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# Difficult Convergence among the Five Main European Union Countries and the Crisis of the Euro Area

**Michele Caputo**[1] · **Francesco Forte**[2]



**Abstract** This paper focuses on the European Union (EU) and European Monetary Union (EMU) as club-governments after an analysis of the characteristics of the union of governments as clubs. Convergence among member countries regarding the parameters relevant for club homogeneity and stability is paramount. We develop empirical research on the convergence path in a model with the five main EU countries, with 15 parameters drawn from neoclassical growth theory and from EU-EMU rules. We examine convergence and stability in the EU club for France, Germany, Italy, Spain and the United Kingdom by measuring their parametric spreads from 2003 (first year of normal circulation of the euro) to 2011. Convergence with growth developed before the great financial fluctuation, then divergence set in. Convergence then reappeared with partial stagnation. Gross domestic product (GDP) was the dominant parameter, while GDP per capita was the least important. The main focus of the paper is on measurement. The results signal the need for changes in institutions and policy tools consistent with the market economy models of the two clubs. Further integration will face the same issues.

**Keywords** Convergence · Stability · Club theory · European monetary union · Growth models

**JEL** E52 · E62 · H41 · O47

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# The EU and EMU as Clubs and their Convergence Parameters

## Union of Governments as Clubs and their Convergence Parameters

According to the now familiar definition of James Buchanan [Buchanan (1965) and Buchanan and Goetz (1972)) [1]], club goods are an intermediate category of public goods: common in use, but to some degree, exclusionary for those who do not participate in the "club." If preferences among members are too heterogeneous, the club must try to adapt its rules to minimize welfare losses (Fedeli and Forte 2012).[2] In a large-club with heterogeneous preferences, minimization may be too difficult and costly. Non-territorial clubs of public goods that one may observe (and private clubs) normally imply a relevant degree of homogeneity. The reason is that those who have inhomogeneous preferences either do not participate in clubs or leave them, once such individuals realize they are unable to adapt to the rules.

Differences arise when governments are territorial clubs, as first theorized for local governments by Buchanan and Goetz (1972), and also in the case of a union of autonomous states, such as the European Union (EU) and the European Monetary Union (EMU), as studied by Buchanan [(Buchanan 1990, 1995, 1996, 1997, 2001a)]. The spatial dimension implies territorial ties and increases the costs of opting out. The problem becomes much more complex for government clubs, whose members are primarily national governments. Indeed, only a unique market may be an "optimal monetary area" (Mundell 1961, 1973).

Monetary union among different countries may be useful because of the enlargement of the market, due to the existence of a common currency. However, market unification is essential to reap the benefits of this enlargement.

The rate of exchange of conventional money in circulation in a union of governments for the member states and their own central banks is an exogenous variable. In fact, countries with wage rigidities cannot regain competition by domestic currency devaluation. Moreover, exiting the monetary club is not a bearable solution for a new monetary union for the non-performing countries. Indeed, the participation of any member state must appear irreversible in order to assure the credibility of new paper money. Therefore, the strict interest of the monetary union is to hinder the exit of a member state, particularly if it is an important one.[3] The situation for non-performing

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[1] The theory of club goods has been broadly developed and has diverse applications [Pauly (1970a) and (Pauly 1970b); Berglas (1976); Sandler and Tschirhart (1980); Cornes and Sandler (1996); Sandler and Tschirhart (1997); (Scotchmer 2002)].

[2] One should not confuse monetary union with the currency association of a state to the currency of another state. Argentina pegged its pesos to the US dollar. The pegging did not work and Argentina was obliged to leave the legal parity with the dollar. Lichtenstein pegged its currency to the Swiss Franc with better results. The Kingdom of Monaco, the Republic of San Marino and the Vatican State use the euro as their currency by a bilateral pact with the EMU (i.e. the European Central Bank (ECB)). If they leave the euro breaking the pact, they must either issue their own currency or, more easily, adopt another currency, with a bilateral pact. The two examples of past monetary unions, the Latin Monetary Union and the Scandinavian Monetary Unions, both of the 19th century, do not correspond to the territorial club model of the EMU, as there was no central bank.

[3] The evolution of the five club members considered here has already been tentatively studied using 29 parameters taken almost at random among those available in the three years 2000, 2005, and 2010 (Caputo 2014a). The results were inconclusive, mostly due to the limited resolution of the data and to the limited time interval used.

countries seeking membership in the EMU is similar to that of the contract of Faust with the devil. The first step is voluntary, the next step is obligatory.

