TRENDS IN EUROPEAN PRODUCTIVITY AND REAL EXCHANGE RATES

Matthew B. Canzoneri, Behzad Diba
and Gwen Eudey

Banco de España - Servicio de Estudios
Documento de Trabajo nº 9610

TRENDS IN EUROPEAN PRODUCTIVITY AND REAL EXCHANGE RATES

Matthew B. Canzoneri, Behzad Diba
and Gwen Eudey (*)

(*) Matthew Canzoneri was visiting the Bank of Spain when this paper was written; he gratefully acknowledges the Bank's support and hospitality. We have benefitted from discussions with Robert Cumby, José Luis Malo de Molina, José Viñals and participants in seminars at the Bank of Spain. However, the usual disclaimer applies. We thank Tamim Bayoumi, 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.

Banco de España - Servicio de Estudios
Documento de Trabajo nº 9610

In publishing this series the Banco de España seeks to disseminate studies of interest that will help acquaint readers better with the Spanish economy.

The analyses, opinions and findings of these papers represent the views of their authors; they are not necessarily those of the Banco de España.

ISSN: 0213-2710
ISBN: 84-7793-467-3
Depósito legal: M-12320-1996
Imprenta del Banco de España

ABSTRACT

Inflation has fallen dramatically in countries like Spain and Italy over the last decade, but the rate of increase in "home good" prices remains stubbornly higher than the rate of increase in "traded good" prices. The paper begins by showing that this discrepancy can be explained (at least in part) by trends in productivity; average labour productivity has grown much more slowly in the home good sector in these countries. The paper goes on to investigate the implications of productivity trends for the consistency of the Maastricht convergence criteria an for the differences in nation inflation rates after EMU. The paper also discusses the difficulties some countries may have in meeting the convergence criteria, and some of the options open to them.

I. INTRODUCTION

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. Figure 1A illustrates the point. Real exchange rates -- the price of home goods in terms of traded goods -- have increased three times faster in Spain and Italy than in Germany.[1] Or in terms of inflation rates, the difference between home good inflation and traded good inflation has been almost 3% in Italy and Spain, but less than 1% in Germany. What is less widely recognized is that this is not just a southern European phenomenon. Figure 1B plots the real exchange rates of some of the countries that might be expected to be at the core of an eventual monetary union. The difference between home good inflation and traded good inflation in Belgium has been more than 3%, higher than in Italy or Spain. Table 1 gives the average inflation differential, and its standard deviation, for various European countries.

What are the forces that are driving these appreciations? What are their implications for the Maastricht Treaty process, and what are their implications for monetary policy should a monetary union actually come about? Three potential explanations of the real appreciations have been put forward. The first, and oldest, is the "productivity hypothesis," which attributes the real appreciations to more rapid productivity growth in the traded good sector.[2] According to this supply side explanation, traded goods have become cheaper to produce, and more so in the countries that have experienced greater real appreciations.

The second, and more recent, potential explanation of the real appreciations extends the productivity hypothesis by considering changes in demand for traded and home goods.[3] According to this "relative demand hypothesis," stronger demand for home goods, possibly related to growing public sector demand, has led to real appreciations that exceed what productivity trends alone would imply.

The third potential explanation of the real appreciations is a political economy argument that has not been formalized in the academic literature but is a focal point of policy oriented discussions in Europe. We will call it the "labor absorption hypothesis". According to this hypothesis, the common market forced the traded good sector in each country to become more competitive; surplus labor shed by the traded good 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, the appreciations were caused by excessive public sector employment and by rents accruing to the protected home good sector.

The present paper focuses primarily on a testable implication of the productivity hypothesis, an implication that should hold regardless of any shifts in relative demands. As we elaborate below, for a class of technologies including Cobb-Douglas production functions, marginal cost pricing implies that the real exchange rate should be proportional to the ratio of average labor productivity in the traded and home good sectors. Figures 1C and D plot the relative productivity series. To anticipate our results, we find that the observed real appreciations are roughly in line with these relative productivity trends. This suggests that a standard neoclassical theory of marginal cost pricing may explain the appreciations; thus, the political economy arguments of the labor absorption hypothesis may be unnecessary.

At a more fundamental level, however, the labor absorption hypothesis may be interpreted as stating that the observed trends in labor productivity are themselves consequences of excessive growth in public sector employment and/or inefficient protection of the home good sector. Our empirical analysis, based on macroeconomic aggregates, cannot determine the fundamental microeconomic causes of the observed trends in labor productivity. We can not determine whether the relationship between the real exchange rate and relative labor productivity should be interpreted along the lines of the neoclassical productivity hypothesis or along the lines of the newer labor absorption hypothesis. This is unfortunate because, as we elaborate below, the policy implications of our findings depend on the underlying causes of the observed trends in productivity.

The first issue we examine is the consistency of the convergence criteria in the Maastricht Treaty. The productivity hypothesis implies that convergence in CPI inflation may not be consistent with fixed exchange rates. If for example monetary policy holds nominal exchange rates fixed, then traded good inflation can be expected to equalize across countries.[4] But if (as suggested by Figure 1C) productivity trends require more real appreciation in say Spain than in Germany, then home good inflation will have to be higher in Spain, and overall CPI inflation will have to be higher as well. So, fixed exchange rates are inconsistent with full convergence in CPI inflation, unless changes in government policy, at the microeconomic level, can speed up productivity growth in the home good sector.

More fundamentally, we will see that a standard neoclassical model predicts real interest rate differentials -- where real rates are defined in terms of CPI inflation -- across countries with different productivity trends. The real interest rate differential is determined by productivity, but monetary policy determines how the differential manifests itself. It can take the form of a CPI inflation differential, or it can come out as a nominal interest rate differential (with an accompanying change in the nominal exchange rate) However, full convergence in CPI inflation and nominal interest rates would require microeconomic policies leading to convergence of relative labor productivities. In the absence of such policies, full convergence in inflation and interest rates is simply not on; it is not an equilibrium solution.

The Maastricht convergence criteria are however more flexible than that; they do not require full convergence in CPI inflation, and the ERM allows exchange rates to vary within 15% bands. To qualify for participation in the monetary union, a country must have an inflation rate that is within 1.5% of the three best performing member countries and an ERM parity that it has not devalued within the last two years. So, the operational question is one of time and magnitude. Do observed differences in productivity imply inflation differentials that are within 1.5% of each other when limited exchange rate flexibility is allowed? Tight monetary policy can keep inflation differentials down in the short run, but generally at a cost in terms of employment; the long term dictates of productivity may not preclude any country from qualifying if the decision period is not too long. However, it should be recognized that countries whose productivity trends are working against them are at a real disadvantage. If they can not institute reforms that lead to an increase in productivity in the service sector, they may have to keep their monetary policies artificially tight, just to prove themselves.

If the convergence criteria are found to be overly burdensome, then one must ask whether a country like Spain or Italy should be held to them. Here is where the underlying causes of the observed trends in labor productivity would seem to be important. If the productivity trends reflect technological factors that cannot be affected by government policy, then one can argue that the observed inflation differentials are due to factors that are independent of monetary policy and are in any case not indicative of any sort of "competitiveness" problem. If on the other hand one ascribes to the labor absorption hypothesis, the conclusion might be quite different. One might expect countries with rapid real appreciations to put pressure on a common central bank for a loose monetary policy, either to ease the financing of public deficits or to try to increase employment. One could argue that reforms are needed both in the public sector and in the service sector, and that the convergence criteria are an appropriate measure of the effectiveness of these reforms.

The second issue we examine is whether countries with very different trends in productivity belong in the same monetary union. We can approach this issue by asking what monetary policy a European central bank should institute. There have been a number of official pronouncements on this:[5] the basic message is that any new European currency must be "as good and as stable as the D-mark". But, this simple notion is not precise enough. A standard neoclassical model implies real interest rate differentials -- where real interest rates are defined in terms of regional CPI inflation -- across regions that have different productivity trends. With a common nominal interest rate, these real interest rate differentials would have to come out as regional inflation differentials. Germany would be expected to have a lower regional inflation rate than say Italy, or the union as a whole. So, what should the European central bank take as its inflation target? If it adopts the old German target, then Germany will end up with a lower regional inflation rate than before EMU. Is this what Germany wants -- a change in its regional inflation policy? On the other hand, the notion that the new European currency should be "as good as the D-mark" could be taken to mean that regional inflation in Germany should remain unchanged. But then, the union wide inflation target would have to be higher than the old German target. Will the Germans permit this?

This discussion raises conceptual questions that are not well understood. Keynesian models are largely silent on what the long-run inflation target should be. More micro based theories tend to focus on the level of interest rates, and not inflation rates. For example, shoe leather costs and seignorage tax distortions are measured by the level of the nominal interest rate. By extension, we might argue that "as good as the D-mark" means that the average level of nominal interest rates in Germany should be maintained. Our model implies that this policy would leave trend inflation in Germany unchanged, but Germans would have to accept a higher inflation rate for the union as a whole. Given recent experience with the German monetary union, some might counter that this would lead to regional distortions in wage setting, a factor that is not accounted for in more neoclassical models.

We do not try to settle these difficult conceptual questions here; we simply try to get an idea of their quantitative importance. We calculate the regional inflation differentials that are implied if current productivity trends in Europe persist, and then we make comparisons with regional productivity differentials observed in the US.

The rest of the paper is organized as follows. In section II, we present the neoclassical framework that predicts the relationship, mentioned above, between trends in average labor productivity and trends in real exchange rates, and we discuss the ways in which this neoclassical framework is, and is not, consistent with the data for eleven European countries. In section III, we assess the consistency of the Maastricht convergence criteria, and we calculate the regional differentials in inflation that would be implied (in a system of fixed exchange rates or EMU) by observed differences in productivity trends. We also make comparisons with the US. In section IV, we summarize our results and draw conclusions. The data are discussed in more detail in an appendix.

II. A MODEL OF PRODUCTIVITY AND INFLATION

First, we define the productivity hypothesis and derive its implications for inflation. Then, we confront the hypothesis with data on eleven European countries. And finally, we try (in a very limited way) to explore the labor absorption hypothesis.

