
Finland	-3.6	4.8	3.9
France	-3.7	4.1	3.6
Italy	-6.8	8.8	6.9
Spain	-6.2	8.2	7.0
Sweden	-4.3	5.0	4.4
United Kingdom	-4.4	6.1	5.8

Note: For each country, the national inflation differential is the difference between the inflation rate in its GDP deflator and the inflation rate in the German GDP deflator. The traded-sector inflation differential is similarly calculated from the price deflators for manufacturing and agriculture. The last observation for Belgium is 1990.

TABLE 3
Percentage Real Appreciations against DM
and Their Components
Average Annual Rates over 1973-1991

	Total	PPP Deviation	Relative Price	Value-Added Share
Austria	1.3	0.4	1.0	-0.1
Belgium	-0.1	-1.8	1.8	-0.1
Denmark	0.5	-0.1	0.6	0.0
Finland	1.4	0.3	1.0	0.0
France	0.5	-0.2	0.7	-0.0
Italy	1.7	0.1	1.6	-0.0
Spain	2.0	0.9	1.1	-0.0
Sweden	0.7	0.2	0.5	-0.0
United Kingdom	2.0	1.4	0.6	0.0

Notes: For each country, we report the average annual rate of real appreciation against Germany (in the column labeled Total) and decompose it into its three components. The first component is the contribution of deviations from PPP in the traded sector. The second component is the contribution of changes in relative prices of home goods. The last component is the contribution of changes in the value-added shares of home goods. See Equation (10) in the text. We don t report the quantitatively negligible second-order terms in Equation (10). The last observation for Belgium is 1990.

TABLE 4
Shares of Home Goods in Nominal Value-Added
in 1973 and 1991

	1973	1991
Austria	0.55	0.67
Belgium	0.60	0.70
Denmark	0.70	0.76
Finland	0.57	0.71
France	0.60	0.73
Germany	0.54	0.65
Italy	0.58	0.70
Spain	0.51	0.66
Sweden	0.65	0.75
United Kingdom	0.62	0.75

Notes: The shares of home goods are calculated as the ratio of nominal value-added in the service sector to nominal value-added in the manufacturing, agriculture and service sectors. The last observation for Belgium, reported in the „1991" column is actually for 1990.

TABLE 5
Percentage Growth Rates of Relative Prices and Productivities
Average Annual Rates

	Relative Price	Relative Productivity
Austria	2.1	2.0
Belgium	3.3	4.0
Denmark	1.4	2.0
Finland	1.5	1.8
France	1.7	1.8
Germany	1.5	1.0
Italy	2.9	3.1
Spain	3.3	3.2
Sweden	1.4	2.1
United Kingdom	1.5	2.7

Notes: The relative price series for each country is the ratio of the price deflator for services to the price deflator for manufacturing and agriculture. The relative productivity series is the ratio of the average product of labor in manufacturing and agriculture to the average product of labor in the service sector. We use all the available data (described in the data appendix) for each country.

TABLE 6
Implied Inflation Differentials with Germany and the „Union„

	With Germany	With Large Union	With Small Union
Germany	----	-1.0	-0.6
Austria	1.2	0.2	0.6
Belgium	2.4	1.4	1.8
France	1.1	0.1	0.5
Finland	1.0	0.0	0.4
Italy	2.0	1.0	1.4
Spain	1.5	0.5	0.9
Denmark	1.0	0.0	0.4
Sweden	0.9	-0.1	0.3
United Kingdom	1.4	0.4	0.8

Notes: The relative productivity growth rates of Table 1 and the 1991 shares of Table 4 are used to evaluate the right-hand side of Equation (12). Our hypothetical large currency union consists of Austria, Belgium, Finland, France, Germany, Italy and Spain. Our hypothetical small union excludes Italy and Spain. The inflation rate for the „union„is calculated as a weighted average of the inflation rates implied by productivity trends and value-added shares in „member„countries, using 1991 GDP figures in US dollars as weights.

TABLE 7
Growth Rates of Relative Productivity, Value-Added Shares and Implied Inflation Differentials Across US Regions

	Relative Productivity Growth	Share of Home Goods	Implied Inflation Differential with Mideast
Mideast	2.20	0.55	----
New England	2.40	0.52	0.0
Plains	2.09	0.50	-0.2
Southeast	2.04	0.53	-0.1
Southwest	1.06	0.52	-0.7
Rockies	2.15	0.54	-0.1
Far West	2.13	0.55	-0.1
Great Lakes	1.69	0.49	-0.4

Notes: For each region, we report the average annual growth rate of relative productivity (the ratio of the average product of labor in manufacturing and agriculture to the average product of labor in the service sector) between 1977 and 1992. We also report the shares of home goods (calculated as the ratio of nominal value-added in the service sector to nominal value-added in the manufacturing, agriculture and service sectors) in 1990. The implied inflation differentials are calculated from Equation (12) using the Mideast as the reference region.