"Club convergence," first employed by Baumol (1986), has been extensively studied in growth theory. (Dowrick and Nguyen (1989); Barro and Sala-i-Martin (1992), (1994); Galor (1996); Ben-David (1997); Reiss (2000); Dowrick and DeLong (2003); Islam (2003); Busetti et al. (2007); Cunado et al. (2006); Fischer and Stirbock (2006); Mathunjwa and Temple (2007); Cavenaille and Dubois (2010); Caputo (2012a, b)). The convergence of the parameters of countries belonging to a given club government (CG) is important in order to ensure the viability of the club. This is relevant to the rules of the club and growth-enhancing employment. Therefore, we consider the following 15 parameters (Table 1) as relevant for the measurement of convergence in the EU and EMU as clubs.

The first eight parameters are relevant measures of the main variables of the neoclassical growth model, with the exception of the "inflation rate." The latter measures the country-specific degree of rigidity in the supply of production factors, particularly labour. The next two parameters are specifications of the eight growth parameters. The other five are the financial parameters of the Maastricht Treaty and of the fiscal compact that, together with inflation, show a considerable influence on monetary policy, the rate of exchange and the fiscal policy of the EU and EMU and of the member countries.

We examine the spreads of the 15 convergence parameters of the five major countries in the period 2003–2011 (Data source: Eurostat). The first two years of the euro, 2001 and 2002, were characterized by peculiar perturbations due to the transition to the new monetary system. Then, between 2006 and 2009, a boom and a bust occurred, and the subsequent sovereign debt crisis clearly revealed the lack of conformity of the EMU club members.

## Convergence Path of the Five Main EU Members, 2003 to 2011

We study the club of the five main EMU members: France, Germany, Italy, Spain, and the UK. Each country is defined by the values of the 15 normalized economic parameters listed in Table 1. We then analyze their degree of inhomogeneity or instability, and therefore club viability, by using the values of these parameters from the period 2003–2011.

Divergences are measured by comparing the distances between club members for each parameter versus all club members as a group using a methodology applied by Caputo et al. (1997) to banks and by Caputo (2014) to EU countries. The distances shall be identified through their indicators as Cartesian coordinates and the use

**Table 1** Convergence parameters to assess the EU and EMU as clubs

| | |
|---|---|
| 1. GDP rate of growth | 9. Value added of agriculture/GDP |
| 2. GDP per capita | 10. Value added of industry/GDP |
| 3. Inflation rate | 11. Public expenditure/GDP |
| 4. Unemployment | 12. General government deficit/GDP |
| 5. Labour product per person | 13. Balance of payments |
| 6. Labour product per hour | 14. Balance of payments-current accounts |
| 7. Investments/GDP | 15. Bond yields |
| 8. Gross savings/GDP | |

of the Hamming algorithm (Hamming 1950) as a check of the results of the pattern recognition method.

Our work is based on the following principles:

a) Lack of convergence or lack of homogeneity of club member *i* is measured with a single parameter $U_{i(t)}$ (defined below) with the subscript identifying the *i*-th club member.
b) Larger values of $U_{i(t)}$ indicate large differences between a single club member and the rest of the club. As a consequence, the member is separated from the others.
c) Large values of the spread of $U_{i(t)}$ designate a greater lack of convergence and significant inhomogeneity among club members.
d) Large values of the spreads may be a sign of club instability.
e) Increases in *b*, *c*, and *d* imply increased lack of convergence (inhomogeneity) and club instability.

The definition and measurement of $U_{i(t)}$ are in relation to the 15 parameters presented in Table 1. In geometric terms, $U_{i(t)}$ is the sum of the geometric distances of the *i*-th member from the others. $U_{i(t)}$ is the measure of the club itself and is the sum of the distances between all the club members.[4] We then conclude that two values are needed in order to define the homogeneity of a club: the measure $U_{i(t)}$ and the spread of $U_{i(t)}$, or the average of the $U_i$ and the spread. The value of $U_{i(t)}$ may indicate if the club is becoming less or more homogeneous, that is, converging to a unique state when all the parameters are theoretically equal. Obviously, the distances obtained are only abstract tools and, so far, we compare the different economies understanding that larger values of $U_{(t)}$ imply relevant differences in the economies.

## Measure of Inhomogeneity

In spite of the short time interval of data available on the economies of the EMU, we try to study the inhomogeneity and instability of the EMU five main countries (France, Germany, Italy, Spain, and the UK) by comparing their algebraic distance. This tests the effect of the 2007–2008 crisis and the following consolidation policies.