The Analytical Framework:

The analytical framework we use in this paper is quite general; it could be embedded in a wide class of models. We do however abstract from short run adjustment problems in order to focus on the long run implications of trends in productivity. In each country, capital and labor are fully employed in the production of traded goods, X, and home goods, N:

$$(1)\quad L^x + L^n = L$$
$$K^x + K^n = K$$

Competition implies that labor is paid the value of its marginal product, and labor mobility implies that nominal wage rates, W, equalize across sectors; so:

$$(2)\quad \frac{\partial X/\partial L^x}{\partial N/\partial L^n} = \frac{W/P^x}{W/P^n} = \frac{P^n}{P^x}$$

Figure 2 illustrates this equilibrium condition in a familiar diagram. The real exchange rate, P^n/P^x, is tangent to the production possibility curve, TT'; it is also tangent the home consumer's indifference curve, II'.

There are two basic approaches to measuring the marginal products in equation (2); Froot and Rogoff (1994) provide a recent survey of the existing literature. Many studies estimate Cobb-Douglas production functions for each sector and relate the marginal product of labor to estimates of factor shares and exogenous productivity shocks (total factor productivity). Other studies work with data on the average product of labor; Marston (1987) is a well known example. We will follow the latter approach for two reasons. First, we do not have to use sectoral data on capital stocks; these data are not thought to be as reliable as the data we need to calculate the average product of labor. Second, as we explain below, our analysis is valid for a broader class of production functions than the Cobb-Douglas specification.

To switch from marginal to average products, we do have to place a restriction on technology. We assume that the marginal product of labor is proportional to the average product of labor in each sector:

$$(3) \quad \frac{\partial X/\partial L^x}{\partial N/\partial L^n} = \frac{\gamma(X/L^x)}{\delta(N/L^n)}$$

With this restriction, the real exchange rate, q, is proportional to the ratio of the average products of labor, x/n, in the two sectors:

$$(4) \quad q \equiv P^n/P^x = (\gamma/\delta)(X/L^x)/(N/L^n) \equiv (\gamma/\delta)(x/n)$$

This proportionality between the real exchange rate and the ratio of average labor products is our version of the "productivity hypothesis"; it will be the basis for all of our empirical work.

A wide class of production functions satisfy the constraint (3). The Cobb-Douglas technology is one example:

(5) $X = \chi(K^{x})^{(1-\gamma)}(L^{x})^{\gamma}$

$N = \omega(K^{n})^{(1-\delta)}(L^{n})^{\delta}$

It should be emphasized that under this interpretation, the ratio of average labor productivities, x/n, is not an exogenous variable. It and the real exchange rate, q, are determined by the shocks to total factor productivity, χ and ω, and by factors driving demand. In Figure 2, the evolution of χ and ω explains how TT′ shifts out over time, while taste parameters and government policy explain the position of II′.

This endogeneity of the average labor products may at first appear to be a drawback to the approach we have chosen to measure the ratio of marginal costs in (2). x/n (unlike the ratio of the total factor productivity shocks, χ and ω) cannot be presumed to be econometrically exogenous with respect to the real exchange rate, q. It turns out however that this will not be a problem for our tests of the productivity hypothesis.[6] Moreover, since some economists have argued that demand factors (in addition to supply factors) are needed to explain real exchange rate movements, our formulation of the productivity hypothesis may actually be an advantage. In particular, with Cobb-Douglas technologies, (4) holds regardless of demand factors and even if capital is not mobile across the two sectors.[7] More generally, it is straightforward to show that (4) holds for CES production functions if both labor and capital are mobile across sectors.

The endogeneity of x/n does, however, complicate the interpretation of our inflation forecasts in the next section. Our implicit assumption will have to be that the combination of supply and demand factors that drive average labor products will continue to drive the ratio x/n along the trend that has been observed over the past two decades.

The final assumptions we need to derive the inflation differentials across countries are the law of one price for the traded good:

(6) $P^x = eP^{x*}$

and a way of calculating "CPI" price levels:

(7) $P = k(P^x)^{(1-\eta)}(P^n)^{\eta}$

P^{x*} is the foreign currency price of the traded good in some other country, e is the nominal exchange rate, and η is the share of home goods in home consumption. CPI inflation, π, can then be defined as:

(8) $\pi \equiv \Delta P/P \approx (1-\eta)\Delta\ln(P^x) + \eta\Delta\ln(P^n) = \Delta\ln(P^x) + \eta\Delta\ln(q)$

We now think of the home country as a country like Italy, and we let the foreign (or starred) country be Germany. We can calculate Italy's inflation differential with Germany from equations (4), (6) and (8):

(9) $\pi - \pi^* = \Delta\ln(e) + \eta\Delta\ln(q) - \eta^*\Delta\ln(q^*)$

$= \Delta\ln(e) + \eta\Delta\ln(x/n) - \eta^*\Delta\ln(x^*/n^*)$

We will use this equation in the next section to examine the consistency of the Maastricht convergence criteria.

To get a better understanding of (9), we consider the change in relative CPI indices:

(10) $\pi - (\pi^* + \Delta\ln(e)) = \eta[\Delta\ln(q) - \Delta\ln(q^*)] = \eta[\Delta\ln(x/n) - \Delta\ln(x^*/n^*)]$

(where for simplicity η^* has been set equal to η). Assuming interest parity, $i = i^* + \Delta\ln(e)$, this change in relative CPI indices can be interpreted as the real interest rate differential across countries; that is:[8]

(11) $(i^* - \pi^*) - (i - \pi) = \pi - (\pi^* + \Delta\ln(e))$

Equations (10) and (11) say that the real interest rate differential depends on relative productivity trends. If x/n is growing faster than x^*/n^*, then the real interest rate in Italy has to be lower than the real interest rate in Germany. This fact is easily understood in the special case where traded good productivity is growing at the same rate in the two countries, or $\Delta\ln(x)=\Delta\ln(x^*)$. Then, if x/n is growing faster than x^*/n^*, it must also be the case that home good productivity is growing slower in Italy than in Germany. Italy is less productive, and therefore less wealthy, than Germany. Expenditure on the composite good must grow less quickly in Italy, and the Italian real interest rate must be lower to make Italian savers content with this outcome. The result is stronger than this simple intuition suggests; that is, there is no need (and probably good reason not) to assume that $\Delta\ln(x)=\Delta\ln(x^*)$.[9]

In any case, real interest rate differentials are determined by trends in labor productivity. Monetary policy determines how these real interest rate differentials are split between inflation differentials and changes in nominal exchange rates. Equation (9) implies that:

(12) $\pi - \pi^* = \eta\Delta\ln(q) - \eta^*\Delta\ln(q^*) = \eta\Delta\ln(x/n) - \eta^*\Delta\ln(x^*/n^*)$

when the nominal exchange rate is fixed, and that:

(13) $-\Delta\ln(e) = \eta\Delta\ln(q) - \eta^*\Delta\ln(q^*) = \eta\Delta\ln(x/n) - \eta^*\Delta\ln(x^*/n^*)$

when inflation rates converge. The real interest rate differential must come out in one place or the other. Under a common currency, it has to come out as a regional inflation differential, since there is no nominal exchange rate to change.

The Data:

We use annual data from 1970 to 1990 on eleven European countries -- Austria, Belgium, Denmark, Finland, Great Britain, France, Germany, Italy, Portugal, Spain, and Sweden.[10] We wanted to include all of the countries in the EU, but data on Luxembourg, the Netherlands and Greece are incomplete. The data come from the OECD National Income Accounts and other sources. A more detailed description of the data can be found in an appendix. Basically, home good production, N, is measured by value added in services, and can be split between market services and non-market services; traded good production, X, is measured by value added in manufacturing and agriculture.[11] Their prices, P^n and P^x, are the corresponding value added price deflators. Average labor productivities, n and x, are measured by value added per employee in the sector.

Testing the Productivity Hypothesis:

Figures 3A through K plot the real exchange rate, q, and the ratio of average labor productivities, x/n, for each country; the variables are in logs and have (with the exception of Portugal) been normalized to zero in 1970. The productivity hypothesis implies that the real exchange rate should follow the trend in productivity, and this tendency is clearly illustrated. In the German, Austrian, and Finish cases, the relationship seems quite close. In some of the other cases however, the relationship seems looser and the trend in productivity seems to over predict the exchange rate's appreciation. The Danish case appears to be the worst example of this.

Formal testing of the model is complicated by the small number of observations and the potential nonstationarity of the data. In some cases, we had more data than what appears in the figures; the tests reported below use all the observations available for each country.[12,13] Table 3 reports for each country the simple correlation between the growth rate of the real exchange rate, $\Delta\ln(q)$, and the growth rate of the productivity ratio, $\Delta\ln(x/n)$. These correlations are generally quite weak, and in some cases negative. This confirms our suspicion that the productivity hypothesis can not explain year to year fluctuations in the real exchange rate. It may however account for the long run trend in the real exchange rate, and that is more pertinent than the short run gyrations for our purposes.

To evaluate the model's ability to explain long run trends, we first consider the hypothesis that the growth rates of the real exchange rate and the productivity ratio have the same population mean. The Classical test for the equality of population means presumes that the random samples are independent across the two populations; it is therefore inappropriate in the present context. To circumvent this problem, we test the hypothesis that the time series of the difference in growth rates -- $\Delta\ln(q) - \Delta\ln(x/n)$ -- has a population mean of zero. As usual, this hypothesis implies that the t-ratio for the sample mean is asymptotically Standard Normal. The results are reported in Table 4: in every case, the sample mean is quantitatively small and not significantly different from zero.

