http://dx.doi.org/10.14195/2183-203X_42_1

Optimum Currency Areas, Real and Nominal Convergence in the European Union

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abstract

It is well known and widely accepted by economists that the characteristics of the countries of the European Monetary Union (EMU) created in 1999 did not match the requirements of an Optimum Currency Area (OCA). The only criteria for membership of the EMU were nominal. A strict level of convergence in inflation and interest rates was imposed. In addition to the nominal convergence, a process of convergence of nominal and real incomes in the new monetary area was expected to be generated with the monetary integration. After summarizing the criteria for a successful currency area in the context of the OCA theory, we study the real and nominal convergence process for an older group of countries (11) to establish whether or not these countries satisfy the conditions of an OCA. We apply ADF tests, together with the Schmidt-Phillips tests, and we estimate the fractional differential process to overcome the disadvantages of the traditional tests, to test for nominal and real convergence. We conclude that a process of real divergence and nominal convergence does exist, and suggest this is a source of genuine imbalance in the European integration process that can destroy the harmonious development of the European Monetary Union.

JEL Classification: C01, E24, F31, J31.

Keywords: Monetary integration, Optimum Currency Areas, real and nominal convergence, unit roots and fractional differentiation.

1. Introduction

In 1961, Robert Mundell published his famous paper entitled "A Theory of Optimum Currency Areas", in which he presented the idea of an optimal monetary area.

Nearly four decades later, in 1999, the European Union (EU) created its monetary area with a common currency: the Euro. Initially, the European single currency was used purely as bank money, but in 2002, the Euro was introduced as coins and banknotes and since then it has been used as a means of payment in the EU.

For centuries before, the situation in Europe, and indeed worldwide, was that each country had its own currency (Baldwin and Wyplosz, 2009), and that in extreme circumstances, some cities in certain regions differentiated their currencies. National symbols were displayed on coins and banknotes and in earlier times feudal lords had their faces stamped on gold and silver coins.

Apart from indicating national and regional boundaries, a currency is also useful because it enables and stimulates real, commercial and financial activity reducing transaction costs. The more people accept a currency, the more useful it is as a currency. In that sense, a continent of many countries and states, as for example, Europe, can be expected to benefit from having the same currency (Rose, 2004; Frankel and Rose, 2002; Baldwin and Wyplosz, 2009; Eicher and Henn, 2009) acceptable anywhere in the region, and which allows for global trade without incurring costly transactions.

This is one of the main reasons underpinning the Optimum Currency Area (OCA) theory, and it is this that we discuss in this paper. We analyze whether the European Union (Eurozone) is indeed an Optimum Currency Area, investigating the existence of real and nominal convergence in a geographical zone in which a restricted group of countries could share the same currency since 1 January, 1999.

In fact, since the beginning of the Euro, there have been many discussions on the issue of whether the Eurozone could actually be classified as an OCA, and of the wiseness of the decision to adopt one common currency. More recently, in the current financial crisis, the skepticism concerning this decision has intensified (Furrutter, 2012), and it is appropriate to re-appraise the EU-OCA discussion to examine the rationale for the creation of a common currency area and its criteria for membership.

Our contribution to the debate focuses on the study of the depth of European integration under the two perspectives of real and nominal convergence. For this purpose, we explore the processes of real convergence and nominal convergence based on spectral analysis, Hurts indicator, Augmented Dickey-Fuller (ADF) and Schmidt-Phillips unit root tests, and fractionally-integrated processes.

The paper is structured in five sections. In section 2 we summarize Robert Mundell's theory concerning OCAs by briefly reviewing the well-known economic and political criteria for a successful currency area. In section 3, from Mundell's OCA-theory we address the question of whether the European Union (Eurozone) really is an OCA. In section 4, we answer this question by assessing the integration process of the older EU 12 (-1) member countries. Finally, in section 5, we present some concluding remarks based on empirical evidence.

2. Optimum Currency Area Theory

The notion of an Optimum Currency Area was pioneered by the economist Robert Mundell (Mundell, 1961). However, whilst credit often goes to this author as the architect of the idea, some scholars (e.g., Scitovsky, 1984) point to earlier studies on the same subject, namely Abba Lerner (Lerner, 1944, 1947).

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An Optimum Currency Area (OCA) is a geographical region which, if sharing a single currency, would be able to maximize economic efficiency in that area. The theory attached to the OCA describes the optimal characteristics for the merger of currencies or the creation of a new currency. In that sense, the theory is a systematic way to decide whether or not a group of countries would benefit from abandoning their national currencies and adopting a single currency. A single currency is associated with monetary union, which itself is one of the final stages of economic integration. For this reason, this theory is often mentioned when discussing the European integration process, and the creation of the Eurozone.

The basic question which OCA theory attempts to answer is *what conditions must be fulfilled for two or more countries to use the same currency instead of separate ones?* At the same time, it is also pertinent to ask in the case of the Eurozone, *is it advantageous for the current 18 member countries to use the Euro as their common currency rather than having their own currencies?*

To answer these questions, the theory of the OCA develops a set of economic and political criteria which recognize that the real economic cost of eliminating the exchange rate instrument and accepting a single currency arises in the presence of asymmetric shocks which do not affect all monetary union member countries in the same way.

The main tenets of OCA theory are that for a currency area to operate properly, member countries must demonstrate similar economic and political conditions and have sufficiently flexible labor, capital, and product markets to allow adjustments in the face of asymmetric shocks.

There are four classic, and often-cited economic criteria for a successful currency area: i) labor mobility across the region; ii) openness with capital mobility and price and wage flexibility across the region; iii) production diversification; and iv) similar business cycles for participant countries. In addition, three political criteria can be identified: v) fiscal transfer mechanism to redistribute income to areas/sectors which have been adversely affected by labor mobility and openness; vi) similar (homogeneous) preferences/ideologies; and vii) solidarity ('commonality of destiny')[1].

The first criterion was suggested by Robert Mundell in 1961 when he developed the concept of an OCA (Mundell, 1961). His main underlying belief was that the costs involved in sharing a common currency would be eliminated if the factors of production, labor and capital, were fully mobile across borders. As it is usually supposed that capital is perfectly mobile, the real barriers then come from the absence of labor mobility.

This criterion implies that countries with good opportunities should attract labor from those with few employment opportunities. In other words, if there is unemployment in one country, people must move to another country. According to the Mundell criterion in an OCA people can move easily. Such ease of movement requires not only the absence of visas, and the presence of workers' rights, but also the removal of any cultural and institutional barriers to free movement, such as different languages and different pension schemes throughout the region. Thus, the labor mobility criterion advocates that if member countries in a currency area are hit by asymmetric shocks, they should have a high degree of labor mobility so as not to create gross disparities between the member countries.

The basic idea behind the second criterion, openness with capital mobility and price and wage flexibility across the region, was formulated by Ronald McKinnon according to whom, countries which are very open to trade, and trade intensely with each other, form an optimum currency area (McKinnon, 1963). So, if trade is flowing freely, the market forces of demand and supply automatically distribute money and goods to where they are necessary. Consequently, their prices will be

1 The labor mobility criterion is related to the way of minimizing the costs of an asymmetric shock within a currency area. The other three economic criteria focus on a different problem. They aim to identify which regions are unlikely to be hit by external shocks infrequent or moderate enough to be of limited concern. The last three criteria deal with more political issues. They ask whether different countries are likely to help each other when faced with asymmetric shocks. In the explanation of the OCA criteria we follow very closely the presentation by Frankel and Rose (1998), and Baldwin and Wyplosz (2009).

the same at home and abroad. Changing the exchange rate will thus not affect the relative prices of such domestic and foreign goods. In other words, exchange rate changes leave the country's competitiveness unchanged. The more open the region, the more important is this observation.

However in practice this does not work perfectly as there is no true wage flexibility. For example, in the case of the Eurozone, member countries trade significantly with each other. Intra-European trade is greater than international trade. As suggested by the most recent empirical analysis of the Euro effect, the use of the European single currency has increased trade by 5-15% in the Eurozone when compared to the trade between non-Euro countries (Micco, Stein and Ordonez, 2003; Rose, 2004; Baldwin, 2006; Berger and Nitsch, 2008; Bergin and Ching-Yi, 2012).

