# Economic Convergence in the EU and in the Eurozone

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## Abstract

The "Economic and Monetary Union" in the EU has been defined as "incomplete" because, while the euro has been with us for almost two decades (since 1999), a genuine economic union has not yet been realized. The initial hopes were that euro's adoption could favour the real economic convergence and homogenization of the Eurozone member. Unfortunately, many dissimilarities persisted in the new century (and with the new economic regime) and were aggravated by the economic crises of the last decade.

The aim of this paper is to ascertain whether real economic convergence was achieved by the EU countries. We are especially interested in differentiating the group of Eurozone (EZ) countries from the EU as a whole (or from the non-EZ countries), in order to detect not only the different sign – convergence versus divergence – but also the speed of convergence (or divergence). For this purpose, we follow a conditional convergence approach based on per-capita income data, for the period 1995-2016. A descriptive analysis is particularly useful to differentiate within the EZ countries.

Considering the unsatisfactory results of the European monetary union in terms of real convergence achievements, and especially the features of the double Eurozone crisis in the last decade, the final section of the paper includes some proposals for policy and institutional changes at the EU and Eurozone levels.

## 1. Introduction

In 2017, two occurrences were of interest for the European Union (EU): the 60$^{th}$ Anniversary of the signature of the Treaty of Rome and the 25$^{th}$ Anniversary of the adoption of the Maastricht Treaty. Now it is almost twenty years that the monetary union (commenced in 1999) is with us. The double crisis in Europe – the 2008-09 financial crisis (with the Great Recession) and the sovereign debt crisis – followed by a weak recovery, especially in the Southern European countries, have questioned the

viability of the European Monetary Union (EMU). But even before the crisis many imbalances existed in the euro area, for example concerning the different competitiveness, current accounts of the balance of payments, levels of public and private debts, etc.

The aim of this paper is to ascertain whether real economic convergence in per capita income was achieved in the EU in the last two decades, both in the whole EU-28 group of countries and in particular within the smaller group of Eurozone (EZ). The econometric literature on economic convergence is well-known (e.g., Barro and Sala-i-Martin). Differently from the simplest absolute convergence (on per capita income) approach, we refer to the concept of "conditional" or "club" convergence (Islam, 2003), by considering either structural or institutional factors that are particularly heterogeneous across EU countries. Then, we also follow a unit root and cointegration VAR approach (extending the univariate approach, frequently found in the literature, e.g. Bernard and Durlauf, 1996) to investigate per capita income convergence across EU countries; in fact, a recent paper by Yurucu and Mehmet (2014) uses a Multivariate Augmented Dickey-Fuller approach to estimate convergence of a number of macroeconomic variables.

We use Eurostat data for the period 1995-2016. We are interested not only in the sign of the convergence coefficient (the so-called beta coefficient), but also the speed of convergence (or divergence). A preliminary descriptive analysis is useful to disentangle detailed feature of the convergence process, by distinguishing between different sub-periods and also different groups of countries within the euro area.

The structure of the paper is as follows. In Section 2 we review the key theories regarding convergence in monetary unions and the empirical studies devoted to the European case. Section 3 presents our descriptive analysis of convergence in the EU. Our econometric investigations are presented and discussed in Section 4. Section 5 concludes also by considering the most relevant policy implications.

## 2. Economic convergence in the EU: economic theories and empirical studies

As well known, the common currency was adopted in a group of rather heterogeneous countries, despite the absence of the requisites that leading economic theories – such as the OCA (Optimum Currency Area) theories[1] – suggested for a viable monetary union. Only nominal convergence criteria (concerning inflation, interest rates, public deficit, public debt, exchange rates) were considered for admission to the "euro club". However, although primarily political, the decision to start the monetary union was based on economic grounds.[2] The assumption was that a common currency would reinforce the benefits of the Single Market[3], thus expanding international trade, production, investment, economic growth. The achievement of similar performances of real variables, the catching-up of backward countries and regions, and real convergence were considered a likely outcome.

In particular, according to the hypothesis of "endogeneity of OCA criteria" (Frankel and Rose, 1998; Rose, 2000), the conditions for an optimal currency area can be satisfied ex-post, if they are not ex-ante, once the monetary union has started. So the participating countries would become increasingly similar. Similarity of productive structures would be assured by international trade, that would be of the "intra-industry type". Contrary to the optimistic view, Krugman's initial position (1993) was that the monetary union would lead to increasing specialisation, diverging economic structures, asymmetric developments, and widening differences in growth rates.