The results of Table 4 suggest that long run trends in the two variables may indeed be related. To pursue this point further, we need to take a stand on the type of nonstationarity that accounts for the apparent growth in these variables over our sample period. Table 5 reports Augmented Dickey-Fuller tests for these variables. The estimated (OLS) regressions are of the form:

(14) $\Delta Y_t = \alpha + \Sigma_{i=1}^{k} \beta_i \Delta Y_{t-i} + \rho Y_{t-1} + \text{error},$

where Y_t is either $\ln(q_t)$ or $\ln(x_t/n_t)$. The τ-statistic, reported in Table 5, is the ratio of the point estimate of ρ to its standard error. In conducting the tests, we use a general-to-specific procedure to choose the lag length k.[14]

The τ statistics in Table 5 fail to reject the presence of unit roots in our time series, except for the Danish real exchange rate series.[15] Similar tests including a linear time trend (not reported) also fail to reject the presence of unit roots in the majority of cases. As is well known, unit root tests can suffer from low power in small samples. Although the annual frequency of our observations mitigates this problem to some extent, our results should be interpreted with caution.[16] We think, however, that Figures 3A to J strongly suggest that these data series do not have a stationary mean. Thus, the only remaining issue is whether the nonstationarity of the mean arises from a deterministic trend or a stochastic trend. Rather than appeal to unit root tests to settle this issue, we take an agnostic position and examine both possibilities below.

If our time series are trend stationary, the results of Table 4 provide an appropriate test for a common trend. To see this point let

$$(15)\quad \ln(q_t) = \alpha_1 + \gamma_1 t + y_{1t}$$

and

$$(16)\quad \ln(x_t/n_t) = \alpha_2 + \gamma_2 t + y_{2t},$$

where t denotes time, and y_{1t} and y_{2t} are stationary time series. Then,

$$(17)\quad \Delta\ln(q_t) - \Delta\ln(x_t/n_t) = \gamma_1 - \gamma_2 + \Delta(y_{1t} - y_{2t})$$

To test $\gamma_1 - \gamma_2 = 0$, we can use the Normal approximation for the sample mean of $\Delta\ln(q_t) - \Delta\ln(x_t/n_t)$, because the deviations from the mean, $\Delta(y_{1t} - y_{2t})$, are stationary. So, for the trend stationary specification, the t ratios in Table 4 constitute evidence in favor of common trends.

If our time series, $\ln(q_t)$ and $\ln(x_t/n_t)$, are difference stationary and share a common stochastic trend, then they must be cointegrated. That is, there must exist a value of b for which $\ln(q_t) - b\ln(x_t/n_t)$ is stationary. In fact, our model implies $b = 1$.[17] In Table 6, we report the point estimates of b from the cointegrating regression of $\ln(q_t)$ on $\ln(x_t/n_t)$ and the τ statistics for the residuals of these cointegrating regressions. The τ statistics are from regressions like (14) above with the intercept restricted to zero. These statistics reject the null of no cointegration for Finland, Germany and Spain using a test of size 0.05, and for Austria, Belgium and Sweden using a test of size 0.10. For the other countries, we don't find cointegration.

The more specific hypothesis $b = 1$ cannot be tested using Table 6 because the standard error of b is not consistently estimated (and, therefore, not reported). We can, however, perform an alternative test by setting $b = 1$ and applying the Augmented Dickey-Fuller test in (14) with Y_t set equal to $\ln(q_t) - \ln(x_t/n_t)$. Table 7 reports the results: we reject the unit root null for Finland, Germany, Italy, and Spain using a test of size 0.05, and for Austria using a test of size 0.10. So, the hypothesis of a common stochastic trend is supported for these five countries.

Given the low power of unit root tests, we think the results in Tables 6 and 7 are really quite encouraging for the productivity hypothesis. In fact, the test results are favorable for the three countries (Finland, Germany and Spain) that have the longest data sets in our sample.[18] This observation suggests that low power in small samples may be behind some of our unfavorable results for other countries. In future work, we plan to investigate this issue by applying our unit root and cointegration tests to pooled samples from different countries.

To summarize the main results here, we think the evidence presented in Tables 4, 6, and 7 suggests that long run trends in the productivity ratio are good predictors of long run trends in the real exchange rate. This complements recent work by Asea and Mendoza (1994), who, using a different setup and sample from ours, also found a long run relationship between productivity shocks and the relative price of traded and nontraded goods.

The labor absorption hypothesis and other observations about the data:

While the above results do offer support for our using the productivity hypothesis to explain inflation differentials, via equation (12), the average growth rates reported in Tables 1 and 2 do suggest caution. In eight of the eleven cases, productivity trends overpredict the real exchange rate appreciations (and therefore the inflation differentials with Germany); there are no substantial cases of underprediction. It is therefore interesting to speculate that something has been left out of the model. It is also interesting to ask why x/n has grown faster in some countries than in others. And finally, it is interesting to think about the labor absorption hypothesis: the possibility that the real exchange rate appreciations may have been caused by excessive growth of public sector employment and protection of the service sector. Here, we can only hope for an impressionistic view from the data; we make no attempt at formal testing.

Figures 4A and B illustrate two representative groups of countries: Belgium, Italy, and Spain have experienced twice as much growth in x/n as Germany, Great Britain and France. Figures 5A and B plot the growth in average labor productivity in traded goods, while Figures 6A and B show the growth in average labor productivity in home goods. Both seem to have been a factor; that is, the group that experienced higher trend growth in x/n did so because traded good productivity grew faster and because home good productivity grew slower.

The fast growth of productivity in traded goods may simply have reflected "catch up" or technology transfer after market liberalization, in which case it might not be expected to continue. Clearly, more work would be needed to draw any conclusions here. Our data may be able to shed more light on the slow growth of productivity in home goods. Figures 7A through J plot average labor productivity in traded goods, in total services, and in non-market services. Productivity growth in non-market services clearly lagged behind productivity growth in total services in most of the countries. This is evidence in support of the labor absorption hypothesis: growth in government employment appears to have dragged productivity down in the service sector of most countries. It is interesting to note however that two of the three high x/n growth countries -- Belgium and Spain -- are exceptions to this; only in Italy is there much evidence that non-market services are the problem.

Some economists have argued that demand factors are needed, in addition to productivity trends, to explain these data. For one thing, it is often asserted that the service sector's share in total production has risen, and this observation is at odds with the productivity hypothesis. The productivity hypothesis asserts that home goods have become more expensive to produce; so, supply factors suggest that the service sector's share should have fallen. Figures 8A and B confirm the conventional view: the service sector's share in production has risen in all of the countries, whether they experienced high x/n growth or low. In fact, the data show a rather remarkable convergence in service sector shares everywhere except Germany, Portugal and possibly Austria (not pictured); Germany is again an outlier, on the low side.

What are the demand factors that would explain the rise in service sector shares? Froot and Rogoff (1991) argued that a rise in government spending was an important determinant of real exchange rate appreciations. De Gregorio, Giovannini and Krueger (1993) found just the opposite. Figures 9A and B show that, with the notable exception of Spain, the share of government in total services has remained constant, or even fallen.[19] De Gregorio, Giovannini and Krueger (1993) did argue that other demand factors were needed to explain the data, as did Stockman and Tesar (1995) (who were however using detrended data). Our analysis is already general enough to have allowed for demand factors. As explained above, both supply and demand factors can be moving P^n/P^x in Figure 2. So, the omission of demand factors need not be a source of rejection for our version of the productivity hypothesis; this is an advantage of using average labor products instead of say total factor productivities (which are usually presumed to be exogenous).

We do however assume marginal cost pricing, while the labor absorption hypothesis suggests that the service sector has been protected. If rents were increasing in the service sector, then the increase in real exchange rates should be outrunning the increase in relative marginal costs, as proxied by x/n. But Tables 1 and 2 show that in eight of the eleven cases productivity trends overpredict the real exchange rate appreciations, and that there are no substantial cases of underprediction. If we have a rejection of the model, it is in the wrong direction for the labor absorption hypothesis.

As we noted in Section I above, the labor absorption argument may be interpreted as the hypothesis that the observed trends in labor productivity are themselves caused by public sector growth and government protection of the home good sector. We cannot test this hypothesis with macroeconomic data, but it should be kept in mind for interpreting the policy implications of our findings. In terms of explaining the observed appreciations <u>in excess of</u> productivity trends, however, neither the labor absorption hypothesis nor the relative demand hypothesis seem useful.

A potentially useful hypothesis may be based on the Lucas and Stockey (1987) distinction between cash goods and credit goods. So far, we have not had to say how money enters the analysis. Suppose now we envision a cash in advance framework where cash is required for the purchase of home goods; by contrast, traded goods can be bought on credit. If the model were modified to accommodate this distinction between cash goods and credit goods, (4) would become:

(18) $P^n/P^x = (\gamma/\delta)(x/n)(1 + i)$

The nominal interest rate, i, becomes a part of the relative cost of the home good, since cash has to be held in the place of bonds to purchase it. Leaving the interest rate out of this equation would make the other relative costs, proxied here by x/n, outrun the rise in the real exchange rate in a period when nominal interest rates were falling.

This explanation works well in the middle and late 80's, when both inflation and short term nominal interest rates were falling. The average fall in short term interest rates is of the same order of magnitude as the over prediction of real exchange rates. On the other hand, this story does not explain the first half of the sample, where x/n also seems to outrun q in some cases. The insufficiency of data precludes our doing much more with this hypothesis.

III. IMPLICATIONS OF OBSERVED PRODUCTIVITY TRENDS FOR INFLATION

The framework developed in the last section allows us to use observed trends in productivity to predict the differences in trend CPI inflation for countries that have fixed their nominal exchange rates or share a common currency. First, we calculate the predicted differentials in trend inflation for our eleven European countries. Then, we analyze the consistency of the Maastricht convergence criteria. And finally, we compare our results for Europe with the inflation differentials implied by productivity trends across regions within the United States.

Inflation Differentials with Germany in a Hard ERM, or in EMU:

Here, we use equation (12) to calculate the inflation differentials with Germany that are implied by trends in relative labor productivity. Table 2 reports the average growth rate of x/n for each country, and this is one way of estimating the trend in the time series for $\ln(x/n)$. Another way would be to calculate the slope of the best linear fit. But since these series may have unit roots, the averages growth rates reported in Table 2 are a more appropriate measure. The other parameter in (12) is η, the share of the home good in consumption. We measure η by the share of home goods in total value added in 1990. On one hand, this estimate is slightly too large for countries that are running a trade deficit. On the other hand, it is slightly too small for projections into the future, since there is an upward trend in the production and consumption of home goods.