According to the third criterion, initially identified by Peter Kenen, countries whose production and exports are widely diversified and of similar structure can be an OCA (Kenen, 1969). Therefore, a country that has a wide range of products will have a slower decrease in its production if external demand falls. On the contrary, a country with a low degree of diversification would then need to use its monetary policy to reduce shocks, whereas a highly diversified economy may find it valuable to form a currency union. In that case, good-specific shocks are likely to be of little aggregate consequence and to affect all member countries in a similar way, thus lessening the need for any exchange rate adjustment (Baldwin and Wyplosz, 2009).

Under these circumstances, member countries in a currency area should be well diversified and produce similar goods. In this way, there will be fewer macroeconomic shocks and they will be more symmetric. Countries that are well diversified will not often face changes in demand for their exports products, and that product diversification decreases the likelihood of asymmetric shocks.

The next relevant criterion of an OCA also implies that member countries of the currency area should not be subject to asymmetric shocks. Participant countries must have similar business cycles, which means that they should experience economic ups and downs at the same time, so that counter-cyclical measures adopted by the area's Central Bank will have positive effects on all countries (Long and Plosses, 1983; Artis and Zhang, 1995; Caporale, Pittis and Prodromidis, 1999). In fact, when one country experiences a boom or recession, other countries in the currency union are likely to follow. This allows the area's Central Bank to stimulate economic growth in downturns and to restrain inflation in booms. So, this criterion requires that member countries of the currency area should not be significantly different in terms of economic development and growth.

The fifth criterion, that of political order, states that for a currency area to operate optimally, there should be a risk-sharing system in the context of a harmonized fiscal policy, such as an automatic fiscal transfer mechanism to redistribute income to regions which have been harmfully affected by labor mobility and openness (Sala-i-Martin and Sachs, 1992; Baldwin and Wyplosz, 2009; Crespo-Cuaresma et al., 2011). Usually, this instrument takes the form of taxation redistribution to less developed countries. Thus, if a country in the area suffers an asymmetric shock, a central fiscal authority would transfer tax revenue collected from the countries that are not adversely affected to that one, or those, which are negatively affected. Put differently, crisis areas pay less tax and receive more welfare benefits. Hence, this criterion implies that countries that do agree to compensate each other for adverse shocks, form an OCA.

However, this fiscal transfer mechanism, although theoretically accepted, is politically difficult to implement as the wealthy countries rarely give up their revenue easily[2]. In fact, such transfers are often implicit, operating in most of the cases in the currency area like a common insurance against asymmetric shocks.

2 The Eurozone is, however, a good example where this mechanism seems to have worked well. In fact, theoretically, this region has a no-bailout clause in the context of the Stability and Growth Pact, meaning that fiscal transfers within national borders are not allowed. Nevertheless, during the recent government debt crisis the no-bailout clause was *de facto* abandoned. For more details see, for example, Breuss (2011), Buti (2011), and Bordo (2011).

But political conditions also matter even for symmetric shocks, as is embodied in the sixth criterion of homogeneous preferences where the currency area member countries must reach a consensus on the way to deal with shocks (van Marrewijk, Ottens and Schuller, 2006). In other words, this criterion requires that all countries agree on how to deal with every possible shock.

In practice there rarely exists one single way to combat negative shocks as the objectives to be achieved may change over time and from one country to another. For example, should a country be more concerned about unemployment, inflation, or about welfare payments? Should a country favor the consumers who wish to have a strong currency to increase their purchasing power, or the exporters who prefer to have a weak currency to reinforce their competitiveness? This criterion also assumes that if the currency area member countries do not share the same preferences over such trade-offs, each of them will want the common Central Bank to pursue different policies. Therefore, there may exist strong political conflicts and at worst, the currency union may not survive. Under these circumstances, in an OCA, countries must agree on the way to conduct policy actions, which frequently depends on institutions and ideologies.

The final criterion, solidarity ('commonality of destiny'), is also related with political considerations but much more so. As we have seen with the previous criteria, even when shocks are symmetric, these can generate political disagreements. Such divergences are usually accepted by member countries of the currency union as costs incurred by living together (Baldwin and Wyplosz, 2009). The consequence is ultimately seen as acceptable because the economic agents of a country readily agree to extend their sense of solidarity to the whole area. In this way, this criterion implies that when the common monetary policy arouses national interest conflicts, these countries need to accept the associated costs in the name of a common destiny. This should be the strategy to better accept temporary conflicts of interest, especially if the shocks are asymmetric or produce asymmetric effects.

3. European Union: An Optimum Currency Area?

Based on the Krugman and Obstfeld (2009) case study of Europe as an OCA, this section summarizes the rich and unending debate around the question of whether Europe (the Eurozone) really fulfils the criteria of an OCA.

Theoretically, the OCA criteria should tell us whether it makes sense to create a currency union in Europe. However, several controversies exist concerning this decision (see, e.g., Bofinger, 1994; Karras, 1996; Bayoumi and Eichengreen, 1997; Kim and Chow, 2003; Mongelli, 2008; Furrutter, 2012). Indeed, the benefits of the establishment of a currency union in Europe are hard to quantify, and it may only be possible to fulfil some of the seven OCA criteria. It should be noted that the criteria established for EU member countries to join the Eurozone are not the same as those established by Mundell (1961) for an OCA in a general sense.

The so called Maastricht criteria[3] require that a country intending to join the Eurozone must converge with the other countries on the basis of: i) inflation, that for a given member country must not exceed by more than 1.5 percentage points that of the three best-performing member countries in terms of price stability during the year preceding the examination of the situation of the member country; ii) long-term interest rates, that must not exceed by more than 2 percentage points that of, at most, the three best-performing member countries in terms of price stability; iii) deficits, where the ratio of the annual public deficit to Gross Domestic Product (GDP) must not exceed 3% at the end of the preceding financial year; and iv) debt, where the ratio of gross public debt to GDP must not exceed 60% at the end of the preceding financial year; and must also have v) exchange rate stability, according to which countries need to respect the normal fluctuation

3 Usually known as nominal convergence criteria that were presented in Article 121(1) of the Treaty establishing the European Community.

margins provided for by the Exchange Rate Mechanism of the European Monetary System, for at least two years, without devaluing against the currency of any other member country.

As already noted, these criteria are not the same as those required by OCA theory, and there is nowadays considerable debate as to whether the Eurozone is optimal in terms of a common currency. This section aims to enrich this debate. Based on the Krugman and Obstfeld (2009) case study, in which these authors examine Europe's suitability for being an OCA discussing the extent of intra-European trade, mobility of Europe's labor force, similarity of economic structure, and the amount of fiscal federalism within the EU, we try to answer the question as to whether the Eurozone is an OCA, and we do this by analyzing the seven criteria one by one.

In what concerns labor mobility, as we have seen before, the OCA theory suggests that this can go a long way toward alleviating the costs of an asymmetric shock when the exchange rate cannot be adjusted (Mundell, 1961; Baldwin and Wyplosz, 2009). However, Europeans do not seem to take much advantage of the Single Market which allows them to work and 'become calm' anywhere in the EU. In fact, Europeans do not even move much across regions within their own countries. People in Europe move less than half as much as US citizens. In Europe, while 21% moved to another region in the same member country, only 4.4% moved to another member country (Baldwin and Wyplosz, 2009; Pasimeni, 2014).

This situation of low labor mobility within the Eurozone is due to several barriers. Indeed, although travel within European countries is relatively easy, requiring no visas, especially within the Schengen area, there are several obstacles relating to work permits, different languages, customs and traditions, different welfare and pensions schemes, different cultures, national attachment, and others. Even worse is the fact that European citizens move mainly for personal reasons, with professional reasons accounting for only 5%. So, it is not surprising that when asymmetric shocks occur, migration plays a smaller role in Europe[4]. This implies that there is a risk of high unemployment rates in the case of product market disturbances, since there is no way of balancing economic shocks via labor migration within the currency union. Under these circumstances, we can say that Europe (Eurozone) is far from fulfilling the labor mobility criterion.

