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DETERMINANTS OF COMPETITIVENESS IN SELECTED MAJOR EU COUNTRIES

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Abstract

This paper aims to examine the determinants of competitiveness of some major EU countries. In the present analysis we focus on selected North and South EU members. Using monthly data for France, Germany, Italy, Spain and the UK, the linkage among real effective exchange rate, terms of trade, industrial production and interest rates is investigated. Initially, the variables under consideration are tested for unit roots in the presence of structural breaks, using the two-break LM test developed by Lee and Strazicich. The number of cointegrating relations is examined using the Johansen-Mosconi-Nielsen test, which allows for structural breaks and is based on the Johansen multivariate procedure. Based on that, a long-term relation among the above variables is specified for each country, and the corresponding VECM is estimated.

Introduction

Competitiveness has significant relevance for European Union's (EU) economic policy. The aim of the high expectational Lisbon strategy in 2000 was '*to make the EU the most competitive and dynamic knowledge-based economy in the world'* (European Parliament). The Europe 2020 Strategy sets as a major priority for the EU the promotion of *a 'more resource efficient, greener and more competitive economy'* (European Commission). Maintaining and enhancing competitiveness has evolved into one of the prime concerns in most countries.

However, since the introduction of a common currency, the cost and price competitiveness of the EU individual member states have drifted apart significantly and persistently with no signs of reversal. South EU countries have experienced wide fluctuations in their external positions since the adoption of the common currency. Their competitiveness vis-à-vis the core EU countries Germany and France has deteriorated. Germany, in contrary, has wittnessed increasing levels of competitiveness. Adherents of the Eurozone claimed that the euro was expected to alleviate exchange rate caused shifts in competitiveness within the EU which could sabotage the free intra-EU trade (Obstfeld and Rogoff, 1995, p.6). Nevertheless, over a decade in a single currency area, shifts in competitiveness are present and more persistent than ever.

A constant decrease in international competitiveness of some members of a single currency area is a peculiar case, as the means for reversal are restricted; nominal exchange rates misalignments and individual monetary policy are no longer available- instead the euro exchange rate against other currencies may be considered to be exogenous and a single monetary policy is introduced under the authority of the super-national European Central Bank. This has important macroeconomic impacts: in a single currency area, a constant loss of competitiveness is likely to be reflected in deterioration in the trade of goods balance and in the balance of payments as well as in accumulated debts. Because of interdependence and spill-over effects the survival of the currency union is considered to be threatened.

This paper uses the real effective exchange rate (REER) based on unit labour cost as an indicator of a country's competitive position and empirically investigates the linkage among the former and terms of trade, interest rate and industrial production, in order to conclude whether the latter variables determine the real effective exchange rate. The case of two countries of the EU south - Italy and Spain is investigated and compared to the one of two core EU countries- France and Germany, as well as the case of an EU but non-euro member- the United Kingdom. The empirical modelling of real exchange rates in these countries is of great interest for three reasons: *first*, the level of real exchange rate is empirically showed to be associated with economic growth for developing and industrial countries, *second*, the broad structural changes in these economies due to the EU accession (such as among others the participation to the Exchange Rate Mechanism and the Maastricht convergence criteria) have inevitably influenced the dynamics of real exchange rates and *third*, the deduction of a conclusion concerning the effects of the three selected variables on the REER could explain the divergence of competitiveness among these countries.

The remainder of this paper is organized as follows. Section 1 presents the concept and the measurement of competitiveness, as well as some stylized facts concerning the latter for the selected member states. Section 2 provides a theoretical framework refering to the effect of the selected three variables on the real exchange rates, according to economic theory, whereas Section 3 provides an empirical assessment in the five selected countries and the derived conclusion.

Section 1

Measuring competitiveness: Some theoretical backround

The level of a country's competitiveness reflects its macroeconomic performance. Competitiveness is a broad concept: it contains qualitative and quantative factors. It is also dynamic since it changes over time. Thus, defining and measuring international competitiveness attracts controversy. A large number of definitions has been proposed in the economic literature. According to Oecd '*it is a measure of a country's advantage or disadvantage in selling its products in international markets'* with Eurostat adding that '*it refers to the ability to generate relatively high income and employment levels on a sustainable basis while competing internationally'*. Thus, the concept of competitiveness is linked to the 'external performance' of a country. The latter could be monitored by current account balances, export growth but also by all factors which may affect a country's external performance in a positive way such as the quality of traded products, technological innovation, research and development, the efficiency of sales networks and the degree of diversification of the traded product; all could constitute measures of competitiveness. In fact, a number of measures and indices have been constructed with the use of different analytical methologies, which function as indicators of a country's competitive position.

This paper investigates the determinants of competitiveness in a narrower meaning, based on relative prices or costs. Economic theory has always considered export performance to be a function of cost and prices. However, the link between this narrow concept and a country’s economic performance is not unambiguous as its international relative price or cost position can be both *cause* and *result* of its economic performance as Turner and Van’t dack (1993, p.9) note. The relevance of "non-price" factors of competitiveness was first pointed out by Kaldor (1978). The "Kaldor paradox" showed that in several countries export market shares increased together with relative unit costs or prices. Nevertheless, developments in cost and price competitiveness have always constituted important factors of an economy’s ability to be competitive in international markets. For this purpose, the *real exchange rate* is used as a measurement of competitiveness.

Even though the real exchange rate was not a part of the traditional growth models (nor of their practical policy incarnations, as Eichengreen (2008, p.1) notes), in recent theory, it is considered to be a major determinant of export-led growth. Recent literature (Rodrik, Eichengreen, McDonald) links the level of the real exchange rate to output and employment growth. Thus, keeping the real exchange rate at competitive levels can be critical for a country’s growth.

The concept of real exchange rate

Exchange rates – the price of a country's currency in terms of another country's currency - play a central role in international markets because they allow the computation of the relative prices of goods and services produced in different countries, thereby allowing the comparison of those prices across countries. The *real* exchange rate constitutes an *adjustment of the nominal exchange rate E to domestic and foreign prices, namely the nominal exchange rate E is deflated with appropriate price or cost factors.* Changes in competitiveness could be thus measured through comparisons of domestic cost and price movements relative to foreign cost and price movements and changes in the nominal exchange rate. As an index of relative prices, it plays a crucial role in open economy and transactions between countries. The real exchange rate approximates the purchasing power of a nation's currency in comparison to its trading partners: a high real exchange rate signifies that the foreign products are relatively cheap and respectively, domestic products are expensive compared to those abroad. Thus, a relative high price and cost level would be an inhibitory factor for a country to compete internationally. In this sence, a rise of country's relative prices reflects a deterioration of its competitiveness. However, Harberger (2004, p.13) considers the real exchange rate not being a good measure of relative competitiveness as he considers them as being two quite different concepts. Despite the critiques, the real exchange rate is a widely accepted indicator. In this context, Boltho (1996, p.2) defines the desirable degree of international competitiveness as *the level of the real exchange rate which, in conjunction with appropriate domestic policies, ensured internal and (broadly defined) external balance*.

The real exchange rate is usually constructed as an *effective* index, since a country competes with not only one but with several other countries in the international markets. The concept of effective was introduced after the collapse of the Bretton Woods. Between the Bretton Woods Agreement in 1944 and the currency realignment of the Smithsonian Agreement in 1971, the US dollar provided a benchmark against which changes in the value of other currencies could be measured, thus the *bilateral* exchange rate was an adequate index. An effective index shows the movements in the real exchange rate relative to the most important trading partners. Thus, the *Real Effective exchange Rate (REER)* is a multilateral index and it is computed as *the weighted geometric average of the price index of a country relative to the prices of its trading partners, weighted by the respective trade shares of each partner,* namely:

$$REER = \prod_{i \neq j} \left(\frac{E_i P_{i(HOME)}}{E_i P_{j(FOREIGN)}} \right)^{W_{ij}}$$

where P_i notes the price index of home country, E_i notes the nominal exchange rate of home country in US dollars, P_j notes the price index of country j (foreign), E_j notes the nominal exchange rate of country j's currency in US dollars, W_{ij}: country j's weight for home. According to this definition, an increase in the index implies a real appreciation of the home currency, whereas a decrease a real depreciation. Thus, in order to compute a country's REER index, a choice of the appropriate deflator should be made, as well as a computation of the weights (w).

The concept of 'real'

Various price indices have been suggested in the literature to serve as deflators, such as, among others, export and import prices, consumer price indices (CPI), and unit labour costs. None of them is considered to be perfect; however the *Unit Labour Cost (ULC)* is considered (Unctad, Turner and Golub, Neary) to be more appropriate in order to indicate international competitiveness. Unit labour cost is defined as the cost of labour per unit of output. Total labour costs include wages, payroll taxes, contributions for social security and pensions. Changes in ULC monitor changes in wages or in *productivity,* namely *the output per person employed.* ULCs rise if total labour costs rise faster than labor productivity. If labor productivity increases and total labour cost remains unchanged, then unit labour cost declines.

The advantages of using REER based on ULC compared to other price indices could be summarized as follows: Firstly, data on wage costs are available on a comparable basis across countries. ULC-based REER does not include temporary fluctuations in profit margins as the CPI and export prices-based does (Nielsen, 1999, p.11), it captures important elements of the catching up process of developing countries (UNCTAD) and it is not affected by indirect taxes, subsidies and price controls compared to CPI (Turner and Van't dack, 1993). Moreover, according to OECD, this index avoids measurement problems such as shifts in the composition of trade flows. Turner and Golub (1997, p.7) further note that CPI tends to understate changes in competitiveness because it is endogenous to the exchange rate as it includes prices of imports. Finally, Lipschitz and McDonald (1992, p.38) and Turner and Golub (1997, p.7) argue that ULCs reflect an important part of production costs which is nontraded (and thus not arbitraged as labour does not move easily), which provides useful information as labour costs can differ widely across countries.

More appropriate as they might be, ULC-based REERs exhibit certain disadvantages: As Turner and Golub (1997, p.7) note, ULCs movements might occasionally occur due to factor substitution, namely the capital- labour ratio could change over time; as a result, changes in capital stock will subsequently change the productivity of labour and therefore the ULCs. This change would not represent a change in the competitiveness of the country though. Omitting other input costs such as capital costs and profit margins is considered by other economists (Bayoumi et al. 2005, eurostat) as a drawback. Furthermore, ULC is sensitive to cyclical movements in labour productivity during the business cycle.