Table 8 reports the results. The countries can be divided into three groups: Belgium, Italy and Spain are in the first group; productivity trends imply that they should have inflation rates that are on average about 2% higher than German rates. Portugal, Denmark, Austria, France, Great Britain, and Sweden are in the second group; they should have inflation rates that are on average about 1% higher than German rates. Finland is in the last group; it should have inflation rates that are about the same as German rates. Again, these are the inflation differentials implied by assuming that the observed trends in productivity will continue under a system of fixed (nominal) exchange rates or a common currency.

Table 9 averages the inflation differentials reported in Table 8 (using 1991 GNP as weights) to find the difference implied by trends in productivity between union wide inflation rates and regional inflation in Germany for monetary unions of various sizes. If, for example, the union policy is to hold inflation constant in Germany, then these are the numbers one should add to the old German inflation target to get the new union wide target. If the union is limited to Germany, Belgium and Austria, then the old German target hardly needs to be raised at all. It should be noted however that this is not because Belgium and Austria are natural partners for Germany in terms of their trends in productivity; in fact, Belgium is at the top of the list in Table 8. The inflation target need not be changed because Belgium and Austria are so small. If France is added to the union, then the old German inflation target must be raised by about a half a percent; France is a big country, and that is what matters here. Adding Great Britain, Denmark, Sweden and Finland does not change the basic picture; the union wide inflation target still has to be about a half a percent higher than the old German target. But adding the southern countries -- Italy, Spain and Portugal -- would make a significant difference: the union target would have to be about one percent higher than the old German target.

Consistency of the Maastricht Convergence Criteria:

Table 8 does suggest that if the observed trends in productivity continue to hold, strict convergence in inflation is inconsistent with a system of fixed exchange rates. However, it must be remembered that the Maastricht convergence criteria are more flexible than that for three reasons: (1) to qualify for EMU, a country's inflation rate need only be within 1.5% of the three best performing member countries; (2) exchange rates can now float within 15% bands; and (3) tight monetary policy may be able to make inflation differentials less than what would be implied by trends in productivity, at least for short periods of time.

In this sample, Austria might be viewed as setting the inflation standard for the "three best performing member countries". If so, it is the inflation differentials with Austria that count, and not the differentials with Germany that are reported in Table 8. However, inflation differentials with Austria can be readily seen in the numbers reported in Table 8 (by simply subtracting 0.8). The relevant inflation differentials for Italy and Spain are about 1%; Belgium is right on the 1.5% border that is allowed by the Treaty.

There is however not much room for error. Italy and Spain have only .5% to spare, and not the 1.5% buffer that the convergence criteria would seem to allow. Belgium has no buffer at all. The large standard deviations reported in Tables 1 and 2 do indicate that inflation differentials can deviate rather substantially in the short run from the trends implied by productivity. The 15% exchange rate bands allow some countries to run tighter monetary policies than their lower inflation neighbors, and this may give them enough latitude. But, the productivity trends in Belgium, Italy and Spain are clearly working against them.

Are European Inflation Differentials Too Large for EMU?

Finally, we ask if the variations in productivity trends reported in Table 2 and the implied inflation differentials reported in Table 8 are larger than those observed across regions in successful monetary unions. If so, one might wonder whether these countries belong in the same monetary union.

Tables 10 and 11 are the counterparts to Tables 2 and 8 for eight regions in the United States; the regions correspond to aggregations used by Bayoumi and Eichengreen (1993).[20] Table 10 reports the average growth rates of relative labor productivity, x/n, from 1977 to 1992. Comparing Table 10 with Table 2, we see that there is considerably less variation in productivity across regions in the Unites states. Table 11 reports the implied inflation differentials between various regions and the Mideast. Comparing Table 11 with Table 8, we see that the implied differentials in regional inflation are only about a fifth the size. The eight regions that make up the US are clearly more homogeneous than the countries that make up the EU.

IV. SUMMARY AND CONCLUSIONS

In section II, we defined the productivity hypothesis, and we tested it formally using data on ten European countries. Our version of the hypothesis asserts that the trend in the ratio of home good and traded good prices should be equal to the trend in the ratio of their marginal costs, as measured by the ratio of their average labor products. Our unit root and cointegration tests were quite supportive of this hypothesis, given the lack of power of these tests and the small number of observations in our samples. We also argued that the cases where we observe appreciations in excess of what productivity trends imply cannot be explained by the relative demand hypothesis or the labor absorption hypothesis, which attribute the trend in real exchange rates to an increase in government spending and/or protection of the service sector. If there is a rejection of the productivity hypothesis in these data, it does not appear to be in favor of either of the alternatives that we have considered. However, we have emphasized repeatedly that the relationship between real exchange rates and relative labor productivity (which defines our version of the productivity hypothesis) can also be interpreted along the lines of the absorption hypothesis; we can not differentiate between the productivity hypothesis and the labor absorption hypothesis using macroeconomic data.

In section III, we calculated the cross country inflation differentials implied by observed trends in average labor productivity (when exchange rates are fixed or the countries share a common currency). The results can be summarized as follows: First, the countries fell into three categories. Trend inflation in Belgium, Italy and Spain should be about 2% higher than trend inflation in Germany; trend inflation in Portugal, Denmark, Austria, France, Great Britain, and Sweden should be about 1% higher than in Germany; and trend inflation in Finland should be about the same as in Germany. Second, if a monetary union were to come about, the difference between union wide inflation and regional inflation in Germany should depend on the size of the union. If the union were limited to Germany, Austria and Belgium, the difference should be negligible. Austria and Belgium are not natural union partners for Germany in terms of their productivity trends, but they are too small to matter. If France were added to the union, then union wide inflation should be .5% higher than German regional inflation. Adding Great Britain, Denmark and Finland would not change that fact, but adding Italy, Spain and Portugal should increase the difference to a full percentage point. Third, the differences in inflation implied by observed productivity differentials across regions in the United States are much smaller than the cross country inflation differentials implied by productivity trends in Europe; regional inflation differences in the US are only about a fifth the size.

What do we make of all this? First, we find no basic inconsistency in the convergence criteria that were written into the Maastricht Treaty. In the eleven countries we considered, the inflation rates implied by trends in productivity were within 1.5% of the Austrian rates. So, if Austria sets the standard for "the three best performing member countries", then the required convergence in inflation is not inconsistent with fixed exchange rates. None of these countries should be excluded from participating in EMU simply because their productivity trends are different from those in Germany.

It should be recognized however that if current trends in productivity persist, the Maastricht convergence criteria put more burden of adjustment on those countries whose productivity trends are working against them. Should countries like Belgium, Italy and Spain be willing to bear this adjustment burden? Should they be forced to? The answers to these questions depend critically on the underlying causes of the slow growth of productivity in these countries' home good sectors.

If we attribute the sluggish productivity growth to an exogenous technological process and assume that it will persist, then the costs of bearing the adjustment burden should be taken seriously. Countries like Belgium, Italy, and Spain have only about a half a percent of leeway, and our results show that short run inflation differentials can vary substantially from those implied by trends in productivity. Monetary policy can of course be used to pull these short run differentials back in line, and the 15% exchange rate bands should be sufficient for this if stage two is not allowed to go on for too long. However, tight monetary policy can come at a price in terms of lost output and employment. Belgium, Italy and Spain might be called upon to run unnaturally tight policies just to prove themselves worthy. Countries like Germany, Finland, Great Britain, Austria, and Denmark have productivity trends that allow them more room to manoeuver; they are clearly at an advantage. Trends in productivity should probably be considered when the Council of Ministers interprets the convergence criteria and decides which countries are eligible to participate in EMU.

By contrast, if we attribute the sluggish productivity gains in the home good sector to excessive public sector growth and/or protection of the service sector, then the Maastricht criteria may provide a useful discipline for restoring a more efficient allocation of resources. More to the point, the convergence criteria may be needed to assure that the monetary union is free of inflationary pressures, since there may be reason to fear that countries exhibiting these problems would lobby for expansionary monetary policies, either to help absorb surplus labor or to accommodate the financing of fiscal deficits. Under this interpretation, strict observance of the convergence criteria would present countries like Belgium, Spain and Italy with a clear choice. They could implement reforms that would increase labor productivity in the home good sector, or they could take a chance that they would have to run unnaturally tight monetary policies just to qualify for EMU.

If a large monetary union does come about, should Germany be willing to accept a union wide inflation target that is about 1% higher than its current target? According to our model, this would hold trend inflation in Germany constant, but it might affect regional wage setting causing problems (at least) in the short run. Should Germany argue for a union wide inflation target that matches its old target? This would imply a tighter inflation policy inside Germany than it had before union; trend inflation in Germany should drop by 1%. Should Germany argue for a policy that held its trend nominal interest rates constant? This policy would leave German shoe leather costs and seignorage tax distortions unchanged. These questions probably require more thought.

Finally, do countries with widely differing productivity trends belong in the same monetary union? Have successful monetary unions had to cope with the questions discussed above? We saw that regional productivity trends are much more homogeneous in the United States than in Europe; the implied regional inflation differentials are a fifth the size of those in the EU. Will full economic integration cause productivity trends to converge in Europe? Is that what produced the homogeneity observed in the US? Once again, these are all questions for future research.

ENDNOTES:

1. Precise definitions of variables and data sources are give in the section that follows.

2. The literature relating real exchange rates to trends in productivity dates back (at least) to Balassa (1964) and Samuelson (1964), who cast the discussion in terms of developing countries. Marston (1987) applied the theory to dollar-yen exchange rates, and most recently Stockman and Tesar (1995) have tried to explain real exchange rate movements using a real business cycle model. Papers that focus on Europe include De Gregorio, Giovannini and Krueger (1993), De Gregorio, Giovannini and Wolf (1993), Froot and Rogoff (1991), Micossi and Milesi-Ferretti (1994), and Rebelo (1993). Froot and Rogoff (1994) provide a recent survey.