In what concerns openness, this criterion matters in OCA theory because, in a small open economy, most of the goods produced and consumed are traded on international markets[5]. Therefore, their prices on the domestic market are largely independent of local conditions and any change in the value of the currency tends to be promptly passed into domestic prices. Most European countries are very open to international trade, usually the more so the smaller they are[6]. As far as the McKinnon criterion is concerned, this explains why the smaller countries are traditionally the most enthusiastic supporters of the currency union. On the other hand, the Kenen criterion is built on the idea that asymmetric shocks are less likely among countries that share similar production patterns and whose trade is diversified.

Based on the study of Baldwin and Wyplosz (2009), who made the decomposition of trade into three types of goods (agriculture, minerals, and manufacturing) and took Germany as a benchmark to determine the level of difference between each country's trade structure, we can conclude that diversification and similarity in Europe (Eurozone) is quite high. Dissimilarity with Germany is highest for Norway (a non-EU country), an oil exporting country, for Greece, where agriculture plays a major role, and for the Netherlands, quite dependent on natural gas, and yet an enthusiastic, and so far enthusiastic European Monetary Union (EMU) member country. This

4 The current migration process underway in Portugal as a consequence of the recent economic crisis is an exception to this reality. However, the scale of the phenomenon is not sufficiently relevant so that we can extract another type of conclusion in the context of the Eurozone.

5 Recall that in the context of the OCA criteria, openness is defined as the share of economic activity devoted to international trade. Again, we follow very closely the presentation by Frankel and Rose (1998) and Baldwin and Wyplosz (2009).

6 The US, China and Japan seem as largely closed, as is the EU (Eurozone) as a whole.

case well illustrates that the Kenen criterion of production diversification is not absolute, that it focuses on the costs of EMU membership, ignoring the economic and political benefits.

According to the OCA criteria, a key element required to minimize the disturbances caused by the presence of idiosyncratic business cycles is the existence of similarities in economic structure, and here especially, similarities in the types of produced goods. Regarding this criterion, and based on the study of Caporale, Pittis and Prodromidis (1999), and also on the work of Furrutter (2012), we confirm that member countries of the EU (Eurozone) are not entirely distinct in their industrial and manufacturing structure. In fact, they have a high volume of intra-industry trade. However, although the countries are all European, and share common cultural traits, they are also very diverse in their business cycles and trade partners. By way of example, Ireland is likely to be more synchronized with the United Kingdom than with Eastern and Central European countries. Also the level of GDP per capita and the growth patterns of the member countries of the EMU vary considerably as well as their economic structure.

Looking at the labor force qualification and capital stock, it is seen that there are considerable differences between northern and southern Europe. While the north is in general, highly equipped with skilled labor, capital, and a high-quality production structure, the south has a less innovative and specialized manufacturing structure, less capitalization, as well as smaller volume of qualified labor. In this context, we can conclude that there is a weak justification for the creation of the Eurozone in the geographical extent we are experiencing nowadays. The high intra-industry trade is a pro-argument of course, but it seems to be outweighed by the number of contra-arguments providing dissimilarities in the economic structure/business cycle.

According to the OCA theory, countries or regions hit by a temporary negative shock could also receive transfers from better-off countries as a compensation for having lost the exchange rate instrument after joining the currency union. Within most countries belonging to currency areas, this redistributive mechanism is automatic, and the transfers are typically the outcome of the combined effect of the tax system and welfare payments (unemployment benefits, transfers to poor people, etc.). However, in the case of Europe (Eurozone) there is no such system at work[7]. Fiscal harmonization is only now being seriously considered in Europe as a requisite for the success of the Euro. Unlike the US, the EU is made up of national governments, all carefully guarding their sovereignty[8].

The EU budget is small, less than 2% of GDP, and almost entirely spent on Common Agricultural Policies and Structural Funds which support the poorer regions independently of whether they are hit, or not, by adverse shocks (Baldwin and Wyplosz, 2009). Any transfer system would need a significant increase in the EU budget, which is not likely to happen in the near future. Under these circumstances, in respect of this criterion, again Europe (Eurozone) is definitely not an OCA.

In terms of the homogeneous preference criterion, as already noted, OCA theory assumes that all countries must share similar views about the use of monetary policy. However, based, for example, on inflation rates, this does not seem to be the case. In fact, low-inflation Germany and formerly high-inflation Italy or Greece have very little in common. Similarly, looking at public debts, there seems to be a gulf separating European countries (Baldwin and Wyplosz, 2009).

In what concerns homogeneity of ideologies, we can conclude that there is mixed behavior. It may be too early to determine whether Europe (Eurozone) is definitely characterized by homogeneous preferences.

Finally, regarding solidarity ('commonality of destiny'), we can say that Europe is far from fulfilling the seven OCA criteria, as there is also mixed behavior within the continent. We can identify some common histories, but also wars and conflicts. Important national differences reveal much

7 For example, Germany was not very willing to tax its citizens to help Greece or Ireland, while the French tax payers do not like very much the idea of helping Portuguese or Spanish people.

8 Even though there is an EU parliament each country is ultimately its own master. Each European government depends on the vote of its citizens and the loss of national sovereignty often leads to losses of votes.

heterogeneity in people's sentiments toward politics in general, and the Eurozone in particular. Nevertheless, while national sentiment dominates, the first years of the Eurozone have not provoked the kind of reaction that differing economic situations could have motivated. Therefore, again, Europe (Eurozone) may not be scoring high on this criterion, but nor is it completely failing, it seems.

In summary, we can say that Europe (Eurozone) is far from fulfilling the seven OCA criteria. According to some authors (e.g. Ricci, 2008), this situation is in part responsible for the actual Eurozone economic difficulties. In fact, while the Eurozone performs well on some of the criteria characterizing an OCA, for example, most European countries do well on openness and production diversification, they do nonetheless report low labor mobility and cannot rely on fiscal federalism (fiscal transfers) to smooth out regional and sectorial economic disturbances.

4. Real and Nominal Convergence in the European Union

In this section we introduce the methodological principles of our empirical analysis and the data we have used to access the problem of convergence. The above criteria for an OCA will be confirmed in terms of empirical results concerning real, technological and output convergence and also nominal convergence.

4.1. Empirical Methodology

In terms of β-convergence, economies with a lower GDP tend to grow faster than those with higher GDP per capita. This concept is related to mobility of different individual countries. Another way to look at this concept in conditional terms is to admit that the growth rate of a country is positively related to the difference that separates it from its own steady state (Sala-i-Martin, 1996). These concepts are important for growth analysis. When we analyze the evolution of an area in terms of an optimum currency area we are not interested in a long-run convergence process. We should look at the present to see if the economies are converging. The concept of convergence is the so called σ-convergence: a group of economies is converging if the dispersion of the variables in question is decreasing over time. The two concepts are related, "a necessary condition for the existence of σ-convergence is the existence of β-convergence" (Sala-i-Martin, 1996, p. 1021), but this last concept is not a sufficient condition. In what follows, our central concepts will be related to the σ-convergence, for real and nominal variables.

Our first analysis undertaken to establish the presence of convergence, real and nominal, is based on the evolution of the Gini coefficient. We want to obtain a picture of the convergence-divergence process by the evolution of this inequality indicator. The values of the Gini, the coefficient of variation, and the Atkinson and Theil indices, with different parameters, give roughly the same picture. Following Milanovic (2005, 2012), we calculate a non-weighted Gini coefficient and a weighted Gini coefficient. The first considers that a country is taken as an individual while the other explicitly considers that all individuals (countries) are different and so we must weight each one with its population. In this last situation, Europe is not an addition of countries, but an addition of European citizens.