Thus, in order for the ULC (as a deflator of the nominal exchange rate) to indicate competitiveness, a number of assumptions should be made as noted in Lipschitz and McDonald (1991). More specifically, *unit labour costs can provide information on the profitability of producing tradable goods if the prices of traded goods are linked through international competition, no intermediate inputs are used in production, the capital stock is fixed, and technology is homogeneous across countries. Under these circumstances, a rise in unit labour costs in the manufacturing sector in the home country, relative to the foreign country, will be associated with a loss in competitiveness and a deterioration of the trade balance of the home country*.

The concept of ‘effective’

The methology for the construction of the weights (w) is a very important subject of investigation as outdated weights can lead to an incorrect assessment of the development in the effective exchange rate as Bayoumi (2005, p.3) stresses. The choice of a weight depends on trade schemes but it could be very complicated, depending on the details included in the computations, which are essential though, in order for the index to appropriately reflect changes in competitiveness.

The weight could reflect a pattern only including imports, or only exports, or both. Import-weighted indices are generally most appropriate when assessing the effect of exchange rate movements on import prices, whereas export-weighted indices are typically used in order to assess competitiveness of a country. A simple way to compute weights using both imports and exports is to use weights based upon bilateral trade volumes namely to express the sum of exports and imports as a proportion of total exports and imports. A more complex computation would include third market effects, namely measuring relative prices among home country and foreign goods in a third foreign country. In addition, these third-market effects could depend on the importance of foreign and domestic goods in overall demand or equal weights could be assigned to direct and third-market competition. For example, as Chinn (2005, p.9) notes, the IMF uses a weight expressed as follows:

wj = (*imports of i/imports and exports of i*) x (*share of i imports from j*)

+ (*exports of i/imports and exports of i*) x (*overall export weight*), where *overall export weight* = β x (*share of exports of i to j out of total i exports*) + (1-β) x (*third market weight*), and where *the third market weight is equal to the weighted average over all third-country markets of country j's import share divided by a weighted average of the combined import share of all of country i's competitors, with the weights being the shares of country i's exports to the various markets.*[1]

Further assumptions should be made regarding the calculation of the weights: The first is how many type of good exist and if it is differentiated by country of source. The second one concerns the degree of substitutability among goods from different countries. Commodities are usually considered to be perfect substitutes, whereas manufactures are assumed to be differentiated goods that are imperfectly substitutable across countries. However, *the appropriateness of these measures relies upon a constant elasticity of substitution (CES) function for utility. This selection of utility function is driven by tractability – nothing guarantees that utility is CES in form, and nothing guarantees that a widget exported from the Euro area is equally substitutable with a widget from Malaysia.* (Chinn, 2005, p.9). And because trade flows change over time, weights should be allowed to change too, either continuously or discretely and infrequently.

Some stylized facts for selected EU countries

On January 1, 1999, eleven EU countries adopted a common currency, the euro, as part of a broader context, the European Monetary Union (EMU),

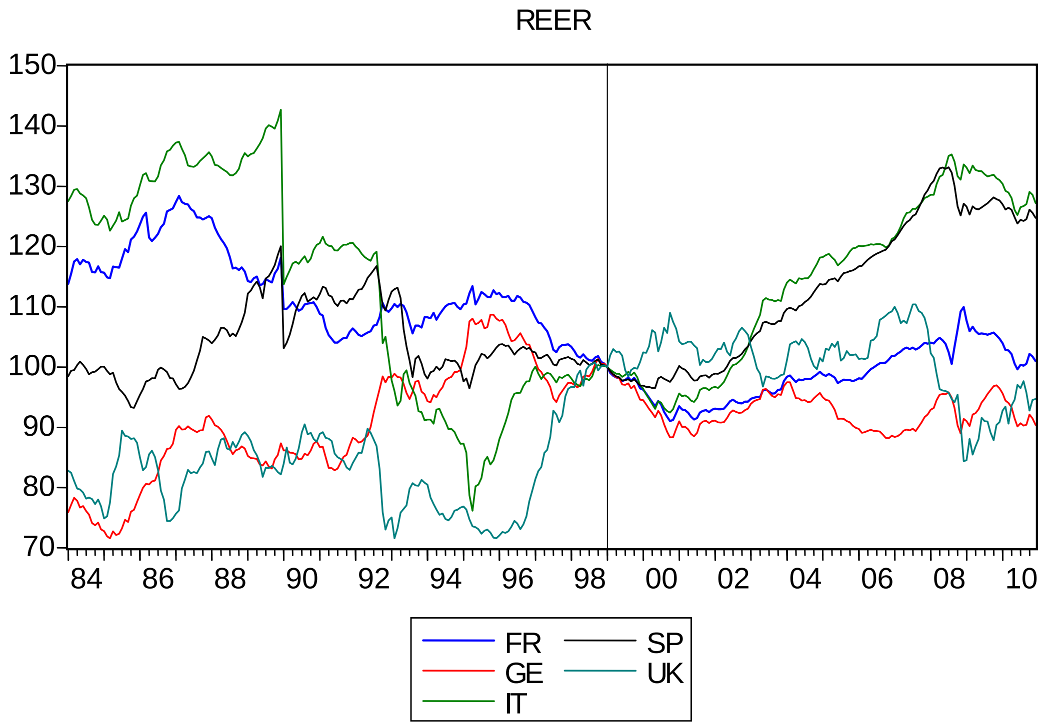
[1] Chinn (2005) does not include a definition for β, however it is concluded it is a weighting factor.

which was introduced by the Maastricht Treaty. This presupposed irriversible fixing of exchange rates among the participants. Not all EU members participated in the Eurozone. In the context of EMU, the participants also abandoned autonomous monetary policy; instead they confered responsibility for it from their Central Banks to the European Central Bank. Therefore, the euro constitutes a natural benchmark to compare the evolution of the REER among these countries.

By introducing a common currency, harmful exchange rate volatility would be eliminated. *The euro was expected to mitigate exchange rate induced shifts in competitiveness within the EU that could undermine the free intra-EU trade* (Obstfeld and Rogoff, 1995, p.6). Thus, the benefits from adopting the single currency would be the elimination of exchange rate volatility ant thus the pressure for *beggar-thy-neighbour* policies would subsequently become extinct. Transaction costs would also be eliminated, transparency during the transactions would be feasible and factor mobility within the EU was supposed to foster growth and enhance competitiveness among the countries.

Nevertheless, over a decade in a single currency area, shifts in competitiveness are not only present, but seem more persistent than ever. As Flassbeck and Spiecker (2011, p.180) note, *it is a monetary system with absolutely fixed nominal exchange rates between its member states, but dramatically divergent real exchange rates.*

Figure 1 : Real exchange rate based on unit labour cost



source of data: IFS

Figure 1 shows the development of real exchange rates (unit labour cost based) in France, Germany, Italy, Spain and United Kingdom. Shading line signifies the adoption of the euro. The divergence is obvious: Italy and Spain have encountered REER appreciation since 1999, thus have lost cost competitiveness vis-à-vis Germany whose REER has depreciated since 1999, whereas France has experienced a rather stable competitive position. UK, which is not a member of the eurozone, experienced an improvement of cost competitiveness position. In particular, Italy and Spain exhibit a REER appreciation of about 22% between 1999 and 2007 (pre-crisis), whereas the one of Germany a depreciated about 12% during the same period. The accumulated differences in the REER within eleven years (1999-2010) has resulted a gap of about 35-40% in competitiveness between Germany on one hand and the two countries of the EU south on the other. This fact is interpreted as follows: a product sold at the same price by France, Germany, Italy, Spain and the UK in 1999, would be 40% cheaper in Germany in 2010, compared to the cost of it in Italy and in Spain.

As shown in the figure above, divergences in REER have been observed even before the launch of the euro. Nevertheless, these episodes were generally followed by nominal exchange rate realignment. (European Commission, 2009). Deficit countries were often dealt with the dilemma of having to devalue or not their currencies in order to reduce their external deficits at the expense of domestic inflation and deteriorated terms of trade. The euro was expected to alleviate exchange rate caused shifts in competitiveness within the EU which could sabotage the free intra-EU trade.

The system has abandoned the use of nominal exchange rates as an instrument to compensate for such divergences. Because of EMU's (and following the 'uneasy triangle' theory that economy cannot simultaneously maintain a fixed exchange rate, free capital movement, and an independent monetary policy), domestic monetary policy by each country is not available to decrease the differences in price and costs competitiveness. Moreover, the EMU has imposed fiscal rigidity and as Blanchard (2008) quotes, fiscal policy is neither available, nor usefull. Thus, the route for adjustment is rather restricted. Thus, since the launch of the euro, imbalances among member states rather that been corrected, they grew. Within this context, a persistent deviation of unit labour costs and prices creates accumulating external deficits, which questions the viability of the whole monetary system.

Section 2

Fundamentals

In order to establish a causal relation between changes in the real exchange rate and thus international competitiveness, information about the driving force of its movement is required. There exist several theories to explain the movements of real exchange rate and several empirical studies are developed to test the implications of those theories. Empirical research on exchange rates in the 1970s and 1980s focuses on the changes of exchange rates which reflected the increased exchange rate volatility after the abandonment of the Bretton- Woods system and the failure of asset models to provide an adequate explanation of exchange rate changes. However, more recently, focus shifts to real variables and the long-run adjustment of real exchange rates.

In this paper we examine whether the terms of trade, the interest rates and the industrial production possess a long-run relationship with the real exchange rates, namely we examine terms of trade (TOT), industrial production (IP) and interest rates (IR) as fundamentals of the REER, thus :

$$\text{REER} = f\,(\text{TOT, IP, IR})$$

A brief presentation of these variables and corresponding literature review follows.

Terms of trade

Terms of trade are defined as the ratio of export to import prices. The mathematical expression is the following:

$$TOT_t = (Px_t / Pm_t) \times 100,$$

where Px_t and Pm_t represent the prices of exports and imports respectivelly at time t. This index reflects the export purchasing power of a country in terms of imports. If a country's export prices are low relatively to its imports (TOT<100), then more goods are required to be exported by the country in order to import a given quantity of foreign goods. In the context of this definition, an increase of the index suggests improvement of terms of trade, whereas a decline suggests deterioration.

Terms of trade are subject to exogenous shocks. Relative prices of traded goods could change as their supply and demand exhibit shifts due to various reasons. Shifts could be in demand of imports or of exports, such as changes in taste, differences in export and import elasticities with respect to income, differences in growth rates, or in supply of exports or of imports such as tariffs, subsidies, embargos, or both.