The need of "similar conditions", in order to contrast asymmetric shocks, goes beyond output specialisation. It should include similarity in fiscal and institutional systems. But, without a real "economic union", despite what was written in the Maastricht Treaty, this homogenization did not materialize. Moreover, at the occurrence of economic shocks, market adjustment mechanism – price and wage flexibility, labour mobility – did not work properly. In addition to this, the non-existence of a

[1] See the seminal works by Mundell (1961), McKinnon (1963), Kenen (1969).

[2] Thygesen (2016) argues that there was both a strong economic justification for moving towards a single currency and a rare political opportunity to begin the process around 1990.

[3] Also thanks to macroeconomic stability (price stability and fiscal discipline), removal of the exchange-rate risk, reduction of uncertainty (concerning inflation and interest rates), increased competition, integration of markets, liberalisation of capital flows. See, for an initial account, European Commission (1990).

common budget makes impossible a supranational fiscal accommodation of the shock.[4] Even more worrying, also the national budgets cannot be used in a complete discretionary way, because of the rules of the Stability and Growth Pact (recently reinforced by the Fiscal Compact).

The absence, so far, of a real economic union bears two consequences, concerning the short-medium run and the long run, respectively. In the short-medium run, business cycles can be different because of the appearance of asymmetric shocks and the lack of appropriate adjustment mechanisms. In empirical studies, the "similarity" of different economies has been empirically assessed with different methods. For example, the degree of synchronisation of business cycles between countries has been estimated by computation the correlation coefficients of output or GDP.[5]

As to the prevailing results, we must distinguish between the recent years, deeply affected by the double crisis, and the pre-crisis period. In fact, until 2007-08 synchronicity of business cycles increased, not only in the European "core" (the countries of Central Europe embracing Germany and the surrounding countries), but also in a wider area including some "peripheral" countries of Southern and Eastern Europe, including many New Members States (NMS). Therefore, in that period the concept of a "core" of European countries – more integrated than the "periphery" – was inappropriate, although some macroeconomic imbalances were already mounting, including: different sectorial specialisations (Buti and Turrini, 2015); imbalances in competitiveness[6] and current accounts deficits (Berger and Nitsch, 2010); growing intra-Eurozone private flows of capital, thanks to the financial

[4] In fact, while in the US the Federal budget represents about 25% of GDP and the State ones about 10%, in the EU the corresponding figures are about 1% and 50% (moreover the Eurozone has not a specific budget). According to De Grauwe (2013), the lacking fiscal capacity is the major "design failure" of EMU.

[5] The degree of symmetry of shocks has also been evaluated in terms of per capita income, productivity, labour market indicators, trade links, etc. See, among others, Marelli and Signorelli (2010, 2016b).

[6] In the decade since 1999, the real exchange rate based on unit labour costs depreciated by about 10% in Germany and appreciated by 10-15% in Italy and Spain. However, after the crises, the "internal devaluations" (i.e. compression of wages) reduced the competitiveness gap in some peripheral countries (Spain, Portugal and Greece). As a matter of fact, in the recent period (2015-16) deflation was more widespread in many countries of EU's periphery.

integration process and the calm financial environment (Beker and Moro, 2016; Hale and Obstfeld, 2014).

Moreover, EMU has shown to be fragile after large economic shocks, such as the 2007-08 financial crisis, the 2009 Great Recession and the subsequent Eurozone's debt crisis. In the latter case, the absence of appropriate crisis management instruments and risk-sharing mechanisms (like the Eurobonds) has caused a double recession and weak recovery. In particular, the austerity measures, have caused a prolonged recession, stagnation and persistent unemployment, especially worrying in the peripheral countries and that has reached unacceptable levels among young people (see Marelli and Signorelli, 2017).