We also apply the usual tests of unit root to confirm the existence of a process of convergence, but we propose some changes to the usual interpretation derived from the growth literature. We investigate whether the differences in an economy with respect to the group average are stationary without constant, and stationary around a trend. In the first situation, if a country difference variable is stationary with a drift, this means a permanent difference between the two economies, and so the country is not converging. This is the reason why we restrict the constant to zero. But if the difference is stationary around a trend, the evolution of its values is fundamental. In the case where the trend coefficient is positive and the variable has negative values, the country can be seen to be approaching the group values, and hence, we can conclude by convergence. The

inverse is also true – a negative trend coefficient and positive values provide evidence of the opposite. These situations will be appreciated by visual inspection. To test stationarity we apply the ADF test without drift and with a trend. We know that ADF tests have a low power if the true data-generation process has an auto-regressive coefficient close to 1. The other important problem associated with ADF tests is related with deterministic regressors because they have a different interpretation under the null and alternative hypothesis. So we also apply the Schmidt-Phillips Lagrange multiplier test (Schmidt and Phillips, 1992), S-P, under which the deterministic parameters have the same interpretation under the null or the alternative. This test allows the choice of the order of the polynomial trend which can be decided by the plotting of the variable under study. We use a second order polynomial for all tests.

In some way, these tests continue the Hume tradition of a knife-edge decision: a series has or has not a unit root. Granger (1980) has justified and introduced the so-called fractionally- integrated processes. We represent an autoregressive fractionally-integrated moving average process as $(1 - L)^d \emptyset(L)x_t = \theta(L)\varepsilon_t$.

The fractional difference parameter is 'd' and $\emptyset(L)$ and $\theta(L)$ are the autoregressive and the moving average polynomials. The usual hypotheses are made: the roots of and $\emptyset(L)$ and $\theta(L)$ are outside the unit circle and ε is a white noise process.

We supplement our analysis of unit root with the estimation of the order of a fractional process for each variable under study. A variable may be non-stationary and at the same time mean-reverting. So, a value of d<1 means that a variable may be a behavior like a random walk out of equilibrium for long periods but which finally returns to its equilibrium value. We will identify this situation as a convergence process.

The estimation of 'd' is made through two methods (Fraley et al., 2013), the first being the usual Geweke and Porter-Hudak (GPH) method (Geweke and Porter-Hudak, 1983). This estimator is based on a regression that uses the periodogram function as an estimate of the spectral density. The bandwidth used is bw = trunc(n^k), where 'n' is the number of observations and 'k' (0<k<1) is a parameter whose default value is 0.5 (Diebold and Rudebusch, 1989). The second method uses the Reisen estimator (Reisen, 1994). This method is based on a regression equation that uses the smoothed periodogram function as an estimate of the spectral density. It uses the same bandwidth of the first method and we take the value 'h', used in the lag Parzen window, equal to .9, bw2 = trunc(n^h).

The oldest test for testing long memory processes is the rescaled range statistic of Hurst (1951). A short-memory process has a value of H=.5 and values H>.5, far from .5, are taken as reflecting long memory. This test has a major problem, which is that it is sensitive to short-term dependence and heteroskedascity. And it is natural to have both problems in the variables we are using in the paper.

McLeod and Hipel (1978) define a process of long memory when the limit of the sum of the absolute value of the auto-correlation in not finite. This definition means that the spectral density of a long-memory variable is unbounded at low frequencies. We also use in our analysis of convergence, the representation of the spectral density of the variables under study[9]. The auto-correlations of a long memory process decline much more slowly than a stationary process and at the same time the spectral density is much higher when the frequency tends to zero, $\omega \rightarrow 0$.

4.2. Data Sources

As indicated earlier, we take 12 (minus Luxembourg) economies as a representative group in terms of economic integration in Europe: Germany, France, Belgium, Italy, Netherlands, United Kingdom, Denmark, Ireland, Greece, Portugal and Spain. Sweden has chosen to remain outside ERM II, thereby intentionally avoiding the fulfilment of the adoption criteria. The situation of the

9 We take m=1, and so L=3 for the Daniell's kernel.

other countries was different so we choose to exclude Sweden from our study. We want to answer the question: have these rather older European countries evolved in a way that they could form a monetary union? Supposing that the answer is positive we can then put the problem of the entry in a sub-sample of these countries of other countries to form the union. But if the answer is negative, the enlargement of this group to include other countries can end in disaster because these core economies are not themselves in a condition where they can together form the union. We consider that the United Kingdom and Denmark have excluded themselves from the EMU because of political reasons and inappropriate economic conditions.

Almost all data is from AMECO (downloaded in October 2014) from 1960 to 2012. The growth rate of Total Factor Productivity (TFP) is also from this source. With data from the Unido Productivity Website (WPD, www.unido.org/data1/wpd/index.cfm) we have homogenized European TFP values in relation to USA values (2005=100 for this country). With these series of TFP we can compare relative differences between European countries and its average over the years. We have also used PWT, version 8, (Feenstra, 2013) variable PL_C to obtain a structure of prices for 2005 that was complemented with GDP deflators from AMECO.

For real convergence we have studied TFP and real GDP per capita and for nominal convergence, Consumer Prices, Nominal Wages (Wn), Consumers Price Inflation and Wage Prices Inflation.

4.3. Empirical Estimations and Results

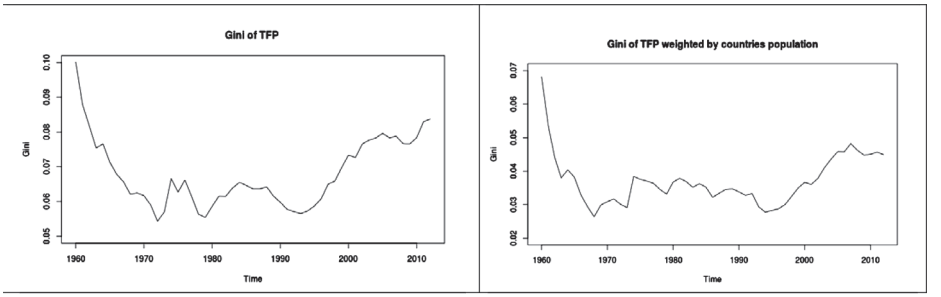
The spectral analysis gives a picture of a not-long memory process for all variables, as does the Hurst indicator. In this case, the values for a more recent sub-period are lower than for the whole period, indicating a more intensive integration for this sub-period. However, we cannot forget that the dimension of our base is very small for the application of these tests[10]. In what follows we begin with real convergence and proceed to nominal convergence.

4.3.1. Real Convergence

The concept of convergence applied to an optimum monetary area is one of sigma-convergence. We apply this concept to the most promising variable, TFP, for the study of real convergence and also to GDP per capita (Dowrick and Nguyen, 1989; Bernard and Jones, 1996).

From Figure 1 it is seen that during the 1960s we had a real convergence process, but between the beginning of the 1970s and the beginning of the 1980s, stagnation took hold, and thereafter, a substantial increase in real divergence is evident.

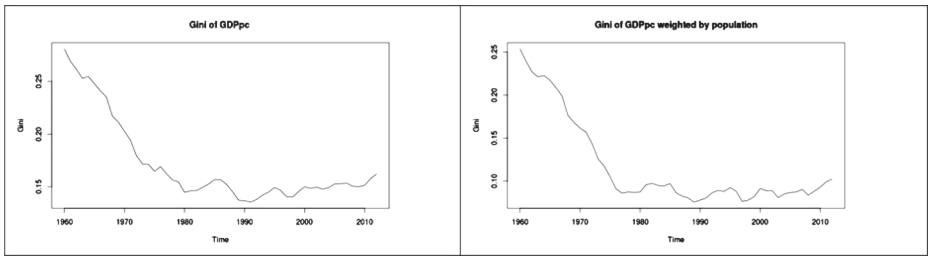
Figure 1: Gini Coefficient for TFP



10 All results can be provided upon request.

We obtain a similar result for GDP convergence (Figure 2). Since the beginning of the 1980s we see a process of real divergence that contrasts with the evolution witnessed before the 1980s when a genuine convergence process was in force.

Figure 2: Gini Coefficient for real GDPpc



The results of the periods 'before 1980' and 'after 1980' allow us to study real, and also nominal convergence, for the period since 1980 until the beginning of the present contraction (2007). For Ireland, Portugal, and Spain, we have also studied the period of European integration, 1973 and 1986 to 2007, respectively.

We present only the results of the ADF tests, S-P tests and the estimation of the fractional integration, but can provide all results upon request.