Table 2 depicts the heavy influence on the gross domestic product (GDP) growth of the five countries. Let $m$ be the number of economies in the club and $n$ the number of parameters. In our case then $m=5$ and $n=15$. The spread (standard deviation) of the distances is obtained by normalising each parameter $p_j$ to the yearly maximum value of its norm, acquiring a new set of normalised

[4] The simple method used here has some similarity with the Hamming method (Hamming 1950). It allows results of different type, such as the quantified definition of the inhomogeneity of the clubs and of their internal and comparative spreads, very useful from the point of view of economy and finance. The Hamming method would need manipulations to give the required results perhaps of inadequate quality for the limited number of entities used. The pattern recognition method, already successfully used for the study of the evolutions of banks (Caputo et al. 1997), would basically need the analysis of two club members and, with some manipulation of the procedure, it could give appreciable results (Caputo 2014a).

**Table 2** GDP growth in real terms during 2000–2013 for the five main EU countries

| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 3.7 | 1.8 | 0.9 | 0.9 | 2.5 | 1.8 | 2.5 | 2.3 | −0.1 | −3.1 | 1.7 | 2.0 | 0.0 | −0.1 |
| Germany | 3.1 | 1.5 | 0.0 | −0,4 | 1.2 | 0.7 | 3.7 | 3.3 | 1.1 | −5.1 | 4.2 | 3.0 | 0.7 | 0.4 |
| Italy | 3.7 | 1.8 | 0.5 | 0.0 | 1.7 | 0.9 | 2.2 | 1.7 | −1.2 | −5.5 | 1.7 | 0.4 | −1.4 | −1.3 |
| Spain | 5.0 | 3.7 | 2.7 | 3.1 | 3.3 | 3.6 | 4.1 | 3.5 | 0.9 | −3.7 | −0.3 | 0.4 | −1.4 | −1.5 |
| U.K. | 4.2 | 2.9 | 2.4 | 3.8 | 2.9 | 2.8 | 2.6 | 3.6 | −1.0 | −4.0 | 1.8 | 1.0 | 0.3 | 0.5 |
| Unweighted Average | 3.9 | 2.34 | 1.3 | 1.48 | 2.32 | 1.96 | 3.02 | 2.88 | −0.0 | −4.3 | 1.8 | 1.3 | −0.36 | −0.40 |

Source: Eurostat

parameters $q_j$. The set $x_{ik,j}$ of the difference couples of the normalised parameters $[q_j;\ p_j]$ is then substituted with

$$q_j = p_j / |p_{j\max}| \tag{3}$$

where $|q_j| \leq 1$ defines a new Cartesian space. We first assume the case when all parameters $p_j$ have positive values and examine the differences

$$x_{ik,j} = q_{ij} - q_{kj} \tag{4}$$

with $|x_{ik,j}| \leq 1$ as components of an abstract distance between the economy identified by $k$ and that identified by $i$ relative to the parameter $j$ in the Cartesian space of the parameters $q_j$. From definition (3), it follows that

$$\sum_{j=1}^{n} \left[ \left( p_{ij} - p_{kj} \right) / p_{j\max} \right]^2 < n \tag{5}$$

or

$$D_{ik} = [\sum_{j=1}^{n} \left[ \left( q_{ij} - q_{kj} \right) \right]^2 ]^{0.5} / \sqrt{n} < 1 \tag{6}$$

where $D_{ik}$ is the abstract distance of the economies $i$ and $k$ in the Cartesian space defined by the parameter $q_j$. The normalizing factor of $D_{ij}$ is obtained first by considering the case when all parameters assume non-negative values and $m$ is even. If the values of the parameters of a given subset of $u<m$ of the $m$ economies of the set are unity and all the others are zero, then the sum of all the $m(m\text{-}1)/2$ distances is $n^{0,5}u(m\text{-}u)$, whose maximum is obtained when $u=m/2$, which gives the distance $m^2\ n^{0,5}\ /4$. If one or more than one of the zero value parameters were to assume a positive value, the sum of the distances would decrease. The same applies to values smaller than 1. The case when $m$ is odd is obtained with the same procedure. When all parameters assume non-negative values, the sum of the distances $D_{ik}$ is smaller than

$$\begin{array}{ll} n^{0.5} m^2/4 & \text{when } m \text{ is even or} \\ n^{0.5} \left( m^2 - 1 \right) / 4 & \text{when } m \text{ is odd} \end{array} \tag{7}$$

which we assume, for simplicity, is the normalizing factor of the distances.