If we now turn to long run issues, we notice that real economic convergence is not guaranteed neither in the EU nor in the Eurozone, because of the lack of adequate fiscal policies, transfers to help lagging regions and countries, incentives to introduce structural reforms. EU's structural funds (such as the Cohesion Fund and the European Regional Development Fund) are not really effective, because of the limited resources. Valuable long run plans, such as the old Lisbon Agenda and the current Europe 2020 strategy, failed – in many fields – for the same reason.[7]

Many empirical investigations have been devoted to economic convergence in the EU and, more specifically, the euro area. Some studies focused on developments in the EMU using OCA's and related theories. Pasimeni (2014) focused on factors mobility (capital and labour); price and wage flexibility; similarity of business cycles; common fiscal capacity (as a mechanism of shock absorption and risk-sharing). Some other studies followed the main strand of literature concerning economic convergence in the long run. A "sigma convergence" approach investigates the evolution over time of some dispersion measures of the GDP per capita, while the "beta convergence" focuses on changes

[7] For an updated account of the performance of the EU as a whole and individual countries regarding various indicators of the Europe 2020 plan, see Eurostat (2016).

over time compared to the initial level of per capita income (or other macrovariables)[8], of different countries (Barro and Sala-I-Martin, 1995). In the "absolute" beta-convergence such initial level is the unique explanatory variable, while in the "conditional" approach there are some control variables.

Marelli and Signorelli (2017)[9], following an absolute beta-convergence approach, detected a convergence for the EU-28 area, statistically significant, in the period 1999-2014; the key explanation of such convergence was related to the catching-up by the NMS. On the other hand, for the initial group of 11 Eurozone countries (EZ1) an overall lack of convergence was prevailing, while a limited convergence was found for the enlarged euro area (19 countries) only in the recent sub-period (2009-17). Similar results were found following an "extended" beta-convergence approach, that assumes that each country may converge toward its own steady-state.[10] Also Tamayo et al. (2014) found limited evidence of absolute convergence, although conditional convergence turned out to be more robust.

In order to investigate the similarity in business cycle evolutions, Marelli and Signorelli (2017) also computed the correlation coefficients of quarterly GDP growth at constant prices with the European averages (EU and EZ); so, the highest coefficients were found in the EZ1 group, i.e. the original countries adopting the euro since 1999. Notice that Gonçalves et al. (2009) had previously found that business cycles correlation increased more among Eurozone members after the implementation of the euro (than among other OECD economies). Also De Grauwe and Ji (2016) found that businesses cycles are relatively well synchronized; the differences are rather in the amplitude of the cycles, i.e. recessions occur at about the same time but in some countries are mild and in others very intense. However, the puzzle in Marelli and Signorelli (2017) results is that correlation

[8] Marelli and Signorelli (2015) investigated, in a beta convergence approach, in addition to GDP per capita, other real variables (e.g. unemployment) and also nominal variables (interest expenditure, deficit/GDP, debt/GDP, etc.).

[9] See in particular Chapter 2 of the book; see also Marelli and Signorelli (2016a).

[10] In this approach, the lack of time-specific fixed effects can be justified, without jeopardising the stationarity of the random disturbances (see Canova and Marcet, 1995).

coefficients turned out to be higher in the "non-euro EU members"[11], than in the eight countries that joined euro since 2007 (the EZ2 group).[12]

In conclusion, previous investigations on long-run convergence in the EU do not allow a clear distinction between the Eurozone and other members of the EU; in other words, the adoption of the euro did not clearly favour real convergence trends. It is possible that new and more sophisticated methods might lead to different results (as we shall show in Section 4). For example, Monfort et al. (2013), by analysing beta convergence in terms of productivity, detected in the EU's two convergence clubs, but also in this case unrelated to the fact that some countries belong to the euro area. In any case, the lack of "real convergence" in per capita incomes in the Eurozone seems consistent with the prevailing "structural divergence" detected by other authors (Buti and Turrini, 2015). Furthermore, the occurrence of large economic shocks – such as those appeared with the economic crises – and the lack of adequate adjustment mechanisms dramatically increased the socio-economic divergences within the EMU (Pasimeni, 2014).

## 3. A descriptive analysis of economic convergence in the EU and the Eurozone

Before presenting and discussing the econometric results on long run economic convergence in the EU and the Eurozone, we offer an introductory analysis useful to understand the general trends in the areas of interest. Different from the econometric investigations, this analysis allows a more detailed study of different sub-periods and more specific groups of countries (and individual countries as well).

[11] It is also worth to be noticed that correlations in this group of countries have increased in the most recent period, becoming similar to those of the Eurozone countries; this is also true for many NMS (with the exception of Poland).