In what concerns TFP convergence, and in terms of ADF and S-P tests (Table 1), for the total period, 1960-2012, Germany, United Kingdom, Denmark, and Portugal are converging to the average. For the sub-period 1980-2007, Germany, France, Belgium and Denmark are converging. For the period of European integration for Ireland, Portugal and Spain, only Portugal is converging. So, during the period of more intense integration only five countries converged, these being: Germany, France, Belgium, Denmark, and Portugal. In terms of 'd' (Table 2), for the whole period, Germany, Belgium, Netherlands, Denmark, and Portugal experienced a technological catching-up all over the period between 1960-2012. For the sub-sample period of 1980-2007 (and integration period for Ireland, Portugal, and Spain), the equivalent group is formed only by the Netherlands, United Kingdom, and Denmark. So, in conclusion, in terms of fractional integration, the deepening of the European integration has not caused a real convergence process in terms of TFP.

Table 1: Unit Root Tests of TFP

	1960-2012					1980-2007			
	ADF.1	**ADF.2**	**SPT**	**SPR**		**ADF.1**	**ADF.2**	**SPT**	**SPR**
GER	-1.86*	-2.06	-2.5	-12.88	GER	-1.97 **	-2.30	-2.51	-13.75
FRA	-1.2	-1.75	-2.86	-15.18	FRA	-1.85 *	-2.32	-1.95	-7.49
BEL	-0.49	-1.56	-2.38	-11.46	BEL	-2.14 **	-1.07	NA	2.15
ITA	0.51	-1.31	-1.85	-5.76	ITA	-0.37	-1.95	-0.46	-0.45
NET	-1	-1.68	-3.1	-18.43	NET	-0.27	-1.39	-0.87	-1.43
UK	-1.76*	-3.08	-1.42	-4.08	UK	0.75	-1.86	NA	1.22
DNM	-1.86*	-1.76	-2.78	-15.38	DNM	-2.63 ***	-3.21 **	-2.52	-13.59
IRE	0.66	-2.93	-1.6	-5.31	IRE	0.12	-0.79	NA	0.24
GRE	-0.13	-2.41	-1.48	-4.58	GRE	-0.03	-0.84	-3.06	-15.46
PRT	-1.81*	-2.52	-2.02	-7.57	PRT	-0.28	-1.48	-1.42	-4.26
SPA	-1.05	-1.77	-4.58***	-41.27	SPA	-0.48	-4.39 ***	NA	1.95
					IRE	0.76	-4.17 **	NA	9.10
					PRT	0.10	-2.57	-1.01	-1.83
					SPA	-1.01	-2.16	-1.79	-6.77

Note: ADF.1 and ADF.2 are the usual ADF tests without drift and with trend, respectively. SPT and SPR are the Schmidt-Phillips 'tau' and 'rho', respectively. The notation *, ** and *** are used to represent the rejection of the null hypothesis at a significant level of 10%, 5% and 1%, respectively.

The results obtained with GDPpc still reduce the number of countries converging to the average, for the whole period: Belgium, United Kingdom, Netherlands, and Denmark, and for the period of more intensive integration: France, Denmark, and Ireland. Concerning fractional differentiation an almost analogous situation to TFP was obtained. For the whole period, Netherlands, United Kingdom, and Denmark also converge in terms of GDPpc, and this group is now accompanied by Portugal and Spain. The results for the sub-period are quite impressive. Only Netherlands has experienced a convergence process between 1980 and 2007. If we consider the 1986-2007 period we have to add Spain to Netherlands.

Table 2: Fractional Integrated Analysis of TFP

	GPH		RAISEN			GPH		RAISEN	
1960-2012	**d**	**S.E.**	**D**	**S.E.**	**1980-2007**	**d**	**S.E.**	**d**	**S.E.**
GER	0.98	0.19	0.94	0.08	GER	1.30	0.32	1.20	0.16
FRA	1.60	0.31	1.11	0.14	FRA	1.10	0.18	1.20	0.09
BEL	0.94	0.27	0.90	0.13	BEL	1.40	0.22	1.40	0.14
ITA	1.70	0.31	0.99	0.10	ITA	1.00	0.25	0.94	0.09
NET	0.97	0.24	0.66	0.04	NET	0.57	0.44	0.38	0.03
UK	1.52	0.38	0.93	0.11	UK	0.67	0.33	0.74	0.13
DNM	0.74	0.28	0.73	0.09	DNM	0.45	0.42	0.39	0.33
IRE	1.60	0.25	1.30	0.13	IRE	1.30	0.11	1.40	0.13
GRE	1.50	0.29	1.10	0.11	GRE	1.20	0.39	0.92	0.11
PRT	0.69	0.15	0.77	0.06	PRT	1.50	0.38	1.20	0.24
SPA	1.40	0.21	1.10	0.09	SPA	1.20	0.14	1.20	0.10
					IRE	1.20	0.07	1.30	0.13
					PRT	2.60	0.56	0.96	0.24
					SPA	0.96	0.06	1.10	0.09

Note: GPH corresponds to the application of the Geweke and Porter-Hudak method, and Raisen to the Raisen method. S.E. means standard error.

Table 3: Unit Roots Tests of GDP

1960-2012					1980-2007				
GDP.R	**ADF.1**	**ADF.2**	**SPT**	**SPR**	**GDP.R**	**ADF.1**	**ADF.2**	**SPT**	**SPR**
GER	-0.45	-1.65	-2.66	-15	GER	-1.38	-1.97	-2.22	-10.88
FRA	-1.08	-2.16	-2.05	-8.89	FRA	-2.01**	-1.63	-2.19	-10.09
BEL	-2.15**	-1.68	-2.31	-10.94	BEL	-1.30	-2.04	-2.53	-14.12
ITA	-0.69	-0.47	-2.16	-9.58	ITA	0.16	-2.27	-2.34	-11.94
NET	0.32	-3.86**	-2.97	-17.91	NET	-0.28	-2.77	-1.83	-7.16
UK	-2.63***	-2.12	-3.1	-19.49	UK	-1.60	-1.74	-2.45	-12.52
DNM	-0.5	-5.8***	-1.87	-6.57	DNM	-0.33	-3.43**	-2.31	-10.83
IRE	-1.01	-2.66	-2.3	-11.11	IRE	-2.84**	-2.54	-0.91	-1.84
GRE	-0.52	-2.34	-1.89	-7.52	GRE	-0.01	0.07	-1.69	-6.08
PRT	-1.59	-2.41	-2.84	-15.66	PRT	-0.53	-1.34	-1.72	-6.43
SPA	-1.39	-2.28	-2.3	-10.99	SPA	-0.88	-1.79	-2.97	-18.64
					IRE	-1.83 *	-2.54	-2.33	-11.71
					PRT	-1.59	-2.41	-2.84	-15.66
					SPA	-0.11	-3.18	-0.68	-1.05

Note: See note s in Table 1.

Table 4: Fractional Integrated Analysis of GDP

	GPH		RAISEN			GPH		RAISEN	
1960-2012	D	S.E.	d	S.E.	1980-2007	d	S.E.	D	S.E.
GER	1.20	0.14	1.20	0.10	GER	1.40	0.16	1.30	0.15
FRA	1.30	0.27	1.40	0.16	FRA	1.20	0.09	1.20	0.10
BEL	1.10	0.25	1.20	0.16	BEL	1.20	0.16	1.30	0.14
ITA	1.50	0.41	1.40	0.14	ITA	1.20	0.31	1.10	0.11
NET	0.08	0.63	0.28	0.18	NET	0.85	0.16	0.88	0.15
UK	0.87	0.09	0.97	0.08	UK	1.70	0.36	1.20	0.27
DNM	0.27	0.20	0.15	0.10	DNM	1.10	0.53	0.46	0.33
IRE	1.40	0.11	1.40	0.11	IRE	1.20	0.10	1.30	0.12
GRE	1.10	0.20	0.91	0.14	GRE	1.50	0.45	1.10	0.13
PRT	0.82	0.12	0.88	0.06	PRT	1.80	0.07	1.40	0.22
SPA	0.72	0.23	0.74	0.10	SPA	1.50	0.40	1.30	0.29
					IRE	1.10	0.02	1.20	0.11
					PRT	1.80	0.45	0.70	0.21
					SPA	-0.56	0.78	0.41	0.25

Note: See notes in Table 2.