Finally, taking into account the possible presence of $r$ parameters, which may assume negative values and that the corresponding values, of $x_{ik,j}$ are subject to the limit $|x_{ik,j}| \leq 2$, formulae (7) are approximated with

$$\begin{array}{ll} U = D_{ik} / \left[ (n+3r)^{0.5} m^2 / 4 \right] & \text{when } m \text{ is even or} \\ U = D_{ik} / \left[ (n+3r)^{0.5} \left( m^2 - 1 \right) / 4 \right] & \text{when } m \text{ is odd.} \end{array} \tag{8}$$

We will consider, as a function of time, the values $U_{(t)}$ of the sum of all the distances between the $n(n-1)/2$ members of the club, the values $U_{i(t)}$ of the sum of the distances of the *i*-th member of the club to the other members as well as the standard deviation of the values $U_{i(t)}$. While the latter gives a quantitative estimate of the difference or inhomogeneity between the club members, the former gives an estimate on how big this inhomogeneity is. The set homogeneity is inversely proportional to the value of $U_{(t)}$ and of $U_{i(t)}$.[5]

## Trends of Club Convergence and Country Correlations

### Homogeneity and Stability of the Clubs of France, Germany, Italy, Spain, and the UK

Figure 1 represents the values of $\mathrm{U}_{\mathrm{i(t)}}$ for each country, and it shows which club member contributed most to the convergence or the inhomogeneity, as well as the time evolution of convergence. We note that that the maximum of $\mathrm{U}_{\mathrm{i(t)}}$ occurs in the years 2007 and 2008, after a rapid increase from the preceding value, implying a rapid increase in divergence (i.e. inhomogeneity) and instability. The increase is significant for both the amplitude and the rate. As for stability, we note the large rapid and varying oscillations of $U_i$, and also the significant sharp increase in $U_i$ before 2008, one year before the economic crisis. We first note the remarkable instability of single members in the period 2006–2011, contemporaneous with a large spread of their homogeneity.

The distances for the UK, which were among the highest until 2005, decreased during the crisis and dramatically increased during the boom. After the crisis, there was a dramatic reduction that preceded the increase. The UK recorded the largest values of $\mathrm{U}_{\mathrm{i(t)}}$ in 2007 and of the rate of change of $\mathrm{U}_{\mathrm{i(t)}}$ in the subsequent years 2006–2007, which was significant both for divergence (inhomogeneity) and instability. Lack of coordination clearly emerged between the two monetary areas of the euro and the pound inside the EU.

Another country that showed divergence particularly affected by the boom and the next depression is Germany, with two peaks instead of one, signalling a lack of coordination inside the Eurozone. Spain and France recorded their maximum divergence (inhomogeneity) and instability in the same year as the UK, while Italy and Germany recorded their maximum in 2008.

Before the crisis, convergence was greater inside the Eurozone than in the UK. After the crisis, the situation changed, with Germany diverging from other countries more than from the UK. The management of crisis has only temporarily reduced the divergence, which does reappear with an upward trend. From Fig. 1a, one may also deduce the increase of the spreads.

The inhomogeneity of the club in the period 2007–2010, obviously, mimics that shown in the Fig. 1. The slope of $U$ in the nine years would be 0.007 compared

[5] Notice that this worrying phenomenon in the results clears when the inhomogeneity and instability trends and the rate of growth in GDP for the five countries, with regard to the sum of the 15 parameters, are normalized to the same scale. Without this normalization, the phenomenon would remain concealed.

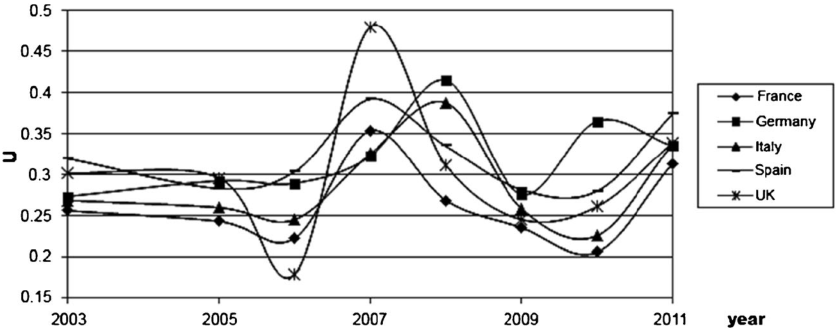


**Fig. 1** The $U_i$ of the club members 2003–2011

with the standard deviation of 0.064, which is 10 times larger. Convergence can also be reached in stagnation.

In Fig. 2, during the period of the boom, the standard deviations (i.e. the spreads between the behaviours of the five countries) reached a peak in 2007, the year of the peak of the boom. After 2007, there was a downward trend for the spread and a new peak was achieved in 2010. Though inhomogeneity increased, the spread between 2010 and 2011 decreased, which is common behavior for the two groups of positively performing and negatively performing diverging countries.