3. See, in particular, Chinn (1995), De Gregorio, Giovannini and Krueger (1993), De Gregorio, Giovannini and Wolf (1993), Froot and Rogoff (1991).

4. De Gregorio, Giovannini and Wolf (1993) provide some evidence that this is indeed occurring in Europe.

5. Alexander Lamfalussy (head of the European Monetary Institute, which is the precursor to a common central bank) has stated that "We must make absolutely sure, and without the slightest possible doubt, that the single European currency is as good and as stable as the D-mark"; and Helmut Kohl (Chancellor of Germany, without which there will be no monetary union) has asserted that "We will not bring a European money into being that does not have the stability of the D-Mark". These statements appeared in the <u>Financial Times</u> on April 27, 1995.

6. We don't present regression equations except in a cointegration framework, where econometric exogeneity is not required.

7. In contrast, the alternative formulation of the productivity hypothesis in terms of factor shares and total factor productivities is independent of demand factors only if we assume perfect capital mobility across sectors and countries and adopt a small-open-economy setup where the interest rate is exogenously determined [see, for example, Froot and Rogoff (1994)].

8. Here, we are abstracting from risk premia to make the discussion simpler. Our empirical work is however based on equation (9). It does not require this assumption.

9. We have worked out (but not published) a complete two country model which serves as the basis for the discussion above.

10. Actually, data on Portugal are from 1977 to 1990.

11. De Gregorio, Giovannini and Wolf (1993) show that this classification makes sense. They calculate ratios of exports to total production and show that, with the exception of transport, only 2% of services are traded; almost 30% of transportation services are traded however.

12. The data periods are as follows: Germany, 1960-1991; France, 1970-1992; Italy, 1970-1993; Great Britain, 1970-1990; Belgium, 1970-1990; Sweden, 1970-1992; Finland, 1960-1992; Austria, 1970-1992; Spain, 1964-1992; Denmark, 1966-1992; Portugal, 1977-1990.

13. We had so few observations on Portugal that we excluded it from the formal testing.

14. For each regression equation, we start with the specification k=2. If β_2 is significantly different from zero (at the 10% level), we pick this specification. If β_2 is not significant, we move to k=1. Repeating this procedure, if β_1 is not significant, we set k=0.

15. The statistics for German data come close to their critical values for a test of size 0.10.

16. The power of the tests depends, not so much on the number of observations, but mainly on the historical length of the data series, say, in years.

17. The presence of cointegration with b = 1 still implies the equality of population means tested in Table 4; but the tests of Table 4 are not sufficient to establish the presence of cointegration.

18. The only other OECD country for which about 30 years of data are available is the U.S. Our results for the U.S. (not reported) also support the productivity hypothesis.

19. Sweden seems to be an outlier in terms of levels, but there is no clear upward trend.

20. Regional sectoral price deflators are not available, so we can not test the productivity hypothesis directly. However, we do have regional GDP inflation rates; their differentials are of the order of magnitude predicted in Table 11.

Appendix: THE DATA

Data for Belgium, Denmark, Finland, Great Britain, France, Germany, Italy, and Sweden come from the OECD National Accounts. Data for Austria, Portugal and Spain come from national statistics. (Francisco de Castro of the Bank of Spain collected and documented the data.) These sources provide annual sectoral data on nominal value added, real value added and number of employees. For ten of the countries, the data are complete for the years 1970 to 1990; for Portugal, the data begin in 1977. The traded sector is made up of the "manufacturing" sector and the "agriculture, hunting forestry and fishing" sector. The non-traded sector is made up of the "wholesale and retail trade, restaurants and hotels" sector, the "transport, storage and communication" sector, the "finance, insurance, real estate and business services" sector, the "community social and personal services" sector, and the "non-market services" sector; the "non-market services" sector is made up of the "producers of government services" subsector and the "other producers" subsector.

Data consistency is always an issue. We are aware of the following 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; they do not include the "other producers" 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 nontraded 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.

Table 1: GROWTH RATE OF REAL EXCHANGE RATE

	BEL	ITA	SPA	POR	DEN	AUS	FRA	GBR	SWE	FIN	GER
average	3.2	2.9	2.5	1.3	1.3	2.1	1.5	1.5	1.0	1.1	0.9
std. dev.	2.8	2.2	2.6	2.9	3.1	1.5	2.0	3.7	3.8	3.3	1.7

data period: 1977-1990 for POR; 1970-1990 for all others.

Table 2: GROWTH RATE OF RELATIVE PRODUCTIVITY

	BEL	ITA	SPA	POR	DEN	AUS	FRA	GBR	SWE	FIN	GER
average	4.0	3.1	3.3	2.9	2.1	2.0	2.0	1.8	1.8	1.1	0.8
std. dev.	2.6	2.6	2.4	3.6	4.8	1.9	1.6	3.6	2.5	3.4	2.4

data period: 1977-1990 for POR; 1970-1990 for all others.

Table 3: CORRELATIONS OF THE GROWTH RATES OF THE REAL EXCHANGE RATE AND THE PRODUCTIVITY RATIO

BEL	ITA	SPA	DEN	AUS	FRA	GBR	SWE	FIN	GER
0.34	0.11	0.05	0.64	-0.04	-0.18	0.39	0.01	0.12	0.47

Table 4: SAMPLE MEANS AND THEIR t-RATIOS (z-STATISTICS) FOR $\Delta\ln(q_t) - \Delta\ln(x_t/n_t)$

	BEL	ITA	SPA	DEN	AUS	FRA	GBR	SWE	FIN	GER
MEAN (percent)	0.8	0.2	-0.1	0.6	-0.1	0.4	0.3	0.6	-0.3	-0.2
z STAT.	1.07	0.32	-0.19	0.81	-0.21	0.62	0.30	0.63	-0.34	-0.52

Table 5: UNIT-ROOT TESTS (τ-STATISTICS) FOR $\ln(q_t)$ AND $\ln(x_t/n_t)$

	BEL	ITA	SPA	DEN	AUS	FRA	GBR	SWE	FIN	GER
ln(q)	-2.29	1.17	-0.45	-2.70*	-1.25	-1.34	-1.76	-0.04	0.98	-2.55
ln(x/n)	-1.26	-0.10	-1.14	-2.40	0.31	-0.82	-1.48	-0.29	0.74	-2.40

NOTE: The τ-statistic is the ratio of the point estimate of ρ to its standard error in equation (14) in the text. The rejection region for the unit root null [from Davidson and MacKinnon (1993), p. 708] consists of values of τ below -2.86 (-2.57) for a test of size 0.05 (0.10). * indicates rejection of the null for a test of size 0.10.

Table 6: TESTS FOR COINTEGRATION BETWEEN $\ln(q_t)$ AND $\ln(x_t/n_t)$

	BEL	ITA	SPA	DEN	AUS	FRA	GBR	SWE	FIN	GER
b	0.79	0.88	0.90	0.54	0.96	0.77	0.70	0.58	0.96	1.05
τ	-3.08*	-2.38	-3.43**	-1.87	-3.05*	-2.37	-1.81	-3.16*	-5.73**	-3.72**

NOTE: b is the slope coefficient in the cointegrating regression of $\ln(q_t)$ on $\ln(x_t/n_t)$. τ is the ratio of the point estimate of ρ to its standard error in:

$$\Delta v_t = \Sigma_{i=1}^{k} \beta_i \Delta v_{t-i} + \rho v_{t-1} + \text{error},$$

where v_t is the residual from the cointegrating regression. We used the general-to-specific procedure described in footnote 12 to choose the lag length k. The rejection region for the null of no cointegration [from Davidson and MacKinnon (1993), p. 722] consists of values of τ below -3.34 (-3.04) for a test of size 0.05 (0.10). ** (*) indicates rejection of the null for a test of size 0.05 (0.10).

Table 7: UNIT-ROOT TESTS (τ-STATISTICS) FOR $\ln(q_t) - \ln(x_t/n_t)$

BEL	ITA	SPA	DEN	AUS	FRA	GBR	SWE	FIN	GER
-0.58	-2.95**	-3.04**	-1.55	-2.69*	-0.45	-2.04	-2.29	-5.31**	-3.22**

NOTE: The τ-statistic is the ratio of the point estimate of ρ to its standard error in equation (14) in the text, with Y_t set equal to $\ln(q_t) - \ln(x_t/n_t)$. The rejection region for the unit root null [from Davidson and MacKinnon (1993), p. 708] consists of values of τ below -2.86 (-2.57) for a test of size 0.05 (0.10). ** (*) indicates rejection of the null for a test of size 0.05 (0.10).

Table 8: INFLATION DIFFERENTIALS WITH GERMANY UNDER FIXED RATES OR EMU

	Inflation Differential	N-Good Share	Growth in x/n	N*-Good Share	Growth in x*/n*
BEL	2.3	0.72	3.98	0.64	0.84
ITA	1.7	0.71	3.12	0.64	0.84
SPA	1.6	0.64	3.29	0.64	0.84
POR	1.3	0.62	2.90	0.84	0.84
DEN	1.1	0.75	2.14	0.64	0.84
AUS	0.8	0.67	2.03	0.64	0.84
FRA	0.9	0.72	1.97	0.64	0.84
GBR	0.8	0.73	1.79	0.64	0.84
SWE	0.8	0.73	1.82	0.64	0.84
FIN	0.2	0.67	1.15	0.64	0.84

production shares in 1990

Table 9: EMU INFLATION DIFFERENTIALS WITH REGIONAL INFLATION IN GERMANY

	Inflation Differential
EMU 1: GER, BEL, AUS	0.3
EMU 2: GER, BEL, AUS, FRA	0.5
EMU 3: GER, BEL, AUS, FRA, GBR, DEN, SWE, FIN	0.6
EMU 4: GER, BEL, AUS, FRA, GBR, DEN, SWE, FIN, ITA, SPA, POR	0.9

weights: GNP in 1991 US dollars, World Bank Atlas, 25th edition

Table 10: GROWTH RATE OF RELATIVE PRODUCTIVITY IN US REGIONS

	New England	Plains	Southeast	Southwest	Rockies	Far West	Great Lakes	Mideast
average	2.4	2.1	2.0	1.1	2.2	2.1	1.7	2.2
std. dev.	1.6	2.0	1.4	3.2	1.9	2.3	1.9	2.0

data period: 1977-1992.