Theoretically, the effect of exogenous shocks in the terms of trade on real exchange rate is *ambiguous*; it could not be a priori designated as positive or negative as the terms of trade affect the real exchange rate through several channels. Results may vary if the shock is generated due to a change in the export prices or due to a change in the export prices. Results also vary if the country exports commodities, energy or manufactures, if the latter are diversified or not and if the countries are dependent on the imported goods. The net result also depends on the weight the exports have in the home consumption basket relatively to the foreign one. As Edwards and van Wijnbergen (1987) propose, for a commodity producing country, an increase in the terms of trade, driven by an increase in export prices, results in an increased demand for and subsequent appreciation of the domestic currency, whereas an increase in the terms of trade driven by a decrease in import prices may similarly result in a depreciation of the international currency. An increase in the relative price of home exports also translates into a rise in the relative domestic consumer price level (and results a real appreciation) if home exports have a greater weight in the home consumption basket than in the foreign consumption basket. (Lane, Milesi-Feretti, 2002, p.549)

In general, a change in the terms of trade is considered to generate two effects that operate in opposite direction. The direct *income effect* arises when a change in the terms of trade, ceteris paribus, generates changes in the real national income and, consequently, changes in demand for tradables *and* non-tradables. This, in turn, causes a pressure for change on the price of non-tradables (since the price of tradables are considered to be exogenous to the system as they are defined internationally) and, as a result, for a change in the general level of prices and consequently in the real exchange rate level. For example, an exogenous shock which increases the prices of exports and thus improves the terms of trade, generates improvement of the national income, a rise in demand for tradables and non-tradables and a real exchange rate appreciation. On the other hand, the indirect *substitution effect* operates in the opposite direction: the change in the terms of trade implies that the relatively more expensive goods are substituted with the relatively cheaper ones; this again causes reverse shifts in demand for tradables, and shifts in supply of non-tradables which results a reverse change in the real exchange rate. In the previous example, the improvement of terms of trade shifts the foreign demand away from domestic exports, causing the production of exports to fall. This effect moves the factors of production away from tradables to non-tradables, reducing the prices of non-tradables in relative terms, and hence results in depreciation of domestic currency in real terms through trade deteriorations. The net effect depends on which of the two opposite effects will dominate. If the income effect dominates a net real appreciation will occur, whereas if the substitution effect dominates a net real depreciation will occur.

The domination is not irrelevant to particular factors, as previously mentioned. *The price elasticity of imports and the one of exports* is one of these factors. In particular, if the price elasticity of exports or imports is low, the income effect would dominate the substitution effect.The price elasticity of imports is pertinent to the *dependency* countries have to imported goods. The more dependent they are to imported goods (for example oil), the lower the price elasticity of imports. A deterioration of the terms of trade due to a fall in the price of exports or a rise in the prices of imports would cause a real depreciation, thus there would be a positive relation between the REER and the TOT.

The *elasticity of substitution* between home and foreign traded goods is another factor which plays a significant role to the net result. If the elasticity of substitution is low, there will be vulnerability in the REER because of the movements in the TOT and the income effect will dominate the substitution effect. The *extent of diversification* of the traded is in absolute relevance with the elasticity of substitution. The manufactured products are usually considered to be diversified among the countries and thus considered to be imperfect substitutes, whereas commodities are usually considered to be perfect substitutes. Thereby, in case of a country which exports commodities and imports manufactures, it is obvious that the substitution effect would be of no significance. In case of a country which exports and imports manufactures, which as mentioned before, are considered to be imperfect substitutes, the substitution effect would probably be lower than the income effect.

Thus, in most cases, as analysed above, the income effect dominates the substitution effect and there is a positive relation between REER and TOT. However, sometimes, the indirect substitution effect dominates the direct income effect, leading to opposite results of any terms of trade effects analysed above. For example, via an improvement in terms of trade could provide producers of non-tradable goods in the economy with foreign exchange resources and lead to increase of production of non-tradable goods, and a subsequent decrease of their price and thus of the price level as a whole. The improvement in the terms of trade may thus lead to depreciation of the real exchange rate. In contrary, a deterioration of the terms of trade would cause foreign exchange limitations to the producers and hence they would be constrained buying inputs for producing non-tradables, which would reduce the production of non-tradables, increase their prices and the price level of the country as a whole and cause an appreciation in the real exchange rate.

As Neary (1988, p.216) notes, changes in exogenous variables are more likely to lead to a real appreciation the greater their effect on the demand for and the smaller their effect on the supply of non-traded relative to traded goods. Bagchi et al. (2003) note that while theoretical work investigates extensively the relationship between terms-of-trade shocks and the real exchange rate, the empirical work on large developed countries generally overlooks the role of the terms of trade in determining the real exchange rate. Usually the countries under investigation are developing ones. Among the selected EU countries under investigation, there are no trade barriers, because of the single market, but there is a diversification concerning the type of products exported, with the countries of the South exporting mostly commodities and low diversified manufactures and importing highly diversified manufactures.

In general, the relevant literature provides empirical results concerning the relation of the two variables; a tendency towards a positive relation between the two is the most frequent case though; an improvement of terms of trade tends to appreciate real exchange rate. Amano and Van Norden (1995) find that the Canadian/US RER depends on TOT and that the influence of monetary factors such as interest rates differentials is only secondary. Since prior to two authors overall TOT influence in the bilateral RER was investigated without much success, this time Amano and Van Norden split the overall TOT index into two components, namely TOTENERGY – the price of exported energy devided by the price of imported manufactured goods and TOTCOMOD - the price of exported non-energy commodities devided again by the price of imported manufactured goods. They find that an increase in TOTCOMOD appreciates RER, whereas an increase in TOTENERGY depreciates RER.

Table 1 : Selected literature on REER (or RER) –TOT linkage

Author(s)	**Countries**	**Depend. variable**	**Independent variable (s)**	**Method**	**Coefficient of TOT**
Amano, Van Norden (1995)	Canada	bilateral RER C$/US$	TOTCOMOD, TOTENERGY Real Int.rates differentials	Non-Linear LS, Phillips & Loretan (1991)	**-0.811 *** **0.223 ***
Chen, Rogoff (2003)	Australia Canada New Zealand	RER	TOT, Commodity prices	OLS	**0.73** **-0.04** **1.01**
Choudhri, Khan (2009)	14 low-medium income count. & 2 high income countries	RER	Labour productivity different., TOT	Dynamic OLS	**0.3 to 0.565**
Coudert et al. (2009)	commodity exp. countries & oil-exp.countries	REER	TOT	Panel Co-integ. techn**.**	**0.648 (for com. exp. countries) 0.262 (for oil exp. countries)**
De Gregorio, Wolf (1994)	14 OECD countries	REER (log)	TOT (log) Total Factor Productivity differ. (log)	SUR in first differ.	**0.47 to 0.49**
Devereux, Connolly (1996)	Argentina, Colombia, Ecuador, Venezuela	RER (log)	TOT (log) commercial policy	Regress real on hypothetical RER and use R^2 to express TOT effect on RER	**0.02 to 0.67**
Lane, Milesi-Feretti (2002)	Ireland	REER (log)	TOT (log) NFA (log) GDP differ. (log)	Johansen Co-integr, Phillips-Hansen	**0.08**

*****home P is the denominator, so an increase implies a depreciation.

In contrast, in Chen and Rogoff (2003), the small coefficient of TOT in the case of Canada, implies that Canada is the exception to the strong correlation that TOT and RER appear to have in the other two countries under investigation- Australia and New Zealand. Choudhri and Khan (2004) primarily examine the Balassa – Samuelson effect in 16 countries, using TOT as an additional determinant of the RER. The results provide strong evidence that TOT is a significant determinant of the RER in the long run. Coudert et al. investigate the effect of TOT on REER in two different cases of countries, namely commodity exporting and oil exporting. Using panel cointegration techniques, they find strong positive relation in both cases, with a stronger effect of TOT on REER in case of commodity exporting countries. De Gregorio and Wolf (1994) present empirical evidence for a sample of fourteen OECD countries. The evidence broadly supports the predictions of the model, namely that a fast improvement in the terms of trade induce a real appreciation. Devereux and Connolly (1996) find that the greater the elasticity of non-traded with respect to the price of the imported goods, the smaller is the RER effect of changes in the exogenous TOT. In their empirical study in four Latin American countries the impact of TOT ranges from 2% (for Venezuela) to 67% (for Argentina). In the case of Ireland, Lane and Milesi-Feretti (2002) find only weak impact of TOT on REER (8%). Thus, in most cases empirical results provide evidence of a positive relation between TOT and REER.

Interest rates

The second possible determinant of the REER examined is the interest rate. Interest rates are the return to holding interest-bearing financial assets. The interest rate under investigation is the ten year maturity central government bond yield. Interest rates on government bonds should influence the decision of foreigners to purchase currency in order to buy them. In this case, higher interest rates attract capital from abroad and the currency should appreciate. What is important is the difference between domestic and foreign interest rates, thus a reduction in interest rates abroad will have the same effects. In the short run, an increase in the interest rate induces *capital inflows*, which results in the appreciation of the real exchange rate according to the Mundell-Fleming model. According to Dornbush (1976, p.1166), the exchange rate adjusts instantaneously to clear the asset market.

However, high real interest rate countries tend to have currencies that are strong in real terms not only in the short run but even more in the long-run. Engel (2011, p.2) justifies this to the influence of expected future risk premiums on the level of the exchange rate. *That is, the country with the relatively high (real) interest rate has the lower risk premium and hence the stronger currency. When a country's (real) interest rate rises, its currency appreciates not only because its assets pay a higher interest rate but also because they are less risky*[2]*.*

Large volumes of foreign portfolio funds moved into Latin America, East Asia and Russia as Edwards (2000, p.1) notes due to *high domestic interest rates, a sense of stability stemming from rigid exchange rates, and what at the time appeared to be rosy prospects.* Harberger (2004, p.2) stresses though that capital inflows lead to a real appreciation of the currency as long as they are not spent exclusively on tradable goods.

In the interest rate literature, the most common case investigated is the one of a lower world (or a big open economy such as the USA) interest rate (and thus a relatively higher domestic one) and not an actual rise in domestic interest rate. In a study of Chuhan, Claessens and Mamigni (1993) lower international interest rates explained about half the variation in capital inflows

[2] parenthesis mine

from the USA to six Latin American countries markets. Calvo et al. (1993, p.108) reached to similar conclusions arguing that capital inflows in Latin America are partly explained by lower international interest rates (thus relatively higher domestic interest rates) and led to real appreciation. Fernandez-Arias (1994) stresses the significance of international interest rates as a determinant of private capital flows. Similar conclusions are derived in the study of Agénor and Hoffmaister (1996), namely negative shocks to US interest rates lead to capital inflows in Asia and a RER appreciaton in the Philippines and Thailand. Calvo, Leiderman and Reinhart (1993) question whether capital inflows to emerging markets could be sustained when a rise in industrial-country interest rates occurs. According to Eichengreen and Mody (1998, p.39), a rise of the US interest rate in 1994 it was associated with capital ouflows in Latin America and the sharp depreciation of the peso and the rest of the Latin American currencies, known as ‘the Tequila crisis’.