## Correlation of the Spreads for the Club Members

Table 3 depicts the spreads of the club members. In Table 4 we report the correlation of the values of $U_{i(t)}$ in nine years among the club members. Note that each value of the standard deviation is normalized to the value of $U$ for the club in that year. A large correlation implies that the two economies are experiencing the same evolution. The significant correlation between France and the UK may be explained by the fact that they are geographically close and have intense land and sea connections.

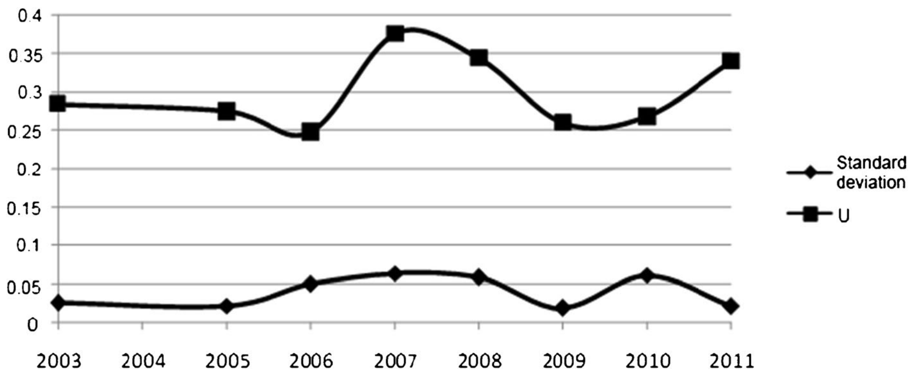


**Fig. 2** Average values of $U_i$ (squares) and of the spread of $U_i$ (diamonds)

**Table 3** Values of $U_{1(t)}$ of the spread for the club members

| | 2003 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| France | 0.2561653 | 0.243044 | 0.222804 | 0.354035 | 0.268724 | 0.235816 | 0.205969 | 0.313553 |
| Germany | 0.2735313 | 0.292635 | 0.289525 | 0.322724 | 0.415102 | 0.275867 | 0.365612 | 0.335239 |
| Italy | 0.268754 | 0.259793 | 0.24539 | 0.325759 | 0.38801 | 0.259031 | 0.225918 | 0.337301 |
| Spain | 0.3196901 | 0.283142 | 0.303655 | 0.392576 | 0.335051 | 0.281837 | 0.279898 | 0.373954 |
| UK | 0.022595 | 0.295745 | 0.179433 | 0.48031 | 0.311582 | 0.245408 | 0.261071 | 0.338833 |
| S.D.(year) | 0.0260958 | 0.022694 | 0.05041 | 0.065184 | 0.058714 | 0.019535 | 0.061919 | 0.021699 |
| Average U | 0.2840801 | 0.274872 | 0.248161 | 0.375081 | 0.343694 | 0.259592 | 0.267694 | 0.339776 |

The significant correlations between Italy and Germany, Italy and Spain, and France and Spain can first be explaned by the fact that they belong to the same monetary area. In addition, France and Spain are geographically close, as are Italy and Germany via Austria. The lack of correlation between France and Germany, together with the large correlation between France and the UK, seems to indicate that participation in the EMU has not (yet) caused a large change with the previous nexus.

## Inhomogeneity, Instability and Lack of Correlation among Parameters

Table 5 shows the correlations between the standard deviation of the values of the yearly $U_{i(t)}$ of the club (all in the range 0.60, 0.39) and the standard deviations of all the parameters of Table 1. The obvious conclusion is that the two considered entities are not correlated (Table 5).

The value of $U_{(t)}$, which measures the lack of convergence (inhomogeneity) of the club members, is given by the sum of the distances of all the club members, whereas the spread (standard deviation), which measures club instability, is given by the differences in the parameters. They may behave differently, even with similar profiles as in Figs. 2 and 3.

**Table 4** Correlation of the values of $U_{i(t)}$ between the members of the club in the nine years

| | |
|---|---|
| Italy-France | 0.49132 |
| Italy-Germany | 0.650011 |
| Italy-Spain | 0.744121 |
| Italy-UK | 0.230873 |
| France-Germany | 0.193899 |
| France-Spain | 0.708769 |
| France-UK | 0.729618 |
| Germany-Spain | 0.669752 |
| Germany-UK | 0.248491 |
| Spain-UK | 0.594851 |

**Table 5** Correlations between yearly spreading of the 15 parameters and of $U_{i(t)}$ values of the club

| Parameter | Correlation |
|---|---|
| 1 | −0.1721 |
| 2 | −0.38672 |
| 3 | −0.59451 |
| 4 | −0.48189 |
| 5 | 0.203012 |
| 6 | −0.12591 |
| 7 | 0.312103 |
| 8 | 0.231282 |
| 9 | −0.08026 |
| 10 | 0.388447 |
| 11 | −0.04815 |
| 12 | 0.195401 |
| 13 | −0.28245 |
| 14 | 0.239851 |
| 15 | −0.14619 |