With respect to real convergence we must conclude that not only, as a group, but also individually, the evidence is against convergence since the number of countries that converge is very small. A deeper analysis might draw a darker picture because the countries are diverging in opposite directions.

4.3.2 Nominal Convergence

We apply the concept of nominal convergence to levels of prices and wages, and then to inflation of prices and wages. In Figures 3 and 4 we see a continuous process of convergence from 1960 until now. Initially, during the 1960s, the process was slow, but thereafter it began to accelerate until 2000.

We begin our individual analysis with ADF and S-P tests applied to nominal wages (Tables 5 and 6). For the whole period, 1960-2012, it is not possible to reject a convergence process for Germany, United Kingdom, Ireland, Greece, Portugal, and Spain. For the sub-period 1980-2007 the group consists of France, Belgium, Italy, and Denmark, and for their integration periods (1973/86-2007) Ireland, Portugal, and Spain. In terms of fractional differentiation for the whole period, only the United Kingdom and Denmark can be taken as converging. For the sub-period 1980-2007, Germany, Italy, Netherlands, Denmark, and Ireland can be taken as converging.

Figure 3: Gini Coefficient for GDP Prices

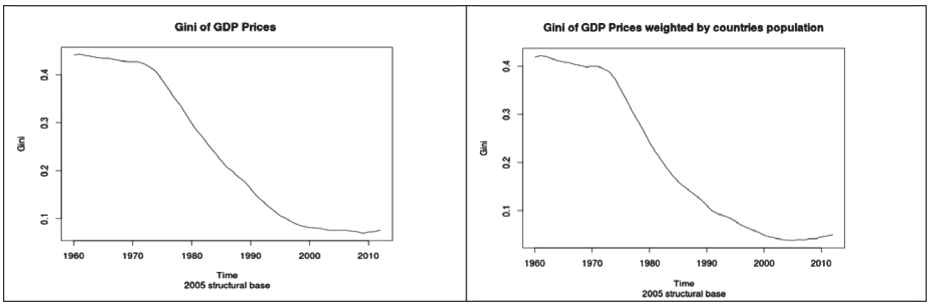


Figure 4: Gini coefficient for Nominal Wages

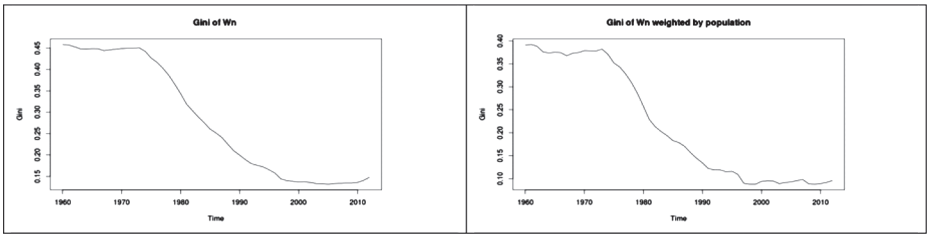


Table 5: Unit Root Tests of Wn

	1960-2012					1980-2007			
	ADF.1	ADF.2	SPT	SPR		ADF.1	ADF.2	SPT	SPR
GER	-2.18 **	-1.26	-2.96	-18.39	GER	-1.07	-1.60	-1.48	-4.86
FRA	-0.82	-1.43	-2.98	-18.74	FRA	-2.90 ***	-1.87		2.60
BEL	-0.94	-1.72	-2.64	-14.54	BEL	-2.63 ***	-2.73	-1.66	-5.49
ITA	-1.41	-1.96	-2.46	-12.91	ITA	-1.81 *	-1.95	-1.43	-4.33
NET	-1.30	-2.03	-2.03	-8.82	NET	-1.39	-2.09	-2.00	-8.23
UK	-3.18 ***	-3.14	-2.30	-10.61	UK	-1.34	-2.28	-2.45	-12.11
DNM	-0.09	-3.08	-1.85	-6.81	DNM	-0.02	-3.56 **	-2.23	-3.18
IRE	-2.65 ***	-1.21	-3.02	-19.32	IRE	0.19	-1.94	-0.76	-1.29
GRE	-1.76 *	-0.40	-1.73	-6.39	GRE	-3.20	-0.24		14.59
PRT	-2.24 **	-0.10	-1.72	-6.31	PRT	-0.74	-2.24	-2.45	-12.94
SPA	-2.16 **	-0.55	-2.90	-17.74	SPA	-1.28	-1.70	-2.48	-13.54
					IRE	-1.87 *	-3.41 *	-1.53	-5.16
					PRT	-0.18	-3.84 **		1.39
					SPA	-0.84	-4.33 **	-1.99	-9.09

Note: See Table 1.

Table 6: Fractional Integrated Analysis of Wn

	GPH		RAISEN			GPH		RAISEN	
1960-2012	**d**	**S.E.**	**d**	**S.E.**	**1980-2007**	**d**	**S.E.**	**d**	**S.E.**
GER	1.18	0.07	1.23	0.07	GER	0.73	0.11	0.90	0.07
FRA	2.00	0.22	1.42	0.20	FRA	1.72	0.15	1.52	0.16
BEL	1.18	0.11	1.23	0.07	BEL	0.95	0.09	1.03	0.08
ITA	1.13	0.13	1.26	0.09	ITA	0.92	0.10	0.80	0.08
NET	1.52	0.18	1.65	0.13	NET	0.98	0.09	0.99	0.08
UK	0.42	0.19	0.48	0.13	UK	1.14	0.29	0.79	0.23
DNM	0.99	0.62	0.33	0.13	DNM	0.54	0.41	0.36	0.30
IRE	1.29	0.06	1.36	0.10	IRE	0.45	0.17	0.76	0.10
GRE	1.19	0.10	1.33	0.08	GRE	1.03	0.02	1.08	0.08
PRT	1.19	0.10	1.33	0.08	PRT	1.11	0.02	1.12	0.10
SPA	1.00	0.10	1.11	0.06	SPA	1.03	0.12	1.00	0.10
					IRE	0.81	0.15	0.92	0.13
					PRT	1.00	0.06	0.96	0.13
					SPA	1.31	0.25	1.05	0.29

Note: See Table 2.

Concerning GDP prices (Tables 7 and 8), and for ADF and S-P tests, for the period 1960 to 2012, only France and Greece do not converge. For the sub-period 1980-2007, Germany, Netherlands, Greece, and Spain (even during the integration period) do not converge. But the evolution of inflation is different, since for Germany inflation is lower than average while for Greece and Spain it is greater than the average. So, the reasons for non-convergence are different. Concerning differential differentiation, for the whole period three countries always present a value of 'd' greater than one: France, Netherlands, and Greece. While Greece shows an opposite evolution for GDP inflation. For the period 1980-2007 every country has at least one estimation value of 'd' less than one, which means convergence. In conclusion, for GDP prices, for 1980-2007 we have a global picture of inflation convergence. The big surprise comes from Portugal, with its values for the integration period, 1986-2007, reflecting a non-convergence process.

Let us now see the results for wages inflation (Tables 9 and 10). For the whole period, in terms of ADF and S-P tests, we can accept convergence for all the countries except for Greece. For the sub-period, 1980-2007, Germany, Ireland, Spain, Denmark, and Portugal (and also for the integration period) are diverging. These results for the whole period, for differential differentiation, confirm the above unit root analysis: we can accept the convergence for all these countries because the value of 'd' is always less than 1. For the period 1980-2007, only one country always has a value of 'd' greater than 1, that being Ireland. But for the integration period the values for Ireland are also less than 1.