Industrial Production

Industrial production index includes mining, quarrying, manufacturing, electricity, gas and water and it reflects economic activity in the industrial sector. More generally, it represents the major part of the tradables sector of the economy. In order to examine if there is a linkage between movements in industrial production index and real effective exchange rate it is important to clarify if movements in industrial production index proxy changes in productivity.

Real exchange rate index takes into account changes in productivity since it is unit labour cost based. An increased productivity (A_t) is reflected through a decreased unit labour cost (presupposing that the nominal wage w_t is sticky or increasing by a less percentage compared to productivity). Thus, an increased industrial production index which reflects a raised productivity is related to a lower real exchange rate index. This is also the case if other factors' productivity rises. For example, an increase in capital productivity would give incentives to producers to substitute labour with capital, thus the nominal wage and consequently the unit labour cost would decrease. In contrast, an exogenous rise in industrial production which comes along with increasing nominal wages (because of increased labour demand) but unchanged productivity, is related to a higher real exchange rate index.

Productivity changes also interact with terms of trade. Many researchers claim that an increase of productivity in the sector of traded goods lowers the international relative price of domestic tradables, namely international spillovers of a rise in domestic productivity are consider to be positive since foreign consumers benefit from reduced import prices. As an effect, the country's terms of trade worsens. This would tend to rather decrease the real effective exchange rate- if the most common case of positive linkage between the TOT and REER is accepted. Thus the real exchange rate is affected by two forces: a depreciation due to the productivity increase and an appreciation due to the exchange rate response (the foreigners ask more domestic currency to buy the relatively cheaper imports) Productivity gains in the tradables sector shifts the supply curve of exports to the right which induces excess supply of foreign exchange, which is mitigated by moves along the export supply and the import demand curves (Harberger, 2004, p.13). The final result depends on the magnitude of these two forces. Harberger (2004, p.13) mentions the 'Le Chatelier' principle (that the effect should not outweigh the cause) in order to end up that the normal result would be a net real depreciation and this is the case in most economic literature (Obsfeld and Rogoff 2004, Benigno and Thoenissen 2008). Corsetti, Dedola and Leduc (2006, p.5) find that an increased productivity in the tradables sector improves rather than worsens terms of trade and finally increases real exchange rate.

In the literature, when the relation between labour productivity and real effective exchange rate is investigated, the Balassa- Samuelson (BS) effect is frequently mentioned as an explanation of the interaction of these two variables. In the model first developed by Harrod (1933), and extended later by Balassa (1964) and Samuelson (1964), productivity differentials between two countries can explain deviations in the REER. Namely, a country's general price level is positively related to the level of per capita income. According to this effect, countries with expanding economies tend to have appreciating real exchange rates due to high productivity growth in the sector of tradables relatively to non-tradables. Growing productivity levels in the tradables sector would cause rises in wages in this sector, compensating for higher productivity. Assuming labour mobility within the economy, wages will tend to equalize across sectors; thus, an increase in the wages and the unit labour costs (since the wage rise is not offset by productivity growth) in the sector of non-tradables is expected. As a result, prices of non-tradables would tend to rise, leading to a real exchange rate appreciation.

In general, the BS effect is considered to be an effect of the ‘catching-up’ process. This could be the case in the EU, in the context of the convergence process. However, some dominant pre-assumptions such as the wage equalization hypothesis do not seem to apply (European Commission 2009, p.23). Moreover, the BS effect is considered to affect more the cpi-based index and less the ulc-based one. De Grauwe (2006, p.716) totally outcasts the BS effect as an explanation of REER ulc-based movements stressing that *since the real exchange rates are based on unit labour costs, they take into account differential productivity growth. As a result, divergent movements in these rates cannot be the result of BS effect.*

Section 3:

TIME SERIES ANALYSIS

Data description

The dataset includes monthly observations on real exchange rates based on unit labour cost, nominal interest rates, industrial production indices and terms of trade indices for France (from 1984:01 to 2009:03), Germany and the UK (from 1984:1 to 2010:12), Italy, (from 1984:01 to 2010:04) and Spain, (from 1990:01 to 2010:12). The data for REER and IP for all countries were obtained from the International Financial Statistics (IFS) of the International Monetary Fund (the type used is described in the previous section). Terms of trade for Germany and the UK and Spain were calculated as the ratio of export to import prices of all commodities derived by the IFS for Germany and the UK and by Instituto National De Estadistica for Spain. Terms of trade for

Italy and France were obtained as an index from Organisation for Economic Co-operation and Development (OECD) database and were multiplied with 100 for consistency with the rest of the data. Industrial production index was obtained from the IFS (calculation details in the Appendix (*)). Interest rates refer to 10-year central government bond yields (bullet issues – end of month) and were obtained from the Eurostat from the beginning of the period for each country to 2007:04 and from the Danish Central Bank from 2007:05 to the rest of the period examined for each country, due to lack of data availability in the Eurostat database. The year 2005 is base year for all data, except for the terms of trade of Spain, for which the base year is 2000.

Unit Roots

Time series could be *stationary* or *non-stationary*. The distinction is based in specific statistic features. When a series is stationary, its mean and variance remains constant over time and does not depend on time, and the covariance between two periods depends on the distance between these two periods and not on the time period itself. Thus, in this case, variables exhibit a tendency to reverse to their means; this implies that any external shocks will only cause temporary fluctuations around the mean. In contrary, variables whose means and variances change over time (they are time-dependent) are considered non-stationary or unit root variables. The non-stationarity of a series has an influence to its behaviour- a shock will have a persistent or infinite influence to the variable.

The estimation method of the standard regression model, Ordinary Least Squares (OLS), is based on the assumption that the means and the variances of the tested variables remain constant over time. Thus, the presence of a unit root implies that the assumptions of classical linear regressions are violated. In this case, a regression of one non-stationary variable on another could generate significant relationships among unrelated variables. Granger and Newbold first defined as '*spurious*' regression results with non-stationary variables. They note that *i) estimates of the regression coefficients are inefficient, ii) forecasts based on the regression equations are sub-optimal and iii) the usual significance tests of the coefficients are invalid*. (Granger & Newbold, 1974) Since the standard assumptions for the asymptotic analysis are not valid for non-stationary series, the t-ratios will not follow a t-distribution and hypothesis tests about the regression parameters will not be valid. Moreover, a high R^2 value is possible even if the variables under examination are totally unrelated.

Summing up, the existence of unit roots in macroeconomic time series generates important implications, thus the essential first step of time series analysis is to examine the possible existence of unit roots. The examination is made with the use of unit root tests.

Structural breaks

Spurious conclusions can also occur when the time series exhibits *structural breaks* and they are not taken into account at the unit root tests. Structural breaks occur in time series when some major changes in policies, or economic events take place and cause unexpected shifts either at the series *trend* (slope), or *level* (intercept), or both. Perron first showed in 1989 that traditional unit root tests lose power when an existing structural break is ignored, because they are biased towards a decreased ability to reject a false unit root null hypothesis. In other words there is an '*intricate interplay*' (Perron 1989) between structural changes and unit roots: traditional tests will estimate the existence of a unit root when the series is subject to structural changes but is otherwise (trend) stationary within time periods specified by the break dates. In order to avoid errors in econometric estimates and incorrect interpretations, structural breaks should not be ignored.

In our case of real effective exchange rates, industrial production, terms of trade and interest rates, there is a necessity to take into account the existence of structural breaks, because data expand in a period of time in which -in the context of the EMU- EU countries were bounded to implement policies that needed to satisfy the Maastricht convergence criteria, the participation to the ERM and the introduction of a new currency. These policies have probably caused structural breaks in series.

After Perron's study, several unit root tests in the presence of structural breaks were suggested. Lee and Strazicich (LS) presented a minimum Lagrange multiplier (LM) test where the break points are not known a priori but estimated endogenously from the data. For this purpose, an algorithm searching for breaks is applied, using dummy variables which capture the break points. The latters' selection criterion is the significance of these dummy variables, which is computed by the minimum t-statistic procedure, namely the break point (or points) is chosen where the test statistic for the unit root hypothesis from across all possible break dates is minimized.

This LM test exhibits certain advantages and remedies limitations of previous suggested tests. Taking the break dates as fixed or exogenous has been criticized; even if the date of the break is imposed on a major change, economic agents could react in another time period than the official date. Thus data-dependent estimates are considered to be more appropriate. Moreover, the test allows for breaks under both the null and the alternative hypothesis: rejection of the null hypothesis unambiguously implies trend stationarity. Thereby, it is not subject to '*spurious rejections*' (Lee & Strazicich 2003 p. 1082) in the presence of a unit root with breaks in contrary to other 'endogenous' break unit root tests which reject the unit root null hypothesis if a break under the unit root null exists, more often as the size (magnitude) of the break increases.

The two-break minimum LM unit root test of Lee and Strazicich (LS- two) can be described as follows: according to the LM (score) principle, a unit root test statistic can be obtained from the regression:

$$\Delta y_t = \delta' \Delta Z_t + \varphi \tilde{S}_{t-1} + \sum_{i=1}^{k} \theta_i \, \Delta \tilde{S}_{t-1} + \varepsilon_t \qquad (1)$$

where S t is a de-trended series such that $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \tilde{\delta}$, t = 2…..T ,$\tilde{\delta}$ is a vector of coefficients in the regression of Δy_t on ΔZ_t and $\psi_x = y_1 - Z_1\tilde{\delta}$, where Z_t is a vector of exogenous variables defined by the data generating process; y_1 and Z_1 are the first observations of y_t and Z_t, respectively, and Δ is the difference operator, ε_t is the error term and is assumed independent and i.i.d. $N(0, \sigma^2)$. ΔS_{t-i}, i = 1,….. k terms are included as necessary to correct for serial correlation.