It is important to notice that the spread diminished continuously until 2006, when it reached a minimum value of 0.4. However, during the boom period, the spread increased, as did $U_{(t)}$, even with a lag. The spread continued to be higher than before the boom, in the first phase of the burst period, in which $U_{(t)}$ was also higher than before the boom. In 2010, when $U_{(t)}$ reached a new minimum, instability also reached a new minimum. However, these minimums were higher than the corresponding minimums before the boom. In a short time, $U_{(t)}$, the spread (i.e. the instability) and inhomogeneity increased again. To sum up, the path to homogeneity and stability that was taking place before the boom was not only halted, but also inverted in the recovery process.

## Parameter Weights

Table 6 depicts the parameters considered important for the convergence and stability of the five main countries of the two clubs. The values of the 15 different parameters range from 0.14 to 0.010. In the nine years these percentages oscillate (i.e. contribute a different weight to the changes in $U_{(t)}$) the oscillations do not alter the level of dispersion. Considering that the 15 parameters are normalized to unity, their average values would be 1/15. As the threshold of the larger effect, we selected (1/15) (1+10 %). For the smaller effect, we selected (1/15) (1–30 %) =0,07333.

Therefore, the most important parameters are those whose effect in the period 2003–2011 was greater than or equal to 0.99 of 0,07333. Those parameters are: GDP growth rate, inflation rate, unemployment, value added (VA) of agriculture on GDP, general government deficit to GDP, balance of payment results on GDP, and current accounts balance of payment results on GDP. We also

**Table 6** Percentage effect of the parameters on $U_{(t)}$

| Parameter | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.143361 | 0.127659 | 0.11196 | 0.075186 | 0.096137 | 0.150048 | 0.082331 | 0.129584 | 0.117776 |
| 2 | 0.017144 | 0.045033 | 0.0729231 | 0.022274 | 0.017313 | 0.014692 | 0.016982 | 0.028052 | 0.029494 |
| 3 | 0.082573 | 0.07114 | 0.0597091 | 0.074713 | 0.062732 | 0.042981 | 0.135162 | 0.082867 | 0.091226 |
| 4 | 0.071635 | 0.069994 | 0.0683541 | 0.070323 | 0.062356 | 0.06927 | 0.090651 | 0.091363 | 0.098913 |
| 5 | 0.016265 | 0.023343 | 0.0304209 | 0.03855 | 0.016415 | 0.027938 | 0.040514 | 0.051991 | 0.010119 |
| 6 | 0.03318 | 0.025322 | 0.0174646 | 0.020109 | 0.035336 | 0.017818 | 0.016296 | 0.016375 | 0.032746 |
| 7 | 0.05344 | 0.052689 | 0.0519386 | 0.065691 | 0.063719 | 0.058989 | 0.050282 | 0.043455 | 0.043686 |
| 8 | 0.040156 | 0.04079 | 0.0414241 | 0.051347 | 0.052215 | 0.054297 | 0.054078 | 0.06 | 0.057068 |
| 9 | 0.108466 | 0.10443 | 0.1003957 | 0.110175 | 0.109915 | 0.109864 | 0.098451 | 0.102611 | 0.102815 |
| 10 | 0.047118 | 0.04923 | 0.0513423 | 0.059115 | 0.065379 | 0.062305 | 0.057924 | 0.061819 | 0.062265 |
| 11 | 0.037171 | 0.03541 | 0.0336491 | 0.038012 | 0.034534 | 0.030897 | 0.023788 | 0.023811 | 0.026358 |
| 12 | 0.119536 | 0.121289 | 0.1230449 | 0.125044 | 0.139279 | 0.139322 | 0.106282 | 0.094754 | 0.121558 |
| 13 | 0.082904 | 0.093066 | 0.1032304 | 0.092985 | 0.090197 | 0.085206 | 0.099072 | 0.060193 | 0.054481 |
| 14 | 0.131481 | 0.115844 | 0.1002093 | 0.117406 | 0.130343 | 0.115621 | 0.093278 | 0.099958 | 0.096189 |
| 15 | 0.015589 | 0.024761 | 0.0339339 | 0.039071 | 0.024128 | 0.020752 | 0.034909 | 0.053167 | 0.055306 |