ENDNOTES:

- [1] This paper is a substantially revised version of Canzoneri, Diba and Eudey (1996). We have changed the title to reflect the new content of the paper. Matthew Canzoneri was visiting the Bank of Spain when the first draft of the earlier paper was written; he gratefully acknowledges the Bank's support and hospitality. We have benefitted from discussions with José Luis Malo de Molina, Jean-Jacques Rey José Viñals, Georg Winckler, and participants in seminars at the Oesterreichische Nationalbank and the Bank of Spain. However, the usual disclaimer applies. We thank Tamim Bayoumi, Gian Maria Milesi-Ferretti and the Bank of Spain for providing the data that were used in this project; and finally, we thank Francisco de Castro, who carefully gathered and documented the data.

1. Precise definitions of variables and data sources are give in the data appendix. Our classification of all services as non-traded was dictated by the data we have for Austria and Spain. For most of the countries we study, the relevant OECD data are available from 1970 to 1993. We drop the observations before 1973 to focus on the floating exchange rate period. We briefly discuss the observations for 1992 and 1993 (which may be contaminated by the European currency crisis and peculiarities of OECD data for former West Germany) in Section III below.

3. Balassa (1964) and Samuelson (1964) cast their discussions in terms of developing countries. Marston (1987) applied the theory to dollar-yen exchange rates. Papers that focus on Europe include De Gregorio, Giovannini and Krueger (1994), De Gregorio, Giovannini and Wolf (1994), Froot and Rogoff (1991), Micossi and Milesi-Ferretti (1994), and Rebelo (1993). Asea and Corden (1994) and Froot and Rogoff (1995) provide recent surveys.

4.Froot and Rogoff (1991) suggest that changes in government demand for home goods may have contributed to movements in real exchange rates. De Gregorio, Giovannini and Krueger (1994) suggest that an increase in the private sector's demand for home goods may account for the observed increase in their relative price. To formalize this idea, De Gregorio, Giovannini and Wolf (1994) use a parameterization of preferences for which the expenditure share of nontraded goods grows with aggregate income, and thus over time.

5.In the academic literature, to our knowledge, the only attempt to model such non-competitive forces is by De Gregorio, Giovannini and Krueger (1994). Their model allows for mark-up pricing in the markets for traded and home goods and for sectoral wage pressures attributed to collective bargaining.

6.Panel unit-root and cointegration tests for OECD countries--reported in Canzoneri, Cumby and Diba (1996)–find strong support for this hypothesis. We report the simplest version of these tests for the subsample of EC countries in Section III below.

7.Our discussion at this point leaves open the possibility that the observed productivity trends themselves may partly reflect excessive public-sector employment or inefficient protection of the home-goods sector. We comment on this possibility in Section III below.

7. See, in particular, Marston (1987) and Engel (1995). This standard decomposition approximates the expenditure-share of the home-good sector by a constant. We discuss a more precise decomposition in Sections II and III below.

9.We use exchange-rate figures for the end of the year to avoid the turbulent period that followed the advent of generalized floating in early 1973.

10.We don't mean to render an opinion on whether or not the Lira was overvalued in 1992. But the broadly measured inflation differential, by itself, should not be taken as a sign of overvaluation.

11.Jean-Jacques Rey has graciously communicated to us the findings of a study at the National Bank of Belgium, in response to an earlier version of this paper. Extending our value-added price indexes and productivity series to 1996, the study finds an even closer correspondence (than what we report in Table 1) between the relative price of home goods and relative productivity. The relative price of home goods faced by Belgian consumers (reflected in components of the CPI), however, has not exhibited such a sharp increase over time; in fact, it has behaved much like the relative price of home goods faced by German consumers. We presume that the difference between the value-added and CPI price data reflects the large share of imports in the Belgian consumption basket. The value-added indexes are more directly relevant for issues (such as international competitiveness) discussed in the present paper. The CPI data, however, are more pertinent for a host of other issues–in particular, for the Maastricht convergence criteria.

12.The production functions specified in (3) are the general solutions to the differential equations: $X/L^X = \_(X/L^X)$ and $H/L^H = y(H/L^H)$. We require only that they satisfy the standard properties of production functions.

13.Markup pricing in goods markets could easily be introduced into our setup. It would not affect the implied long-run relationship between ln(Q) and ln(x/h) as long as the ratio of sectoral markups in each country exhibits mean reversion.

14.We use the general-to-specific procedures suggested by Hall (1994) and Ng and Perron (1995) to determine the number of lags in the Augmented Dickey-Fuller regression for each country.

15.As they suggest, we use common time dummies to account for correlation across cross section units.

16.This stronger evidence comes from the Im, Pesaran and Shin test as well as other panel unit-root and cointegration tests and survives more careful econometric scrutiny of the small sample properties of the tests, alternative ways of dealing with correlation across cross-sectional units, etc.

17.An earlier version of this paper [Canzoneri, Diba and Eudey (1996)] contains the decomposition of the relative productivity trends into their traded-sector and home-sector components for all the countries we study. The earlier version also discussed the possibility that slower productivity growth in the home-good sector may be traced to the inclusion of the public sector. The results, however, were not clear cut.

18.Data quality may be an issue for 1990 and 1991 as well. Excluding these two years, however,

would not change the general message of our results.

19. Regional sectoral price deflators are not available, so we cannot test the productivity hypothesis for US regions directly. However, we do have regional GDP inflation rates; their differentials are of the order of magnitude predicted in Table 7.