Two structural breaks can be considered as follows: Model A allows for two shifts in level and is described by $Z_t = [1, t, D_{1t}, D_{2t}]$, where $D_{jt} = 1$ for $t \geq T_{Bj} + 1$, j = 1, 2, and 0 otherwise. T_{Bj} denotes the time period when a break occurs. Corresponding to the two-break equivalent of Perron's (1989) Model C, with two changes in level and trend, Z_t is described by

$$[1, t, D_{1t}, D_{2t}, DT^*_{1t}, DT^*_{2t}]',$$

where $D_{jt} = 1$ for $t \geq T_{Bj} + 1$, $j = 1, 2$, and zero otherwise, $DT^*_{jt} = t - T_{Bj}$ for $t \geq T_{Bj} + 1$, $j = 1, 2$, and zero otherwise, and T_{Bj} stands again for the time period of the breaks. The unit root null hypothesis is described in Eq. (1) by $\varphi = 0$. The test statistics are defined as follows:

$$\tilde{\rho} = T\,\tilde{\varphi}$$

$\tilde{\tau} =$ t-statistic for the null hypothesis $\varphi = 0$

To endogenously determine the location of two breaks ($\lambda_j = T_{Bj}/T$, $j = 1, 2$), the minimum LM unit root test searches the time point where:

$$LM_\tau = Inf_\lambda \tilde{\tau}(\lambda)$$

As mentioned earlier, the breakpoints are determined to be where the test statistic is minimized. Critical values that correspond to the location of the breaks are used since, for model C, they depend on the locaton of the breaks (λ_j). Critical values for Model A are independent from the break locations.

Empirical analysis

The stationarity of real effective exchange rates, industrial production, terms of trade and interest rates is investigated, in the context of LS unit root test in the presence of two structural breaks initially, and one if the previous analysis shows only one significant structural break. GAUSS (version 3.2.38) software was used. Maximum lag is set at 12, since the data are monthly.

Starting with the Real Effective Exchange Rate, the results of LS- two test appear in table . As shown from the LM statistics, series appear to be non-stationary in three levels of sigificance in case of France, Italy, Spain and the UK. For the REER of Germany, the unit root null is rejected at 10% level of significance. Thus, it could be argued that for all five countries, REER does not have the tendency to converge to an equilibrium value- represented by the mean- in the long run; its movements can not be treated only as transitory deviations from the equilibrium.

Table 2 also presents the structural break points and their t-statistics. During the time periods of investigation, the data of Spain and the United Kingdom appear to have two significant trend breaks, whereas the data of Germany two breaks, the first one in trend only and the second in level and trend. In France, there also two breaks in series, the first one in level and trend and the second in trend only. Finally, REER of Italy exhibits two breaks, the first one in level only (very large t-statistic) and the second one in level and trend jointly. Figure indicates the diagrams of REER for each country, in which the dates of each structural break are marked.

The REER of France exhibits the first structural break in November 1989, probably associating with the German unification, whereas the second in June 2005 might indicate the fact that costs in France increased more than prices during 2005. For the German REER, the first break point is located in April 1994, in a period of continuous post-unification loss of competitiveness. The second break is located in May 2000, a time period between the launch of the euro in financial markets and the inroduction of it in circulation. For Italy, the break points might be clearer to interpret: there is a significant break in December 1989, signifying the 'technical adjustment' to the nominal exchange rate of lira before entering the ERM narrow band of ± 2.25% in January 1990, switching from the wide ±6%. The second break in May 1995 probably reflects the currency crisis that period, caused by Italy’s high public debt and inflation. The EMS crisis and the multiple devaluations of Spanish peseta could be the reason for a structural break in Spain’s REER in March 1993. The second, in October 2003, might reflect an adjustment after the launch of the euro in circulation. Finally, for the UK, the aftermath of ERM crisis is probably the reason for the structural break in November 1993 and the launch of the euro in the financial markets in January 1999 for the break in July 1998.

Continuing with the examination of Terms of Trade for unit roots in the presence of structural breaks, we find the following results: Only the data for the UK appear to be non-stationary in all three levels of significance. The terms of trade of France and Italy are non-stationary in 1% and 5%, but stationary in 10%. The data of Germany and Spain are stationary in all three levels of significance. Two statistically significant structural breaks appear in data for all countries. Interest rates are non-stationary in all three levels of significance for Germany and the UK, whereas in France and Italy the non-stationarity unit root null is rejected in 10% level and in Spain in 5% level. Finally, industrial production appears to be stationary in all three levels of significance in France, Italy and Spain, whereas in Germany and the UK the unit root hypothesis is rejected in 5% level.

Table 2 : Two- break LM unit root test results

Country	Variables	Model	Est. k	Est. break points	Est. λ_1,λ_2	LM
FRANCE	REER	C	11	1989:11, 2004:03	(0.2,0.8)	-3.165
	TOT	C	12	1985:10, 1993:08	(0.2,0.4)	-5.538*
	IR	C	11	1988:07, 1997:01	(0.2,0.6)	-5.721*
	IP	C	12	1997:07, 2004:08	(0.6,0.8)	-7.183***
GERMANY	REER	C	12	1994:04, 2000:05	(0.4,0.6)	-5.388*
	TOT	C	9	1985:01, 1997:03	(0.2,0.6)	-6.096**
	IR	C	11	1989:12, 1998:04	(0.2,0.6)	-5.068
	IP	C	12	1991:10, 2006:11	(0.4,0.8)	-6.373**
ITALY	REER	C	11	1989:12, 1995:02	(0.2,0.4)	-4.226
	TOT	C	12	1986:03, 1999:10	(0.2,0.6)	-5.573*
	IR	C	8	1988:12, 1997:08	(0.2,0.6)	-5.507*
	IP	C	12	2002:07, 2005:08	(0.6,0.8)	-8.585***
SPAIN	REER	C	11	1993:03, 2003:10	(0.2,0.6)	-3.608
	TOT	C	12	1999:07, 2001:08	(0.4,0.6)	-6.771***
	IR	C	11	1995:03, 1997:03	(0.2,0.6)	-5.622**
	IP	C	12	1989:07, 2004:08	(0.4,0.8)	-6.723***
UNITED KINGDOM	REER	C	12	1993:11, 1998:07	(0.4,0.6)	-4.735
	TOT	C	12	1985:10, 2003:03	(0.2,0.8)	-4.952
	IR	C	11	1989:07, 1998:10^{n}	(0.2,0.6)	-5.159
	IP	C	12	2000:03, 2006:02	(0.6,0.8)	-5.813**

Est.k is the estimated number of lags in the test regression (1) to correct for serial correlation.n signifies that the relevant break is not significant at the 5% level of significance.***,**,*denotes rejection of the unit root hypothesis at the 1%, 5%, and 10% respectivelly.

Model A Critical values 1%	5%	10%	Critical values $\lambda=(\lambda_1, \lambda_2)$	Model C Critical values 1%	5%	10%
-4.54	-3.84	-3.50	λ=(0.2, 0.4)	-6.16	-5.59	-5.27
			λ=(0.2, 0.6)	-6.41	-5.74	-5.32
			λ=(0.2, 0.8)	-6.33	-5.71	-5.33
			λ=(0.4, 0.6)	-6.45	-5.67	-5.31
			λ=(0.4, 0.8)	-6.42	-5.65	-5.32
			λ=(0.6, 0.8)	-6.32	-5.73	-5.32

Table 3: One- break unit root results

Country	Variable	Model	Est.k	Est. break	Est. λ	LM
UK	IR	C	11	1998:01	0.5	-3.833

Model A Critical values 1%	5%	10%	Break point $\lambda=(\lambda_1)$	Model C Critical values 1%	5%	10%
-4.24	-3.57	-3.21	λ=0.1	-5.11	-4.50	-4.21
			λ=0.2	-5.07	-4.47	-4.20
			λ=0.3	-5.15	-4.45	-4.18
			λ=0.4	-5.05	-4.50	-4.18
			λ=0.5	-5.11	-4.51	-4.17

Investigating the linkage among the variables

Cointegration

Having tested the data for unit roots in the presence of structural breaks, we proceed to investigation of the linkage among the variables. As mentioned before, since the data in most cases are non-stationary, the traditional OLS regression method would provide spurious linkages among REER, TOT, IR and IP. Taking first differences in order to implement the OLS regression method instead of levels of the variables to get stationarity could solve the problem of non-stationarity if the differenced variables are stationary. However, if the variables are non-stationary but *cointegrated*, running a regression with first-differenced variables could lose the long-term information, since the regression with first differences models a short term linkage.

The concept of cointegration was introduced in 1987 by Engle and Granger (Granger and Engle ,1987, p.253). As they note: *“The components* *of the vector x_t are said to be co-integrated of order d, b, denoted x_t ~ CI(d, b), if (i) all components of x_t are I(d)*[3]*; (ii) there exists a vector α (≠ 0) so that $z_t=\alpha' x_t$-I(d -b), b>0. The vector α is called the co-integrating vector".*

Campbell & Perron (1991, p.164) gave a broader definition in 1991: "*A (n × 1) vector of variables y_t is said to be cointegrated if at least one nonzero n-element vector β_i exists such that $\beta' y_t$ is trend stationary. β_i is called a cointegrating vector. If r such linearly independent vectors β_i (i = 1, . . . , r) exist, we say that y_t is cointegrated with cointegrating rank r. We then define the (n × r) matrix of cointegrating vectors β = (β_1, . . . , β_r). The r elements of the vector $\beta' y_t$ are trend-stationary, and β is called the cointegrating matrix.*

In other words, a specific linear combination of two or more non-stationary variables may be stationary and link them with a long-term cointegration relationship. Namely, even though singularly non-stationary, the variables maintain a stationaty relation in the long period. Although the variables may drift away from equilibrium in the short run, eventually equilibrium will be restored.

The Johansen procedure

According to the *Johansen procedure*, estimations of the cointegration vectors are based on the maximum likehood estimation method through a Gaussian *Vector Autoregression* (VAR) model. This procedure permits more than one cointegration relations; it investigates the maximum number of cointegration vectors, thus it also specifies the cointegration *rank*. Apart from estimations of

[3] a series is said to be integrated of order d or I(d), if it requires to be differentiated d times to yield a stationary series.

all the cointegrating vectors, it provides test statistics for the number of cointegrating vectors which have an exact limiting distribution, the latter being a function of only one parameter.

A VAR model is a system of equations in which all variables are endogenous. Each equation expresses each variable as a function of its own lags and the lags of the rest of the variables. Mathematically expressed:

$$Var(\rho) : y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \ldots\ldots + A_\rho y_{t-\rho} + Bx_t + \varepsilon_t \qquad (2)$$

where : y_t (mx1) is the vector of variables investigated, c (mx1) is the vector of intercepts, A_i (mxm) is the coefficients matrices, ρ is the number of lags and ε_t is the error vector which $\varepsilon_t \sim iid\ N(0,\sigma^2)$. By reparametrizing equation (2): $\Delta y_t = c + \Pi y_{t-1} + \Pi_1 \Delta y_{t-1} + \ldots\ldots + \Pi_\rho \Delta y_{t-\rho} + \Delta x_t + \varepsilon_t$, where Δ is the differencing operator such that $\Delta y_t = y_t - y_{t-1}$ and $\Pi = -I + A_1 + \ldots\ldots + A_i$ i= 1, 2, ….., ρ. The rank of matrix Π defines the number of cointegration relations.