The values for the year 2004 have been interpolated

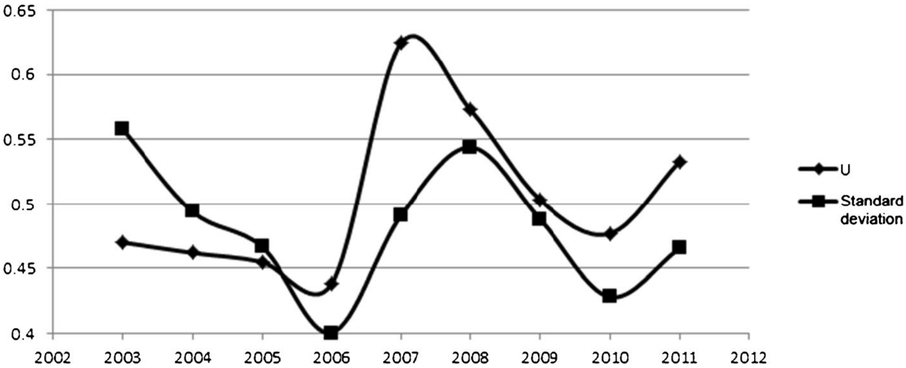


**Fig. 3** Club inhomogeneity $U_{(t)}$ and the sum of the spread of the parameters $U_{i(t)}$ of the club normalized

note that GDP per capita, labour product per person, labour product per hour, public expenditure contributions on GDP and bond yield produced almost negligible contributions.

Table 7 shows the average value of the larger-effect parameters and of the irrelevant parameters, whereas Fig. 3 gives the behaviour of the larger effect parameters in the various years of the considered period. For the larger effect parameters, it is clear that changes in the percentage effects on $U_{(t)}$ are not correlated with each other. For instance, beginning in 2008, parameters 1 (GDP-growth rate) and 3 (inflation rate) spread in different ways.

Only in 2010 did the parameter effects seem to stabilise in a way similar to what occurred for the values of $U$ of the single economies shown in the Fig. 1. However, parameter 12 (general government deficit/GDP) rises to 0.12 and does not converge with the group.

We also note that the largest contribution in percentage terms and rate is from the GDP rate of growth in 2006–2008 and inflation in the 2008–2009 period. The global and current balance of payments make the most important contribution in the 2007–2009 boom and bust and in the first recovery period. A differential of inflation (deriving from the rigidity of domestic supply) as signalled by parameter 3, may increase domestic production costs, thus decreasing exports and increasing imports with a negative effect on global and current balance of payments (parameter 13 and 14) and on the GDP growth rate

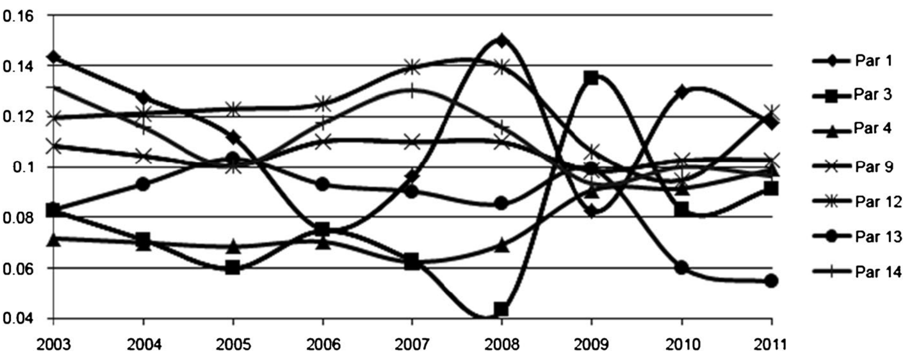


**Fig. 4** Parameters with average percentage value effects on the $U_{(t)}$ of the club greater than or equal to 0.075

**Table 7** Parameters and effect sizes

| | |
|---|---|
| a) Parameters with larger effects (average of the parameter effect/total effect) | |
| 1. GDP rate of growth | 0,115 |
| 3. Inflation rate | 0.079 |
| 4. Unemployment | 0.077 |
| 9. Value added of agriculture/GDP | 0.106 |
| 12. General government deficit/GDP | 0.121 |
| 13. Balance of payments | 0.085 |
| 14. Balance of payments on current | 0.111 |
| b) Parameters with irrelevant effects (average of parameter effect/total effect) | |
| 5. Labour product per person | 0.028 |
| 6. Labour product per hour | 0.023 |
| 11. Public expenditure/GDP | 0.031 |
| 15. Bond yield | 0.034 |

(parameter 1). A low or negative GDP growth rate could have a negative effect on government revenues, while it may foster public expenditure growth because of the increased request by the private economies for interventions by the public economy. Thus, the general government deficit (parameter 12) may increase.

It is also worth noting that per capita GDP does not appear among the parameters with effect to the dynamic of $U_{(t)}$ in spite of the importance of the GDP rate of growth. Yet under a nearly invariant population, GDP per capita is strictly correlated with GDP growth rate. The explanation for the apparent contradiction lies in varying populations in the five countries, which results from fluctuation in the population of emigrants.