Table 7: Unit Root Tests of GDP Inflation

	1961-2012					1980-2007			
	ADF.1	ADF.2	SPT	SPR		ADF.1	ADF.2	SPT	SPR
GER	-1.87 *	-1.88	-2.98	-15.65	GER	-1.21	-2.25	-2.37	-10.76
FRA	-1.48	-1.54	-2.41	-11.87	FRA	-2.03 **	-1.80	-1.77	-5.98
BEL	-2.67 ***	-2.72	-1.53	-4.19	BEL	-1.66 *	-2.74		20.54
ITA	-3.16 ***	-3.31 **	-4.16 ***	-26.80	ITA	-2.80 **	-4.86 ***		33.38
NET	-1.81 *	-1.71	-2.37	-11.10	NET	-1.55	-2.10	-1.13	-2.55
UK	-3.39 ***	-3.49 ***	-2.16	-7.94	UK	-2.63 ***	-3.84 ***	-2.53	-12.13
DNM	-2.29 **	-2.29 **	-6.33 ***	-61.84	DNM	-1.89 *	-2.27	-1.76	-5.20
IRE	-3.28 ***	-3.32 *	-2.84	-14.94	IRE	-2.16 **	-2.32	-2.19	-9.30
GRE	-1.59	-1.62	-2.12	-9.02	GRE	-1.04	-1.92	-2.23	-10.52
PRT	-1.63 *	-1.52	-2.11	-8.61	PRT	-1.07	-5.19 ***		0.48
SPA	-2.84 ***	-3.21 *	-2.03	-7.47	SPA	-1.05	-2.64	-2.22	-8.27
					IRE	-2.32 ***	-2.23	-2.64	-13.04
					PRT	-1.76 *	-4.35 **		13.71
					SPA	-0.87	-2.41	-1.50	-3.42

Note: See Table 1.

Table 8: Fractional Integrated Analysis of GDP Inflation

	GPH		RAISEN			GPH		RAISEN	
1960-2012	D	S.E.	d	S.E.	1980-2007	D	S.E.	D	S.E.
GER	1.14	0.48	0.65	0.07	GER	0.62	0.26	0.50	0.11
FRA	1.64	0.34	1.24	0.22	FRA	1.79	0.38	0.93	0.12
BEL	0.45	0.34	0.41	0.10	BEL	0.36	0.26	0.20	0.04
ITA	1.25	0.47	0.77	0.19	ITA	0.31	0.52	0.06	0.18
NET	1.23	0.20	1.03	0.15	NET	0.76	0.63	0.77	0.06
UK	-0.37	0.32	-0.04	0.07	UK	0.02	0.26	0.07	0.20
DNM	0.58	0.44	0.55	0.07	DNM	0.81	0.23	0.45	0.06
IRE	0.26	0.33	0.32	0.24	IRE	0.63	0.50	0.44	0.15
GRE	1.22	0.19	1.01	0.12	GRE	1.06	0.25	0.91	0.16
PRT	1.15	0.26	0.97	0.15	PRT	0.70	0.15	0.39	0.04
SPA	0.51	0.18	0.35	0.05	SPA	0.36	0.30	0.37	0.11
					IRE	0.94	0.68	0.56	0.25
					PRT	1.20	0.40	1.08	0.13
					SPA	0.98	0.43	0.55	0.12

Note: See Table 2.

Table 9: Unit Root Tests of Wn Inflation

	1961-2012					1980-2007			
	ADF.1	ADF.2	SPT	SPR		ADF.1	ADF.2	SPT	SPR
GER	-2.08 **	-2.12	-3.08	-16.79	GER	-0.88	-2.33	-2.42	-9.59
FRA	-1.89 *	-2.14	-2.55	-12.64	FRA	-2.84 ***	-2.31		7.97
BEL	-3.13 ***	-3.93 **	-4.04 **	-25.08 **	BEL	-3.02 ***	-3.27 *		2.68
ITA	-3.05 ***	-2.99	-4.29 ***	-30.24 **	ITA	-2.17 **	-2.96		1.37
NET	-2.38 **	-2.57	-2.03	-8.00	NET	-2.26 **	-3.57 **	-0.11	-0.02
UK	-5.09 ***	-4.99 ***		18.41	UK	-2.92 ***	-2.99		2.77
DNM	-2.15 **	-4.40 **		23.88	DNM	-1.38	-4.70 ***		26.96
IRE	-3.30 ***	-3.35 **	-2.69	-12.72	IRE	-0.26	-1.99	-2.86	-10.85
GRE	-1.26	-2.00	-3.36 **	-18.14	GRE	-3.15 ***	-3.04		23.80
PRT	-1.63 *	-3.43 *	-4.82 ***	-38.01 ***	PRT	-1.05	-2.53	-4.43 ***	-20.87 *
SPA	-3.37 ***	-3.63 **	-3.21	-16.60	SPA	-1.53	-1.62	-2.21	-8.88
					IRE	-0.27	-1.68	-4.04 **	-26.10 **
					PRT	0.57	-3.47 *		7.72
					SPA	-1.22	-1.15	-2.11	-7.98

Note: See Table 1.

Table 10: Fractional Integrated Analysis of Wn Inflation

	GPH		RAISEN			GPH		RAISEN	
1960-2012	d	S.E.	d	S.E.	1980-2007	d	S.E.	D	S.E.
GER	0.72	0.42	0.47	0.09	GER	0.62	0.16	0.59	0.10
FRA	0.64	0.34	0.71	0.15	FRA	0.92	0.25	0.88	0.13
BEL	0.30	0.44	0.14	0.10	BEL	0.16	0.21	0.06	0.12
ITA	0.58	0.39	0.49	0.19	ITA	0.53	0.50	0.33	0.08
NET	0.65	0.27	0.58	0.13	NET	0.71	0.26	0.61	0.07
UK	-0.52	0.17	-0.43	0.10	UK	0.59	0.59	0.07	0.31
DNM	-0.01	0.18	-0.08	0.08	DNM	-0.86	0.54	-0.08	0.17
IRE	0.30	0.13	0.16	0.11	IRE	1.11	0.22	1.02	0.15
GRE	0.45	0.22	0.28	0.10	GRE	0.54	0.33	0.15	0.07
PRT	0.73	0.55	0.54	0.14	PRT	1.16	0.40	0.71	0.11
SPA	-0.07	0.36	0.09	0.15	SPA	1.20	0.27	0.88	0.23
					IRE	0.89	0.30	0.97	0.20
					PRT	0.95	0.50	0.69	0.16
					SPA	1.10	0.12	0.90	0.20

Note: See Table 2.

Summing up, we conclude that there is evidence of a convergence process in the evolution of wage increases for all these countries, although some doubts exist for Germany, Ireland, Spain, Denmark, and Portugal.

5. Conclusion

We have presented the conditions that a group of economies must obey to form an OCA. In almost all situations an OCA was the result of a political process that has motivated integrated regional economies to converge. This process was a real and nominal one. So, the European process, based as it was on a political decision, cannot be considered an unusual one. What was different was the nature of this area in as much as there was no political unification, with countries continuing as sovereign entities. The decision was made to respect nominal criteria in order to guarantee monetary and financial stability and the creation of the single market to accomplish the remainder of an OCA. Active public intervention occurred to achieve some of the nominal criteria but almost no intervention occurred to achieve real convergence. Consequently, the OCA has continued without free mobility of labor and with mitigated mobility of physical capital.

We have analyzed the integration process for an older group of European countries and we confirm the existence of price inflation convergence, and determined the consequence of the integration of goods markets. We also conclude that wage inflation convergence exists, but we think this is more the result of contagion and Union behavior than of European labor market integration (Pasimeni, 2014). Additionally, we observe the existence of wage convergence but perhaps the most important result is the absence of real convergence. Summing up our results, wage convergence, without intensive capital mobility, (+) real divergence, we see that we have the worst of all possible results, and we must say that this will be a source of real imbalance between countries in the process of European integration.

Acknowledgements

The authors thanks an anonymous referee and also Adelaide Duarte for their helpful comments and suggestions. We also thank colleagues for their comments given in the conferences: International Scientific Conference, Economic Sciences on the Crossroad, Institute of Economic Sciences, 4 December, 2013, Belgrade; Macroeconomic Policy in Times of Crisis, NIFIP, Faculty of Economics, University of Oporto, 28-29 November, 2013; an INFER International Workshop on European Economic Integration: Present and Future Challenges, ISEG, Lisbon, 20-21 June, 2014. The usual disclaimer applies.