The maximum number of cointegrating vectors can not be more than the number of variables used in the model minus one, namely: $r(\Pi) = r < m$ (m: number of variables in the model).

If rank (Π) = m, the variables are stationary and the model is VAR in levels.

If rank (Π)=0, the variables are not cointegrated (a long-term relation among the variables does not exist) and the model could be formed as VAR in first differences.

If 0 < rank (Π) = r < n, all variables are cointegrated, Π can be expressed as $\Pi = \alpha\beta'$, where β (mxr) is the *cointegration matrix* and α (mxr) is the *loading or adjustment matrix*. The r linear independent columns of β are the cointegrating vectors; each vector reflects a long-term relation among the variables that constitute vector y_t.

The rank (r) is found either by using maximum eigenvalue or trace tests, with the use of the likelihood ratio with m-r restrictions:

$$LR \sim \chi^2 \text{ (m-r)}$$

Vector error correction model

If variables are detected to be cointegrated, an estimation of a *vector correction model* (VECM) can be made. As mentioned before, cointegration denotes a *long-term* inter-relation among the variables. However, in the short run, these variables could diverge from equilibrium. This deviation from long-run equilibrium can be corrected through adjustments. The elements of vector α (adjustment matrix) determine the speed of adjustment to the long time equilibrium. Thus, a VECM reflects the short term adjustment dynamics among the variables to their long term cointegration relationships, through restrictions imposed to a VAR model. The basic structure of an ECM is

$$\Delta y_t = c + \beta \Delta y_{t-1} - \alpha \varepsilon_{t-1} + u_t ,$$

where ε is the error correction component of the model.

Structural breaks

The basic version of Johansen procedure assumes that any linear time trend has a constant slope- no structural breaks are taken into account. However, as in the case of unit root testing, structural changes could create distortions if they are omited during the investigation for the existence of any cointegration relations. In a later version of Johansen procedure, Johansen Mosconi and Nielsen (2000) consider the effects of known level and trend structural breaks by using dummies into cointegration procedure.

The cointegration tests (in JmulTi) are based on the following general model:

$$y_t = D_t + x_t$$

where y_t is a m-dimensional vector of endogenous variables, D_t is a deterministic term, e.g., $D_t = \mu_0 + \mu_1 t$ may be a linear trend term, and x_t is a VAR(p) process with vector error correction model (VECM) representation

$$\Delta x_t = \Pi x_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + u_t$$

where u_t is a vector white noise process with $u_t \sim (0,\Sigma_u)$. The rank of Π is the cointegrating rank of x_t and hence of y_t. Therefore, the cointegration tests check hypotheses:

$H_0(r_0) : rk(\Pi) = r_0$

$H_1(r0) : rk(\Pi) > r_0, r_0 = 0, . . . ,m - 1$

In case of constant and linear trend, the deterministic term has the form $D_t = \mu_0 + \mu_1 t$ (+seasonal dummies) and the data generating process of the y_t can be written as:

$$\Delta y_t = c + \Pi^* \begin{bmatrix} y_{t-1} \\ t-1 \end{bmatrix} + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + u_t$$

where $\Pi^* = \alpha[\beta' : \eta]$ is a (m ×(m +1)) matrix of rank r_0 with $\eta = -\beta\mu_1$ and the seasonals are neglected. The general setup of a VECM is of the form:

$$\Gamma_0 \Delta y_t = \alpha[\beta' : \eta'] + \begin{bmatrix} y_{t-1} \\ D_{t-1}^{co} \end{bmatrix} + \Gamma_1 \Delta y_{t-1} + \cdots \dots \dots . + \Gamma_p \Delta y_{t-p} + B_0 x_t + \cdots \dots . + C D_t + u_t$$

where $y_t = (y_{1t}, . . . , y_{Mt})'$ is a vector of m endogenous variables, $x_t = (x_{1t}, . . . , x_{Kt})'$ is a vector of k exogenous variables, D_t^{co} contains all deterministic terms included in the cointegration relations and D_t contains all remaining deterministic variables. A single deterministic term cannot appear in both D_t and D_t^{co} so that the two vectors have to contain mutually exclusive terms. For instance, in case of trend and constant structural breaks in series, the term D_t^{co} might include all trend break dummies, whereas D_t the constant break dummies. Vector x of exogenous variables contains in this case the constant break dummies first differences. The residual vector u_t is assumed to be a m-dimensional zero mean white noise process with positive definite covariance matrix $E(u_t u'_t) = \Sigma_u$.

Empirical results

Following the presentation of the theoretical model of cointegration, we proceed to the estimation of multivariate VARs, including all variables, namely real exchange rate, terms of trade, interest rates and industrial production, in order to examine possible economic influences on each other, in other terms, causality among them. To construct our VAR model we assume the 4x1 vector y_t = [REER, TOT, IP, IR], thus the model has the following form:

$$y_t = c + A_1 y_{t-1} + A_2\, y_{t-2} + \ldots + A_\rho y_{t-\rho} + u_t,$$

where A (4x4) the coefficients matrix, ρ the number of lags. The appropriate lag length is determined by allowing a different lag length for each equation at each time and choosing the model with the lowest Akaike Info Criterion (AIC). [AIC (n) = log $\tilde{\sigma}^2_u$ (n) + (2/T) n] where σ^2_u (n) is estimated by $\hat{}u\hat{}u/T$, n is the number of lagged differences included. J-Multi software is used for the computations. The two structural break points used, are the ones computed previously for the REER data.

Table 4 shows the cointegration results. As the results indicate, there is one cointegrating vector – a long-run relationship among the variables for each country. Thus, an estimation of the corresponding VECMs can be made. The computations were again made with J-multi software taking into account the cointagration rank previously specified. Table 5 presents the estimated coefficients of the reduced form equations, normalised on the real exchange, along with the p-values (in parentheses) of the likelihood ratio test statistics for the long-time exclusion tests, in order to investigate whether any of the variables under investigation, namely TOT, IR and IP can be excluded

Table 4 : Johansen- Mosconi- Nielsen cointegration tests with two structural breaks

Countries	**Rank (r_0)**	**LR (r0)**	**p-values**	**Est. lag**
France	0	115.03***	0.003	14
	1	64.68	0.148	
	2	36.64	0.268	
	3	12.56	0.572	
Germany	0	75.80***	0.002	3
	1	38.88	0.119	
	2	17.65	0.375	
	3	6.89	0.365	
Italy	0	115.39***	0.003	6
	1	54.86	0.455	
	2	32.09	0.471	
	3	13.22	0.505	
Spain	0	113.75***	0.005	12
	1	67.56*	0.097	
	2	30.79	0.569	
	3	10.03	0.791	
United Kingdom	0	110.91***	0.011	14
	1	66.42	0.137	
	2	28.42	0.731	
	3	12.70	0.615	

Est. k denotes the estimated lag length in the VECM.
***, **, * denote rejection of the null hypothesis at the 0.01, 0.05 and 0.10 level of significance respectively

from any cointegrating equation. The two implied structural breaks can be excluded from the cointegration equation of France and Germany, whereas for Italy, Spain and the UK, only the first break appears to be statistically significant, thus affecting the REER in the long run.

Table 5 : Estimated coefficients of the cointegrating vectors

coefficients	FRANCE	GERMANY	ITALY	SPAIN	UK
β **(TOT)**	1.179** (0.000)	0.886** (0.000)	8.265** (0.000)	1.449** (0.000)	-3.59** (0.000)
β **(IR)**	9.57** (0.000)	2.681** (0.010)	20.533** (0.000)	6.308** (0.000)	11.024** (0.010)
β **(IP)**	-1.656** (0.000)	-0.975** (0.000)	8.202** (0.000)	1.005** (0.000)	3.081** (0.000)
SB1	-0.118 (0.777)	-0.072 (0.354)	-3.169** (0.000)	0.49** (0.000)	-0.308** (0.034)
SB2	-0.009 (0.853)	0.027 (0.580)	-0.590 (0.217)	0.028 (0.470)	-0.121 (0.452)
trend	0.432** (0.00)	0.169** (0.000)	1.258** (0.000)	0.263** (0.000)	0.380** (0.000)

The above cointegrating vectors are presented having the explanatory variables on the right-hand side. β's are the parameters of the cointegrating vectors normalised on the real effective exchange rate. SB1 and SB2 are the first and the second structural break respectively. Numbers in parentheses are the p-values.
** denotes rejection of the null hypothesis at the 0.05 level of significance.

Weak exogeneity tests are also performed; thus a variable could be considered as weakly exogenous to the long-run parameters or not according to the results. The results are presented on table 6 and are based on the estimated VECM. Results indicate that in case of France terms of trade and industrial production are found to be weekly exogenous to the real exchange rate, which implies that these two variables drive the REER to its equilibrium. In contrary, for Germany, Italy and the UK the REER itself, as well as the interest rate appear to be the driving forces for the REER. In case of Spain, none of the variables appear to be weakly exogenous.

Table 6: Adjustment coefficients and weak exogeneity tests.

	FRANCE	GERMANY	ITALY	SPAIN	UK
α_{REER}	-0.047** (-4.870)	-0.014 (-1.413)	-0.002 (-1.159)	-0.051** (-5.190)	0.005 (0.571)
α_{TOT}	0.013 (0.765)	0.011* (1.710)	0.006** (2.454)	0.078** (2.396)	-0.015** (-3.147)
α_{IR}	0.006** 2.168	0.001 (0.372)	0.000 (-0.016)	0.013** (3.193)	-0.002 (-1.337)
α_{IP}	-0.004 (-0.126)	-0.320** (-5.326)	0.141** (6.238)	0.090** (2.240)	0.063** (4.613)

α s are the adjustment coefficients. Numbers in parentheses are the t statistics for H_0: $\alpha_i = 0$.** ,* denote rejection of the null hypothesis at the 0.05 and 0.10 level of significance respectivelly

Estimated cointegration equations

Based on these results the long-run relationship among the four variables can be determined for each country.