## Inhomogeneity, Instability and GDP Rate of Growth

As GDP growth appears to be the leading parameter, let us now consider, in Fig. 5, the trend of $U_{(t)}$ and the spreads (standard deviations of the sum of all parameters) in comparison with the trend of GDP growth for the five EU countries. We observe that convergence occurred during the period of moderate growth in the first half of the first decade of the 21st century, and that the trend toward divergence and instability reappeared in the deflationary period from 2011 on. The downward fluctuation of GDP growth in 2009 to a negative level coincided with the inhomogeneity reduction and with minimization of instability. To put it differently, more homogeneity and stability in 1999 were obtained by the deflation of GDP below zero. However, this outcome does not mean that the inhomogeneity and instability have been taken care of structurally. Indeed, as soon as a modest growth rate was regained in 2010, both inhomogeneity and instability reappeared. The next deflation permitted a reduction in the spreads, but inhomogeneity increased.[6]

[6] At first, it is less clear why distances and spreads in the value added of agriculture on GDP should matter. However, this spread is clearly a proxy for the different social structure of the northern and southern countries, with Germany and the UK on one side, Spain and Italy on the other, and France in between but more close to the southern countries as one can see from Table 8.

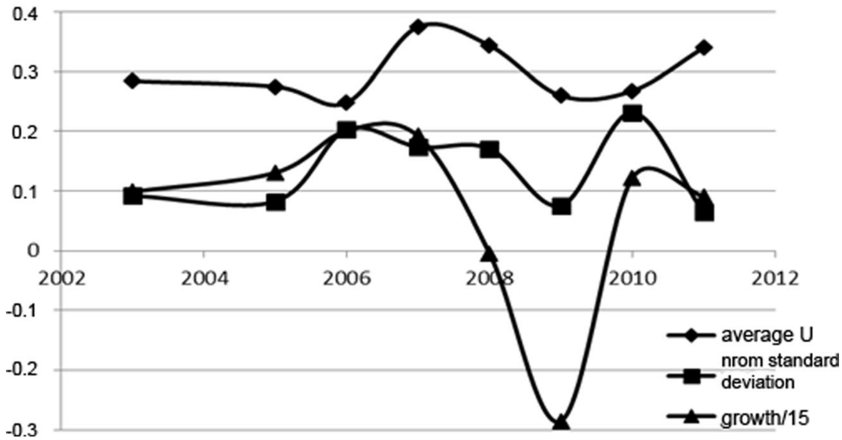


**Fig. 5** Trend of inhomogeneity, instability and the GDP growth rate for the five countries reduced to 1/15

## Concluding Remarks

One limitation of our study is that a different set of parameters may produce different results. Though this is true, the parameters that we adopted are those of the growth models, the Maastricht Treaty and the fiscal compact given by the EU and EMU rules. By taking seriously our measures of $U_{(t)}$ and of $U_{i(t)}$, what emerges from our research is that a different EU and EMU policy is needed in order to satisfy the EU and EMU club rules and to ensure convergence to homogeneity and stability. Until now, the EU system of rules establishes an explicit trade-off between the reforms needed in the poorer-performing countries and the constraint alleviation on reduction of budgetary deficits.

A similar tradeoff has been promoted by the Bundesbank, as the most influential member of the ECB, between a cautious expansionary monetary policy and the reduction of budgetary deficits with realization of reforms by the less well performing countries. The two tradeoffs, however, originated in a sort of chicken game between the EU and ECB authorities and the less well performing countries. This delayed the reforms, budgetary consolidations, and resumption of growth, creating a deflationary scenario in which both the reforms and consolidation became increasingly difficult.

To ensure stability and growth of the two clubs, the adoption of the reforms should be enforced by binding rules and commands and should allow autonomous actions by the

**Table 8** Value added of agriculture/GDP in five EU major countries, 2003–2013

| Country | 2003 | 2007 | 2010 | 2011 | 2013 |
|---|---|---|---|---|---|
| France | 2.5 | 2.1 | 1.8* | 1.8 | 1.8 |
| Germany | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 |
| Italy | 2.5 | 2.0 | 1.9 | 2.0 | 2.1 |
| Spain | 4.0 | 2.9 | 2.7 | 2.5 | 2.6 |
| U.K. | 1.0 | 0.7 | 0.7 | 0.7 | 0.7 |

Central Bank in pursuance of its mandate of monetary stability. Additional European common actions are needed to complete the unique market. The shift from the club model to the almost federation model would face the same issues in a less free situation.

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