Table 11: US REGIONAL INFLATION DIFFERENTIALS (WITH MIDEAST REGION)

	Inflation Differential	N-Good Share	Growth in x/n	N*-Good Share	Growth in x*/n*
New England	0.0	0.52	2.40	0.55	2.20
Plains	-0.2	0.50	2.09	0.55	2.20
Southeast	-0.1	0.53	2.04	0.55	2.20
Southwest	-0.7	0.52	1.06	0.55	2.20
Rockies	-0.1	0.54	2.15	0.55	2.20
Far West	-0.1	0.55	2.13	0.55	2.20
Great Lakes	-0.4	0.49	1.69	0.55	2.20

production shares in 1990

Figure 1A: Real Exchange Rates
Southern Countries and Germany

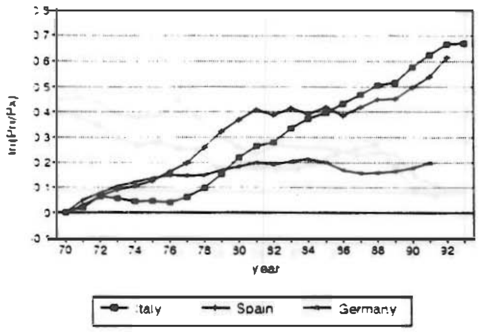


Figure 1B: Real Exchange Rates
Some Core Countries

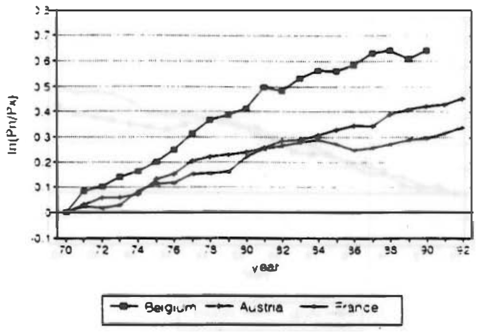


Figure 1C: Relative Productivity
Southern Countries and Germany

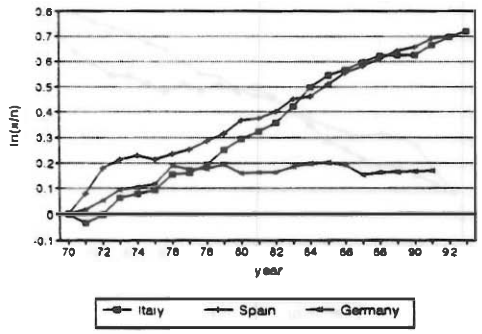


Figure 1D: Relative Productivity
Some Core Countries

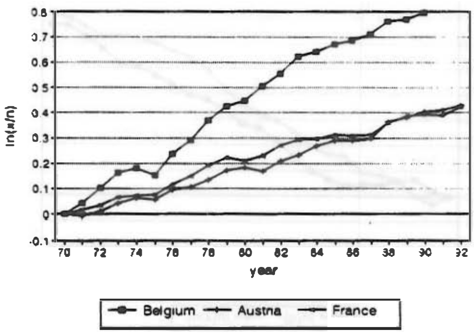


Figure 2

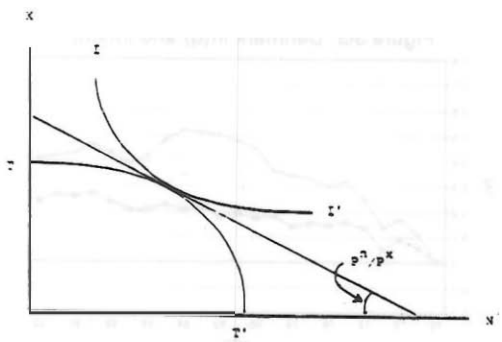


Figure 3A: German ln(q) and ln(x/n)

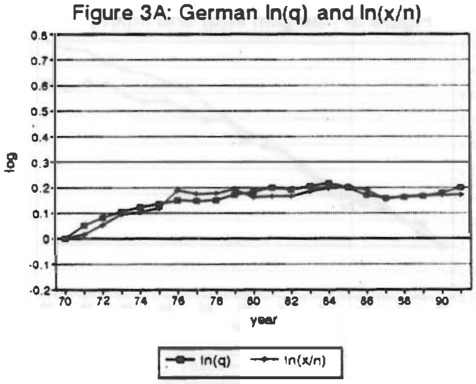


Figure 3B: French ln(q) and ln(x/n)

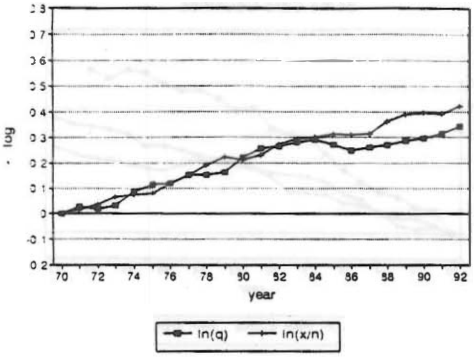


Figure 3C: British ln(q) and ln(x/n)

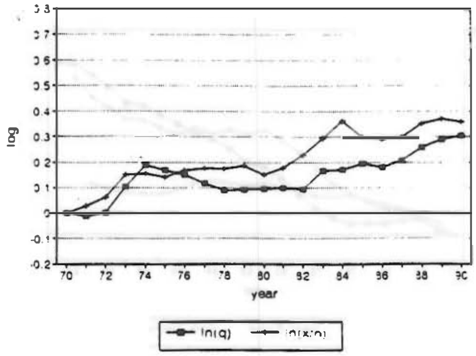


Figure 3D: Italian ln(q) and ln(x/n)

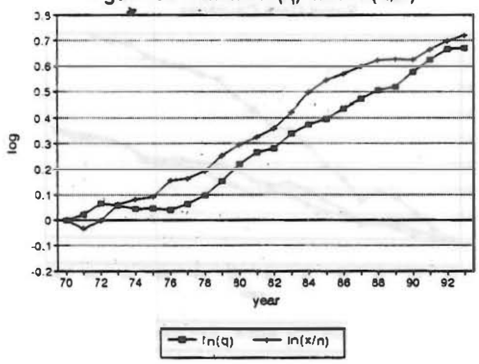


Figure 3E: Spanish ln(q) and ln(x/n)

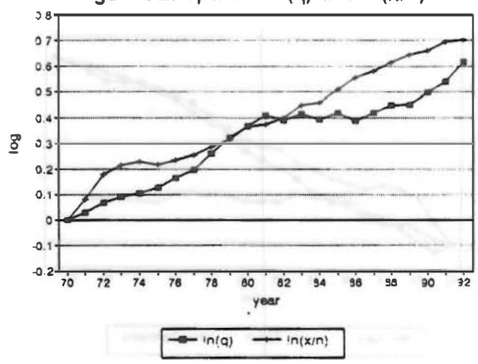


Figure 3F: Belgian ln(q) and ln(x/n)

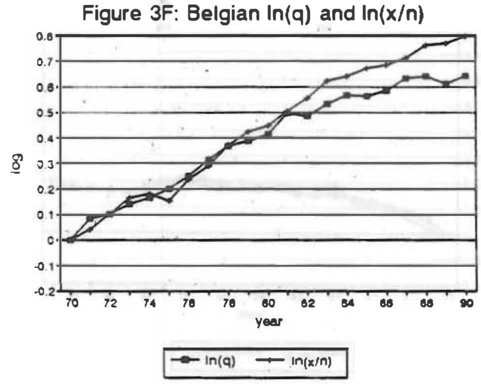


Figure 3G: Denmark ln(q) and ln(x/n)

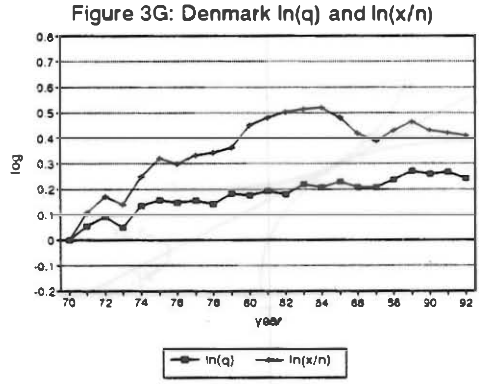


Figure 3H: Austrian ln(q) and ln(x/n)

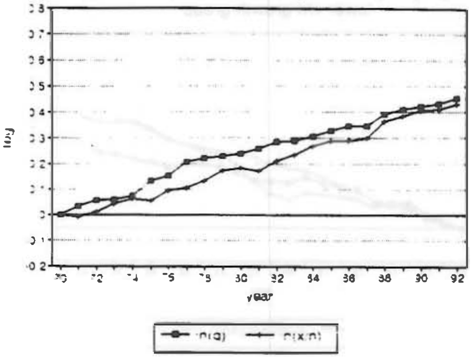


Figure 3I: Swedish ln(q) and ln(x/n)

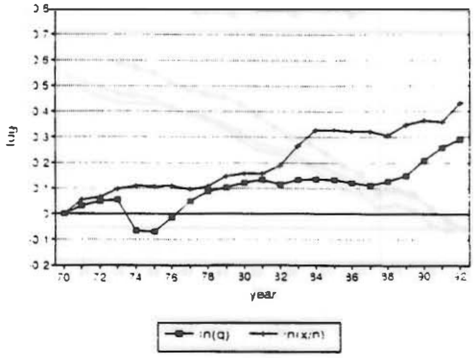


Figure 3J: Finish ln(q) and ln(x/n)

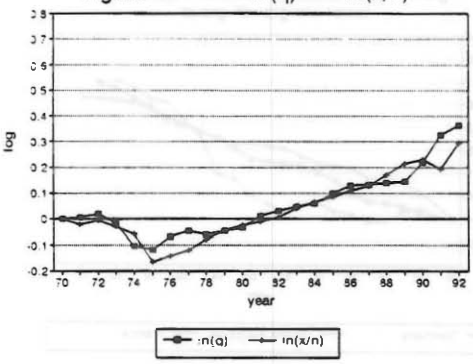


Figure 3K: Portugese ln(q) and ln(x/n)