Starting with France, the cointegration equation based on Table 5 is:[4]

$REER_{FR}$ = 1.179 TOT + 9.57IR - 1.656IP + 0.432 trend

The TOT and IR coefficients are positive, implying that an improvement in TOT and an increase in the interest rate raise REER. The sign of the TOT coefficient is in line with the majority of empirical results in the relevant

[4] The two structural breaks are not reported in the equation because they were found to be statistically insignificant.

literature. The coefficient of the interest rate is also in line with economic theory, implying that an increase in the IR increases, in turn, the REER. The IP coefficient is negative; this reflects high levels of productivity in France, which is considered to be among the most productive countries in the world (oecd). Thus, as analysed in the previous section, an increase in IP causes an opposite change in REER, in line with economic theory.

Based on Table 5 the equilibrium REER for Germany is: [5]

$$REER_{GE} = 0.886TOT + 2.681IR - 0.975IP + 0.169trend$$

TOT and IR coefficients are positive, implying that an improvement in TOT and an increase in the interest rate raise REER. IP coefficient is negative, which implies that a rise in industrial production causes a decrease in the REER. In this case, the coefficient sign can be explained as follows. Traditionally, wage increases in Germany were in line with hourly productivity. However, collective bargaining in 1996 (and earlier) put pressure in workers' unions for restrictions to the growth of nominal and real wages (in order to fight unemployment or in order to regain competitiveness after the reunification). On the other hand, Germany exhibited gains in productivity, which were not fully passed on nominal compensations, namely German workers produced more than they costed. The EMU's inflation target of 2% allowed an analogous annual nominal wage growth, however Germany exhibited nominal wage increases below this target. This has been characterised as '*wage dumping policy*' (Flassbeck and Spiecker, 2011, p.182, footnote). As a result, industrial production increases, but

[5] The two structural breaks are not reported in the equation because they were found to be statistically insignificant.

simultaneously unit labor cost falls, which signifies a negative relation between IP and REER.

According to the results, cointegration equation for Italy's REER is:[6]

$$REER_{IT} = 8.265TOT + 20.533IR + 8.202IP - 3.169SB1 + 1.258trend$$

As in the previous cases, the coefficients of TOT and IR are positive. In contrary, IP coefficient appears to be in this case positive. As stressed in the previous section this could not be due to the Balassa- Samuelson effect. According to the European Commission (Economic and Financial Affairs Directorate, 2010, p.87), *stagnation in productivity in both tradable and non-tradable sectors growth in Italy since the end of the 1990s is considered to be the key factor behind the rise in the REER based on unit labour costs*. Low productivity growth was especially evident in manufacturing.

For Spain the long-run relatioship is[7]:

$$REER_{SP} = 1.449TOT + 6.308IR + 1.005IP + 0.49SB1 + 0.263trend$$

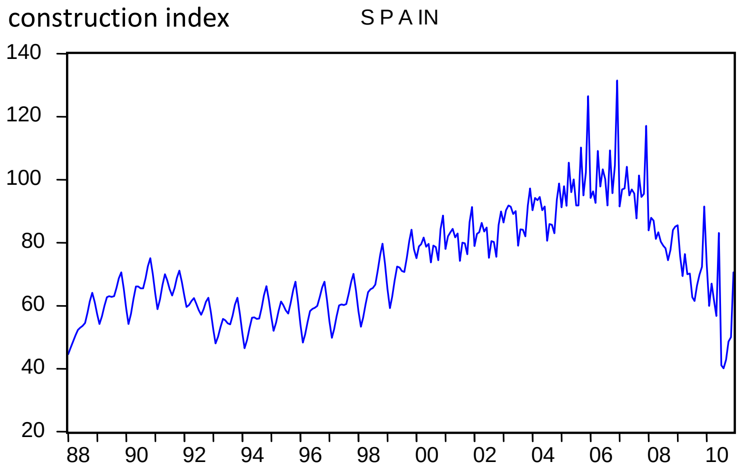
For Spain, productivity growth has been slow during the last decade with high allocation of investment to low productivity sectors. From close to zero in 1999-2000, productivity growth (in terms of output per hour worked) remained almost flat at less than 1% between 2002 and 2006. According to the Quarterly Report on the Euro area (2009, p.34), *although housing investment*

[6] The second structural break is not reported in the equation, because it is found to be statistically insignifficant. SB1 denotes the second structural break, which is located in February 1995.

[7] The second structural break is not reported in the equation, since it is not statistically significant. SB2 is for the second break located in October 2003

helps to raise the capital stock, it is unlikelly to have positive spill-over effects on total factor productivity and its contribution to the economy's long-term production potential is therefore limited. A large shift in labor resources to a low productivity sector such as construction weighs negatively on overall productivity performance. In addition, Spain's growth of GDP has been coming along with rapid population growth. Figure 2 shows a continuous increase in construction index of Spain during the period under investigation until 2007, when the housing 'bubble' exploded. Thus, as developed in the previous section, a rise in IP, causes a rise in REER, since it does not signify rising productivity.

Figure 2 : Construction index of Spain



2005=100, source of data: oecd

For UK, the cointegration equation is:

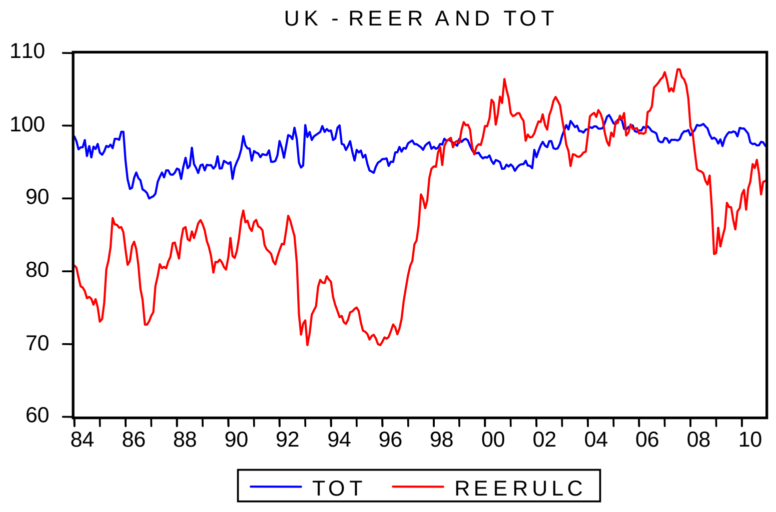
$$REER_{UK} = -3.59TOT + 11.024IR + 3.081IP - 0.308SB_1 + 0.38trend$$ [8]

In contrary to the previous cases, TOT influence REER negativelly. Indeed, Figure 3 shows that TOT and REER are far from moving together. The UK's

[8] The second structural break is not reported in the equation, because it is found to be statistically insignificant. The first is located in July 1998.

terms of trade have generally improved over the last 20 years, indicating that exports prices have been rising relative to import prices. More specifically, according to Dury et al. (2003, p.164), the relative price of exports to imports rose over the period 1995 Q3 to 2003 Q1. Export prices of services rose while import prices stayed broadly unchanged. In the goods sector, both export and import prices fell, though import prices fell by more than export prices (20% compared with 10%), resulting in a rise in the relative price of exports to imports of goods. The nominal depreciation of the British Pound in 2007 did not alter this pattern. UK traditionally has a great share of services exports in which is considered to have a comparative advantage (Duri et al., 2003, p.168). Great Britain has experienced a rise of its financial services industry (Jones, 2009, p.100). Trade has tended to have less impact on the export price of (UK) invisibles, compared to its effect on the price of its visible imports. The rise in the terms of trade has been more marked for services than for goods.

Figure 3 : REER and TOT development in UK



source of data: ifs

In addition, since UK and exports and imports (large share of services exports and goods imports) are not very close substitutes, Duri et al.(2003, p.171) argue that *a larger productivity improvement would have been needed to bring about the improvement in the terms of trade, and that in turn would mean that the increase in foreign incomes could bid up the price of non-traded goods abroad, by enough to mean that the overall real exchange rate for the United Kingdom falls.*

Interest rate has a positive coefficient as expected, whereas IP has also a positive coefficient which implies that a change in IP causes a change in REER to the same direction. This perhaps could be explained by the shrinking British manufacturing sector combined with changes in the nominal exchange rate (nominal devaluation of the British Pound).

CONCLUSIONS

This paper provides an empirical analysis of the real exchange rate in five major EU countries, namely France, Germany, Italy, Spain and the United Kingdom. The analysis of the real exchange rate is based on an empirical model in which, in the long run, the real exchange rate is specified as a function of the terms of trade, interest rate and industrial production. Because of the size of the sample, the existence of structural breaks in the data was investigated and was taken into account to the cointegration procedure.

As the results indicate, there is a long-run relationship among each country's REER and the aforementioned variables. Terms of trade and are positively linked to the real effective exchange rate in four out of five selected countries, the magnitude of this impact, however, differs in each case. There are large coefficients in case of Italy and the UK with the latter having a negative linkage between TOT and REER. Interest rate is positively linked to REER in all five countries and its coefficients reflect that it has a large impact in the REER. Industrial production’s coefficients reflect *structural differences* among countries, mainly divergence in productivity levels, which is considered to be a major factor of divergence in competitiveness. These structural differences are quite difficult to be managed, especially in a common currency area.

Further study

A further empirical study concerning diverging competitiveness among the selected EU countries could include an investigation for evidence of a cointegration relationship among the REER of Germany and the rest EU countries.

Furthermore, a study of the role of the common currency in competitiveness could take place by dividing the time period in two sections, before and after the euro, and proceed seperately.