[12] Marelli and Signorelli (2017) also estimated the sensitivity of the business cycle of individual countries with respect to the average European cycle and once again it turned out that the similarity of business cycle has increased everywhere, independently from belonging to the euro area or not. Finally, by computing intra-EU trade (exports by EU members to other EU members) over GDP, it turned out that the crises halted the trade integration process within the Eurozone, but they reinforced trade integration in some non-euro EU members.

First of all, we present a simple sigma-convergence analysis of real per capita incomes[13] for the period 1992-2016. The initial year coincides with the signature of the Maastricht Treaty and the start of the process leading to the monetary union. The chosen dispersion measure is the coefficient of variation. The results are shown in Figure 1. For all 28 countries[14], now members of the EU, we can observe an increasing dispersion in the '90s, partly caused by the "transitional recession" of the NMS; on the contrary, the catching-up of these countries in the new century explains the overall decreasing dispersion.

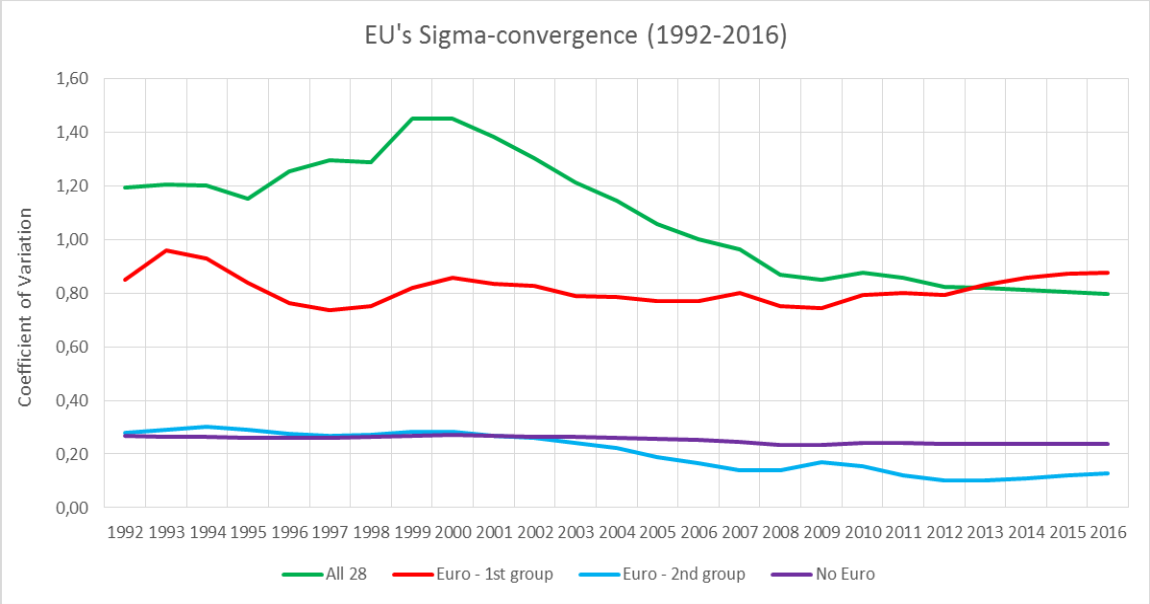
In the first Eurozone's group (the 11 members joining in 1999 the euro area, here named EZ1 group), we notice a decreasing dispersion[15] in the '90s, in this case driven by the fast growth of some peripheral countries (Ireland, Spain) and the slower growth of some initially reach countries (France, Germany). After a rather stable situation in the first decade of the new century, the dispersion increased in the crisis period, because the negative shocks affected chiefly the peripheral (and low-income) countries.

**Figure 1**

[13] Domestic product per capita in 2015 US dollars (source: the Conference board). We have used these data because the data in euro (from Eurostat) had missing values for the long time series in some countries.

[14] It is not appropriate to name this group as EU-28, since in 1992 there were 12 members in the EU, progressively augmented (after the 1995, 2004, 2007, 2013 enlargements) to 28 members. Of course, in this period the United Kingdom was full member of the EU.