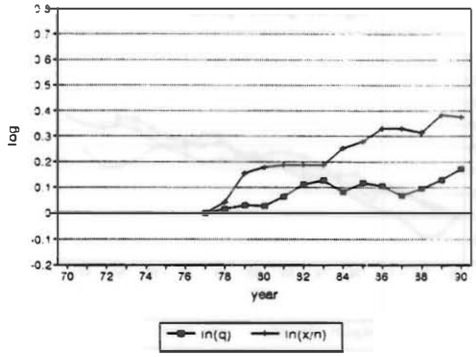


Figure 4A: Relative Productivity Growth
high growth group

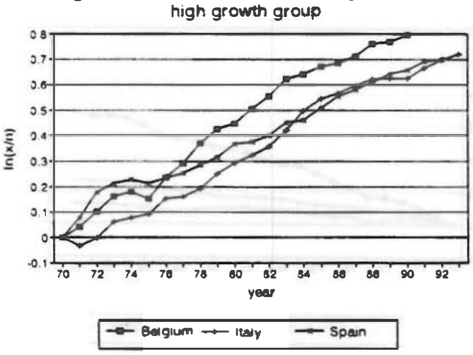


Figure 4B: Relative Productivity Growth
lower growth group

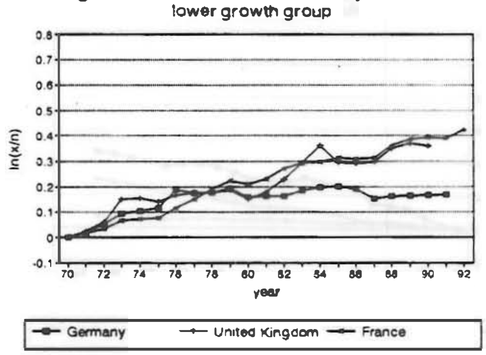


Figure 5A: X Good Productivity Growth
high x/n growth group

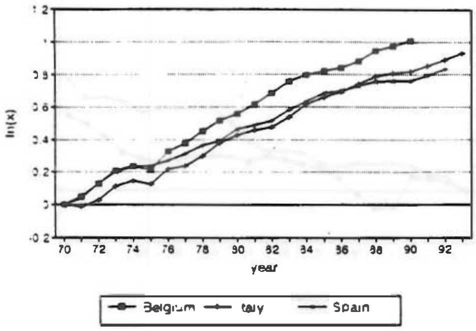


Figure 5B: X Good Productivity Growth
lower x/n growth group

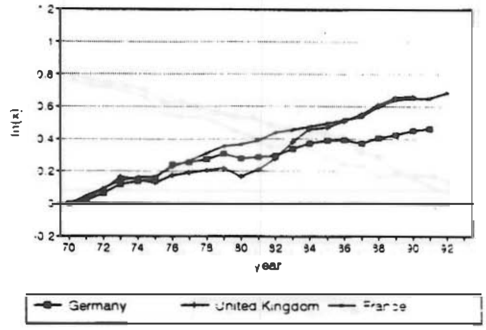


Figure 6A: N Good Productivity Growth
high x/n growth group

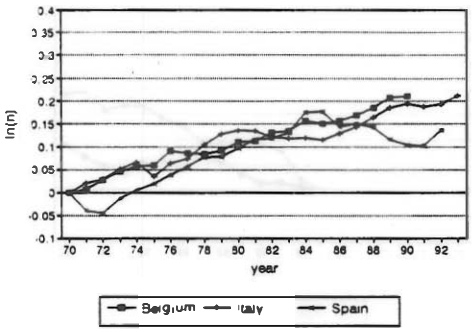


Figure 6B: N Good Productivity Growth
lower x/n growth group

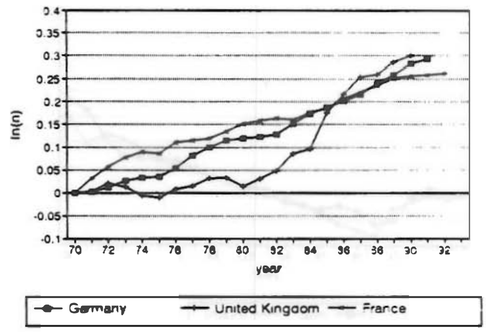


Figure 7A: German Labor Productivity
value added per worker

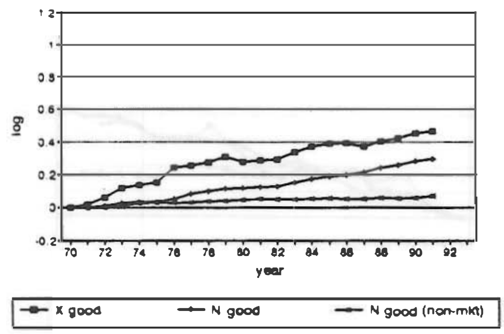


Figure 7B: French Labor Productivity
value added per worker

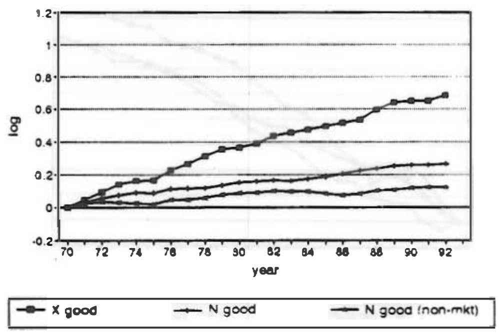


Figure 7C: British Labor Productivity
value added per worker

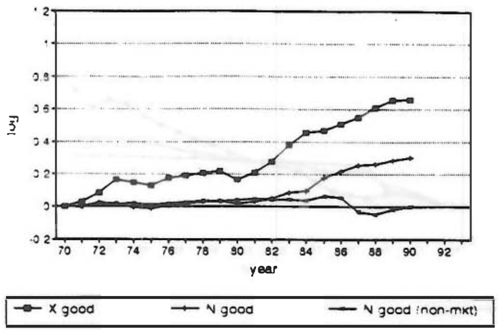


Figure 7D: Italian Labor Productivity
value added per worker

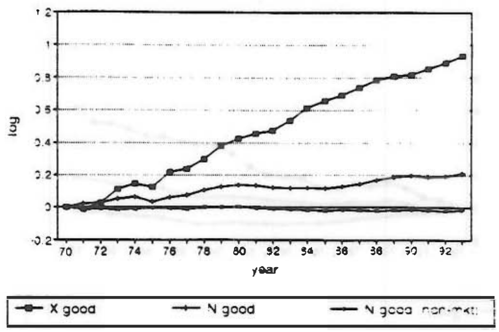


Figure 7E: Spanish Labor Productivity
value added per worker

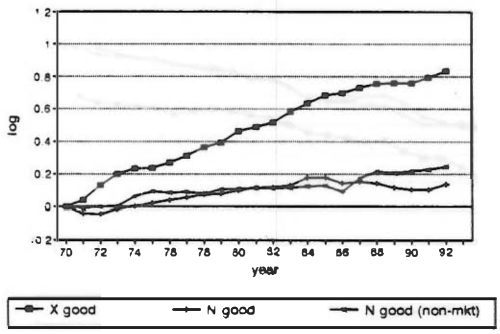


Figure 7F: Belgian Labor Productivity
value added per worker

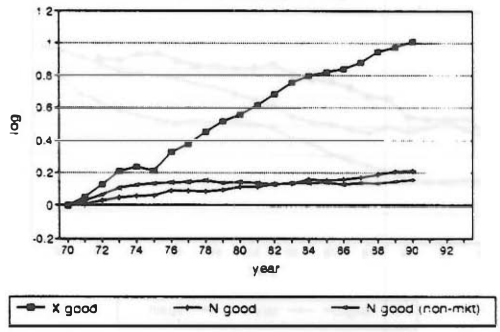


Figure 7G: Danish Labor Productivity
value added per worker

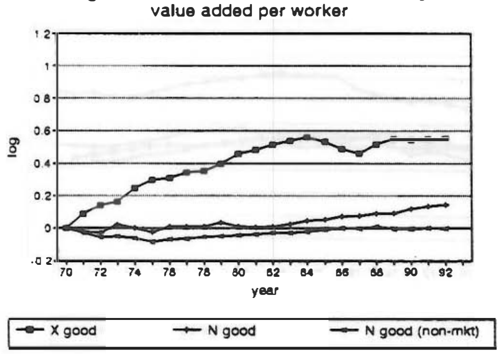


Figure 7H: Austrian Labor Productivity
value added per worker

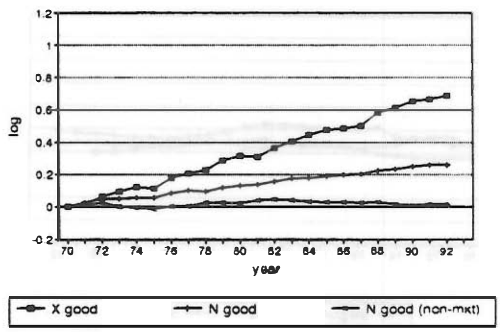


Figure 7I: Swedish Labor Productivity
value added per worker

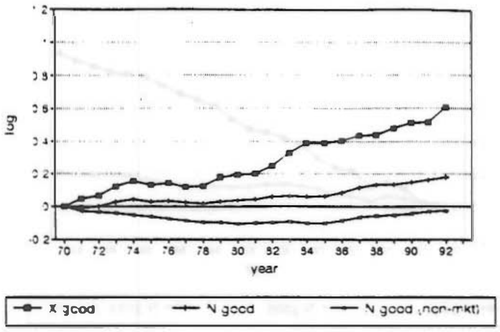


Figure 7J: Finish Labor Productivity
value added per worker

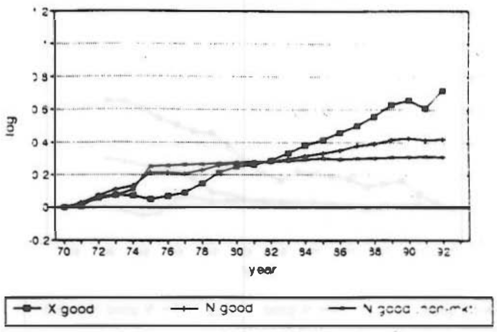


Figure 8A: N Good Share in Production
high x/n growth group

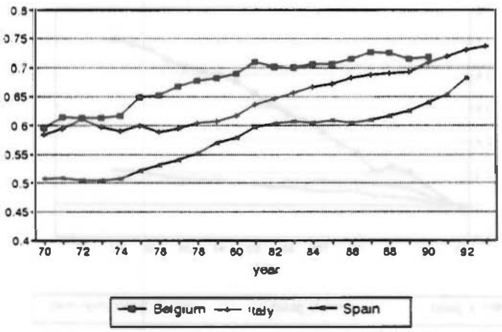


Figure 8B: N Good Share in Production
lower x/n growth group

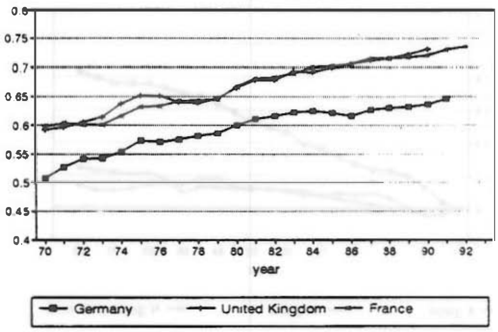


Figure 9A: Non-Market Share in N Good
high x/n growth group

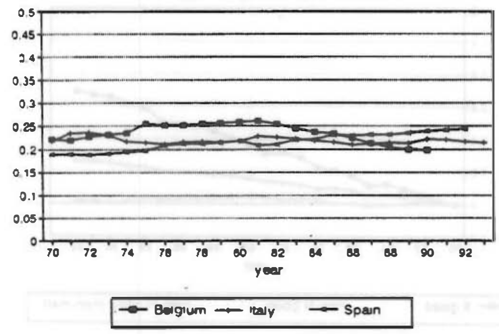
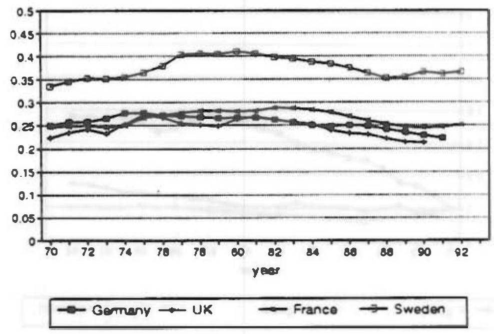


Figure 9B: Non-Market Share in N Good
lower x/n growth group



REFERENCES:

Asea, Patrick K. and Enrique G. Mendoza, "The Balassa-Samuelson Model: A General Equilibrium Appraisal," Review of International Economics, October 1994, p. 244-267.

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

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

Chinn, Menzie David, "Whither the Yen? Implications of an Intertemporal Model of the Yen/Dollar Rate," mimeo, October 1995.

Davidson, Russell and James G. MacKinnon (1993), Estimation and Inference in Econometrics (Oxford University Press).

De Gregorio, Jose, Alberto Giovannini, Thomas Krueger, "The Behavior of Nontradable Goods Prices in Europe: Evidence and Interpretation," mimeo, April 1993.

De Gregorio, Jose, Alberto Giovannini, Holger Wolf, "International Evidence on Tradables and Nontradables Inflation," mimeo, September 1993.

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

Froot, Kenneth, and Kenneth Rogoff, "Perspectives on PPP and Long-Run Real Exchange Rates," NBER Working Paper # 4952, December 1994. Forthcoming in Gene Grossman and Kenneth Rogoff (eds.) Handbook of International Economics, Volume 3, North Holland Press.

Hsieh, David, "The Determination of the Real Exchange Rate: The Productivity Approach," Journal of International Economics, 12, 1982, p. 355-362.

Lucas, Robert and Stokey, Nancy "Money and Interest in a Cash-In-Advance Economy", Econometrica, Vol. 55, No. 3, May, 1987, p. 491-513.

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

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

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

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

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

WORKING PAPERS (1)

9429 **Susana Núñez:** Perspectivas de los sistemas de pagos: una reflexión crítica.

9430 **José Viñals:** ¿Es posible la convergencia en España?: En busca del tiempo perdido.

9501 **Jorge Blázquez y Miguel Sebastián:** Capital público y restricción presupuestaria gubernamental.

9502 **Ana Buisán:** Principales determinantes de los ingresos por turismo.

9503 **Ana Buisán y Esther Gordo:** La protección nominal como factor determinante de las importaciones de bienes.

9504 **Ricardo Mestre:** A macroeconomic evaluation of the Spanish monetary policy transmission mechanism.

9505 **Fernando Restoy and Ana Revenga:** Optimal exchange rate flexibility in an economy with intersectoral rigidities and nontraded goods.