References

Artis, M.; Zhang, W. (1995) International Business Cycles and the ERM: Is there a European Business Cycle?, *CEPR*, Discussion Paper 1191.

Baldwin, R. (2006) *In or Out: Does it Matter? An Evidence Based Analysis of the Euro's Trade Effects*, London, Centre for Economic Policy Research.

Baldwin, R.; Wyplosz, C. (2009) *The Economics of European Integration*, New York, McGraw Hill, 3rd Edition.

Bayoumi, T.; Eichengreen, B. (1997) Ever Closer to Heaven? An Optimum-Currency-Area Index for European Countries, *European Economic Review*, 41(3-5), 761-770.

Berger, H.; Nitsch, V. (2008) Zooming out: The Trade Effect of the Euro in Historical Perspective, *Journal of International Money and Finance*, 27(8), 1244-1260.

Bergin, P.; Ching-Yi, L. (2012) The Dynamic Effects of a Currency Union on Trade, *Journal of International Economics*, 87(2), 191-204.

Bernard, A.; Jones, I. (1996) Productivity across Industries and Countries: Time Series Theory and Evidence, *Review of Economics and Statistics*, 78(1), 135-146.

Bofinger, P. (1994) Is Europe an Optimum Currency Area?, *CEPR*, Discussion Paper 915.

Bordo, M.; Markiewicz, A.; Jonung, L. (2011) The Euro Needs a Fiscal Union: Some Lessons from History, *NBER*, Working Paper 17380.

Breuss, F. (2011) Downsizing the Eurozone into an OCA or Entry into a Fiscal Transfer Union, *CESifo Forum*, 4, 5-12.

Buti, M. (2011) Balancing Imbalances: Improving Economic Governance in the EU after the Crisis, *CESifo Forum*, 12, 3-11.

Caporale, G.; Pittis, N.; Prodromidis, K. (1999) Is Europe an Optimum Currency Area? Business Cycles in the EU, *Journal of Economic Integration*, 14(2), 169-202.

Crespo-Cuaresma, J.; Plaffermayr, M.; Amador, O.; Keppelet, C. (2011) Macroeconomic Aspects of European Integration: Fiscal Policy, Trade Integration and the European Business Cycle, *FIW Research Report*, 4.

Diebold, X.; Rudebusch, D. (1989) Long Memory and Persistence in Aggregate Output, *Journal of Monetary Economics*, 24(2), 189-209.

Dowrick, S.; Nguyen, D. (1989) OECD Comparative Economic Growth 1950-1985: Catch Up and Convergence, *American Economic Review*, 79(5), 1010-1130.

Eicher, T.; Henn, C. (2009) One Money, One Market – A Revised Benchmark, *IMF*, Working Paper 189.

Feenstra, R.; Inklaar, R.; Timmer, M. (2013) The Next Generation of the Penn World Table, available for download at www.ggdc.net/pwt.

Fraley, C.; Leisch, F.; Maechler, M.; Reisen, V.; Lemonte, A. (2013) Package 'fracdiff' for R, Version 1.4(2), August 29.

Frankel, J.; Rose, A. (1998) The Endogenity of the Optimum Currency Area Criteria, *Economic Journal*, 108(449), 1009-1025.

Frankel, J.; Rose, A. (2002) An Estimate of the Effect of Common Currencies on Trade and Income, *Quarterly Journal of Economics*, 117(2), 437-466.

Furruter, M. (2012) The Eurozone: An Optimal Currency Area?, *IFIER* Papers, February.

Geweke, J.; Porter-Hudak, S. (1983) The Estimation and Application of Long Memory Time Series Models, *Journal of Time Series Analysis*, 4(4), 221-238.

Granger, C. (1980) Long Memory Relationships and the Aggregation of Dynamic Models, *Journal of Econometrics*, 14(2), 227-238.

Hurst, H. (1951) Long Term Storage Capacity of Reservoirs, *Transactions of the American Society of Civil Engineers*, 116, 770-799.

Karras, G. (1996) Is Europe an Optimum Currency Area? Evidence on the Magnitude and Asymmetry of Common and Country-Specific Shock in 20 European Countries, *Journal of Economic Integration*, 11(3), 366-384.

Kenen, P. (1969) *The Theory of Optimum Currency Areas: An Eclectic View*, in Mundell, R.; Swoboda, A. (eds.), Monetary Problems of the International Economy, Chicago, University of Chicago Press, Chicago, 41-60.

Kim, Y.; Chow, H. (2003) Optimum Currency Area in Europe: An Alternative Assessment, *Economic Letters*, 81(3), 297-304.

Krugman, P.; Obstfeld, M. (2009) *Case Study: Is Europe an Optimum Currency Area?*, in International Economics: Theory and Policy, Boston, Mass.: Pearson, Addison-Wesley, 582-587.

Lerner, A. (1944) *The Economics of Control: Principles of Welfare Economics*, New York, Macmillan.

Lerner, A. (1947) Discussion of 'International Monetary Policy and the Search for Economic Stability' by Ragnar Nurkse, *American Economic Review*, 37(2), 592-594.

Long, J.; Plosses, C. (1983) Real Business Cycles, *Journal of Political Economy*, 91(1), 39-69.

McKinnon, R. (1963) Optimum Currency Area, *American Economic Review*, 53(4), 717-724.

McLeod, A.; Hipel, K. (1978) Preservation of the Rescaled Adjustment Range, 1: A Reassessment of the Hurts Phenomenon, *Water Resources Research*, 14(3), 491-508.

Micco, A.; Stein, E; Ordonez, G. (2003) The Currency Union Effect on Trade: Early Evidence from EMU, *Economic Policy*, 18(37), 315-356.

Milanovic, B. (2005) *Worlds Apart: Measuring International and Global Inequality*, Princeton, Princeton University.

Milanovic, B. (2012) Global Inequality Recalculated and Updated: the effect of new PPP Estimates on Global Inequality and 2005 Estimates, *Journal of Economic Inequality*, 10(1), 1-18.

Mongelli, F. (2008) European Economic and Monetary Integration and the Optimum Currency Area Theory, *European Commission*, Economic Papers 302.

Mundell, R. (1961) A Theory of Optimum Currency Areas, *American Economic Review*, 51(4), 657-665.

Pasimeni, P. (2014) An Optimum Currency Crisis, *The European Journal of Comparative Economics*, 11(2), 173-204.

Reisen, V. (1994) Estimation of the Fractional Difference Parameter in the ARFIMA(p,d,q) Model using the Smoothed Period gram, *Journal Time Series Analysis*, 15(1), 335–350.

Ricci, L. (2008) A Model of an Optimum Currency Area, *Economies: the open-access, open – assessment E-Journal*, 2(8), 1-31.

Rose, A. (1961) One Money, One Market: The Effect of Common Currencies on Trade, *Economic Policy*, 15(30), 7-46.

Rose, A. (2004) *The Effect of Common Currencies on International Trade: A Meta-Analysis*, in Alexander, V.; Mélitz, J.; von Furstenberg, G. (eds.), Monetary Unions and Hard Pegs, Oxford, Oxford University Press, 101-111.

Sala-i-Martin, X.; Sachs, J. (1992) *Fiscal Federalism and Optimum Currency Areas: Evidence for Europe from the United States*, in Canzoneri, M.; Grilli, V.; Masson, P. (eds.), Establishing a Central Bank: Issues in Europe and Lessons from the US, Cambridge, Cambridge University Press, 195-227.

Sala-i-Martin, X. (1996) The Classical Approach to Convergence Analysis, *The Economic Journal*, 106(437), 1019-1036.

Schmidt, P.; Phillips, P. (1992) Lm Tests of a Unit Root in the Presence of Deterministic Trends, *Oxford Bulletin of Economics and Statistics*, 54(3), 257-287.

Scitovsky, T. (1984) Lerner's Contribution to Economics, *Journal of Economic Literature*, 22(4), 1547-1571.

van Marrewijk, C.; Ottens, D.; Schuller, S. (2006) *International Economics: Theory, Application, and Policy*, Oxford, UK, Oxford University Press.