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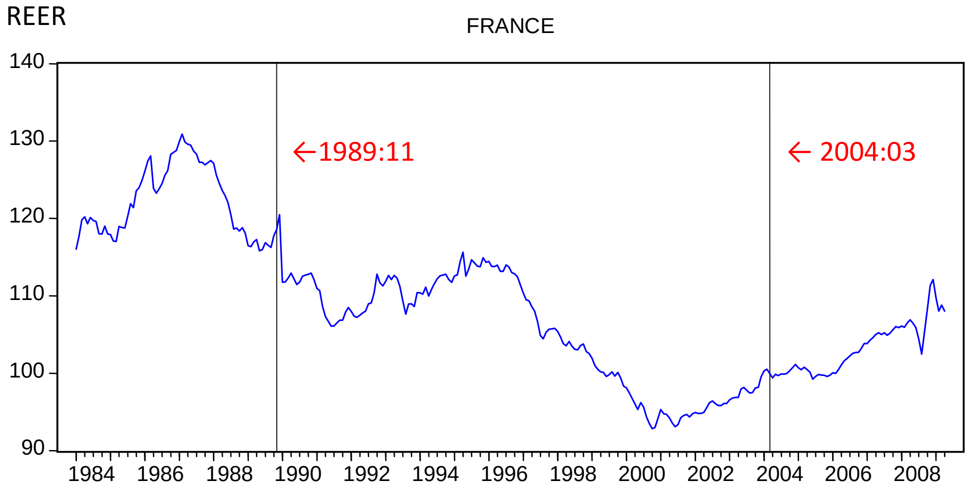
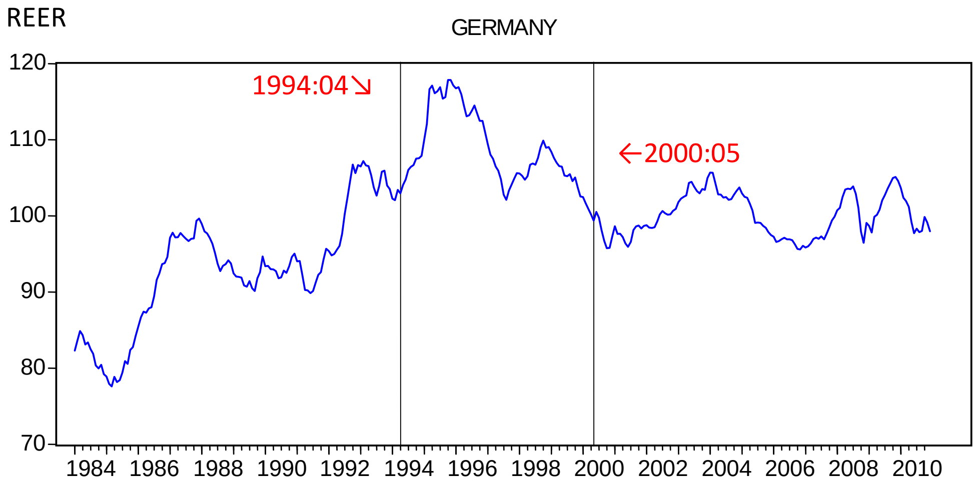
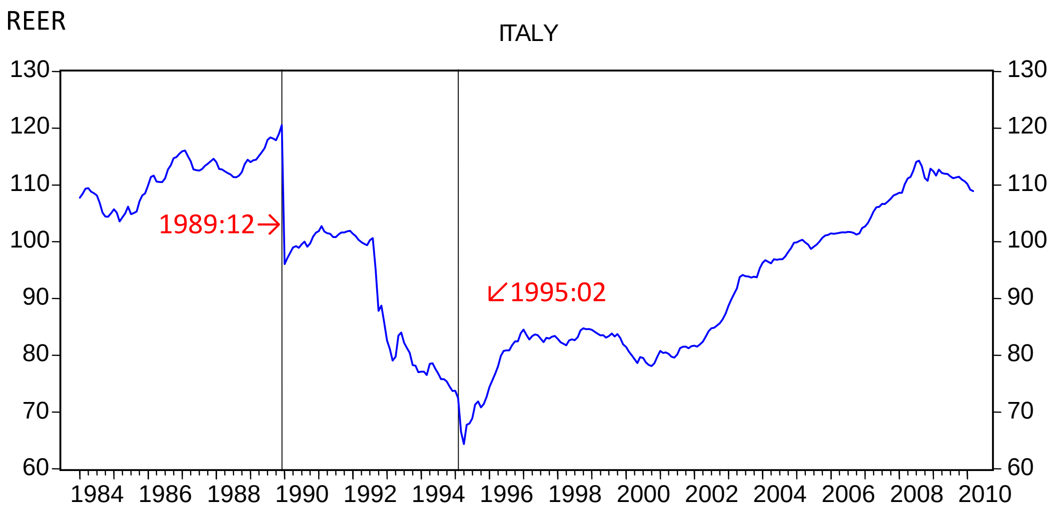
APPENDIX

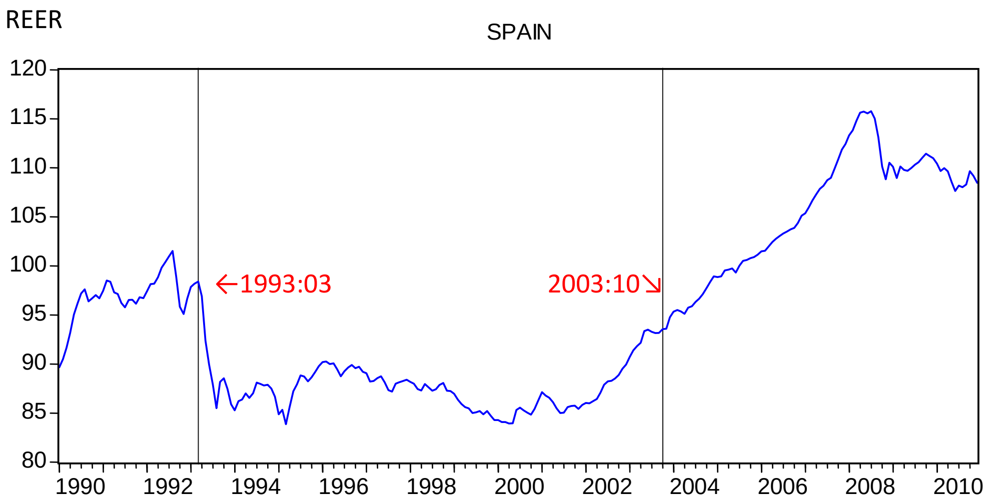
* According to the IFS, the aggregate index is calculated using a weighted geometric mean of country indices. The individual country production series are weighted by the 2005 value added in industry, as derived from individual countries' national accounts and expressed in U.S. dollars. Different weighting bases—1963, 1970, 1975, 1980, 1984–86, 1990, 1995, 2000, and 2005—have been used, and the index series are chain-linked by the technique of ratio splicing at the overlap years and are shifted to the reference base 2005=100. The weights used in the calculation are identical in concept for all countries and cover, where possible, mining, quarrying, manufacturing, and electricity, gas, and water. Although industrial production data for some countries are not available for more recent periods, the aggregate index will be calculated for any period for which data for more than 60 percent of the area index aggregate have been reported.

Figure 4: Structural breaks on REER of each country


REER
FRANCE
140
130
120
110
100
90
←1989:11
← 2004:03
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008


REER
GERMANY
120
110
100
90
80
70
1994:04↘
←2000:05
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010


REER
ITALY
130
120
110
100
90
80
70
60
1989:12→
↙1995:02
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010



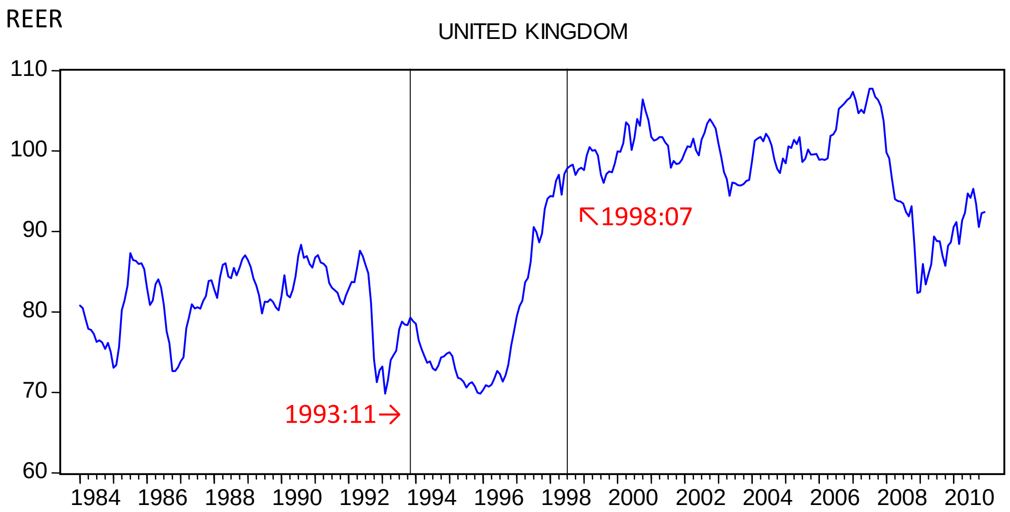
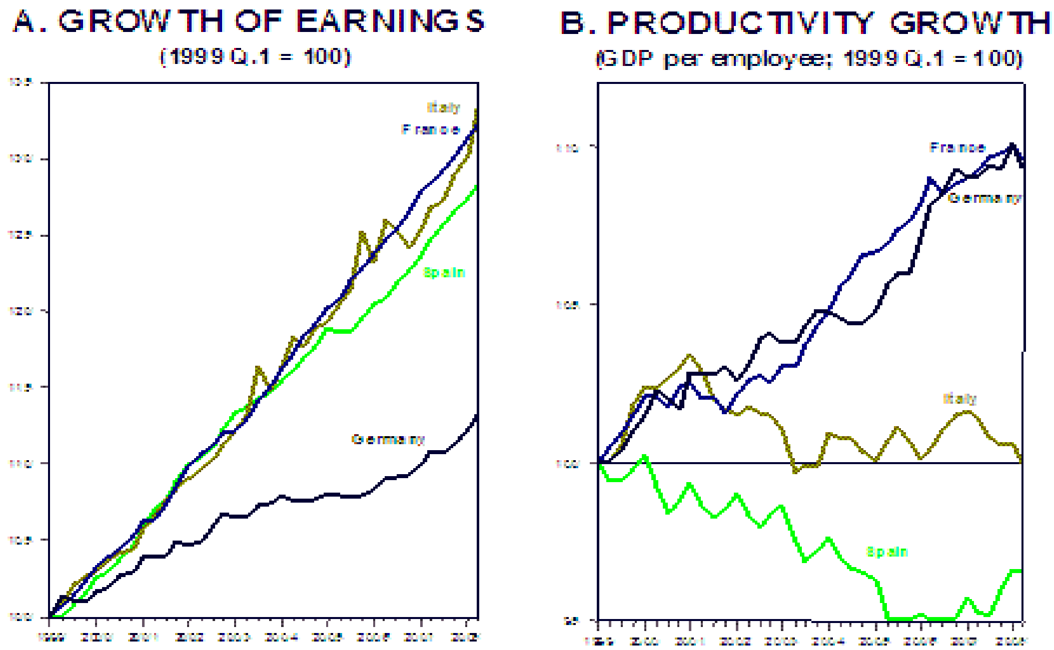


Figure 5 : Wage and productivity growth



Source: Oxford Economics Data Bank