9506 **Ángel Estrada and Javier Vallés:** Investment and financial costs: Spanish evidence with panel data. (The Spanish original of this publication has the same number.)

9507 **Francisco Alonso:** La modelización de la volatilidad del mercado bursátil español.

9508 **Francisco Alonso y Fernando Restoy:** La remuneración de la volatilidad en el mercado español de renta variable.

9509 **Fernando C. Ballabriga, Miguel Sebastián y Javier Vallés:** España en Europa: asimetrías reales y nominales.

9510 **Juan Carlos Casado, Juan Alberto Campoy y Carlos Chuliá:** La regulación financiera española desde la adhesión a la Unión Europea.

9511 **Juan Luis Díaz del Hoyo y A. Javier Prado Domínguez:** Los FRAs como guías de las expectativas del mercado sobre tipos de interés.

9512 **José M.ª Sánchez Sáez y Teresa Sastre de Miguel:** ¿Es el tamaño un factor explicativo de las diferencias entre entidades bancarias?

9513 **Juan Ayuso y Soledad Núñez:** ¿Desestabilizan los activos derivados el mercado al contado?: La experiencia española en el mercado de deuda pública.

9514 **M.ª Cruz Manzano Frías y M.ª Teresa Sastre de Miguel:** Factores relevantes en la determinación del margen de explotación de bancos y cajas de ahorros.

9515 **Fernando Restoy and Philippe Weil:** Approximate equilibrium asset prices.

9516 **Gabriel Quirós:** El mercado francés de deuda pública.

9517 **Ana L. Revenga and Samuel Bentolila:** What affects the employment rate intensity of growth?

9518 **Ignacio Iglesias Araúzo y Jaime Esteban Velasco:** Repos y operaciones simultáneas: estudio de la normativa.

9519 **Ignacio Fuentes:** Las instituciones bancarias españolas y el Mercado Único.

9520 **Ignacio Hernando:** Política monetaria y estructura financiera de las empresas.

9521 **Luis Julián Álvarez y Miguel Sebastián:** La inflación latente en España: una perspectiva macroeconómica.

9522 **Soledad Núñez Ramos:** Estimación de la estructura temporal de los tipos de interés en España: elección entre métodos alternativos.

9523 **Isabel Argimón, José M. González-Páramo y José M.ª Roldán Alegre:** Does public spending crowd out private investment? Evidence from a panel of 14 OECD countries.

9524 **Luis Julián Álvarez, Fernando C. Ballabriga y Javier Jareño:** Un modelo macroeconométrico trimestral para la economía española.

9525 **Aurora Alejano y Juan M.ª Peñalosa:** La integración financiera de la economía española: efectos sobre los mercados financieros y la política monetaria.

9526 **Ramón Gómez Salvador y Juan J. Dolado:** Creación y destrucción de empleo en España: un análisis descriptivo con datos de la CBBE.

9527 **Santiago Fernández de Lis y Javier Santillán:** Regímenes cambiarios e integración monetaria en Europa.

9528 **Gabriel Quirós:** Mercados financieros alemanes.

9529 **Juan Ayuso Huertas:** Is there a trade-off between exchange rate risk and interest rate risk? (The Spanish original of this publication has the same number.)

9530 **Fernando Restoy:** Determinantes de la curva de rendimientos: hipótesis expectacional y primas de riesgo.

9531 **Juan Ayuso and María Pérez Jurado:** Devaluations and depreciation expectations in the EMS.

9532 **Paul Scbulstad and Ángel Serrat:** An Empirical Examination of a Multilateral Target Zone Model.

9601 **Juan Ayuso, Soledad Núñez and María Pérez-Jurado:** Volatility in Spanish financial markets: The recent experience.

9602 **Javier Andrés e Ignacio Hernando:** ¿Cómo afecta la inflación al crecimiento económico? Evidencia para los países de la OCDE.

9603 **Barbara Dluhoscb:** On the fate of newcomers in the European Union: Lessons from the Spanish experience.

9604 **Santiago Fernández de Lis:** Classifications of Central Banks by Autonomy: A comparative analysis.

9605 **M.ª Cruz Manzano Frías y Sofía Galmés Belmonte:** Políticas de precios de las entidades de crédito y tipo de clientela: efectos sobre el mecanismo de transmisión.

9606 **Malte Krüger:** Speculation, Hedging and Intermediation in the Foreign Exchange Market.

9607 **Agustín Maravall:** Short-Term Analysis of Macroeconomic Time Series.

9608 **Agustín Maravall and Christophe Planas:** Estimation Error and the Specification of Unobserved Component Models.

9609 **Agustín Maravall:** Unobserved Components in Economic Time Series.

9610 **Matthew B. Canzoneri, Behzad Diba and Gwen Eudey:** Trends in European Productivity and Real Exchange Rates.

(1) Previously published Working Papers are listed in the Banco de España publications catalogue.

Queries should be addressed to: Banco de España
Sección de Publicaciones. Negociado de Distribución y Gestión
Telephone: 338 51 80
Alcalá, 50. 28014 Madrid