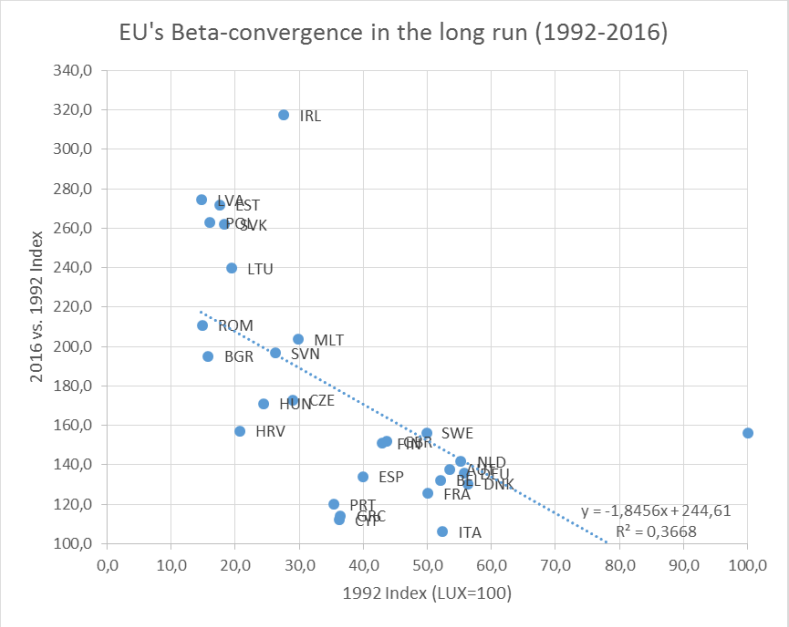
[15] The level of the dispersion coefficient is not important, since it tends to decrease with the number of countries in the group.




Finally, in the no-euro group the coefficients of variation has been pretty stable in the 25 years period, while in the EZ2 (the second group of countries joining the euro from 2007 to 2015, in addition to Greece in 2001), the decreasing dispersion in the last decade is mainly explained by the fast growth of the NMS that recently joined the euro club.

Now we provide a visual representation of the beta-convergence approach. In Figure 2, the x-axis measures the initial (1992) level of per capita income, expressed as index number (the richest country, i.e. Luxembourg, equal to 100); the x-axis shows the index numbers of the growth of per capita income (1992=100) over the full period, 1992-2016.

**Figure 2**




An inverse relationship is rather clear, confirming convergence. In the graph, some points are more distant from the regression line: in particular, Italy[16] and some other countries of Southern Europe, with initial middle income and subsequent slow growth; Ireland and some NMS (especially the Baltic states), with initial low income and very fast growth, a pattern that in any case drives the overall convergence.

**Figure 3**

[16] Notice that per capita income increased in the 24-years period by only 6% in Italy (the worst performance of all countries) compared to almost 220% in Ireland (purposely named the "Celtic tiger").

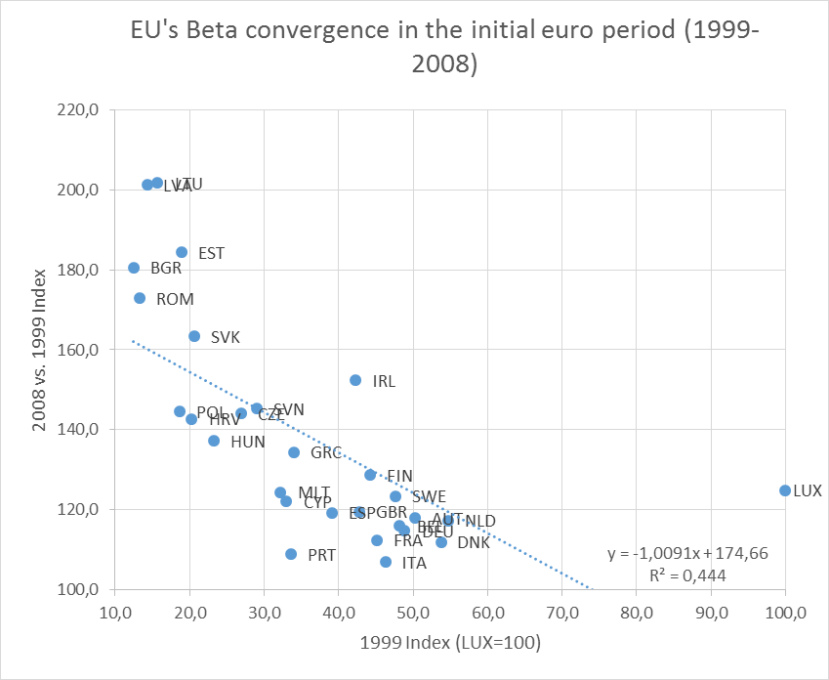
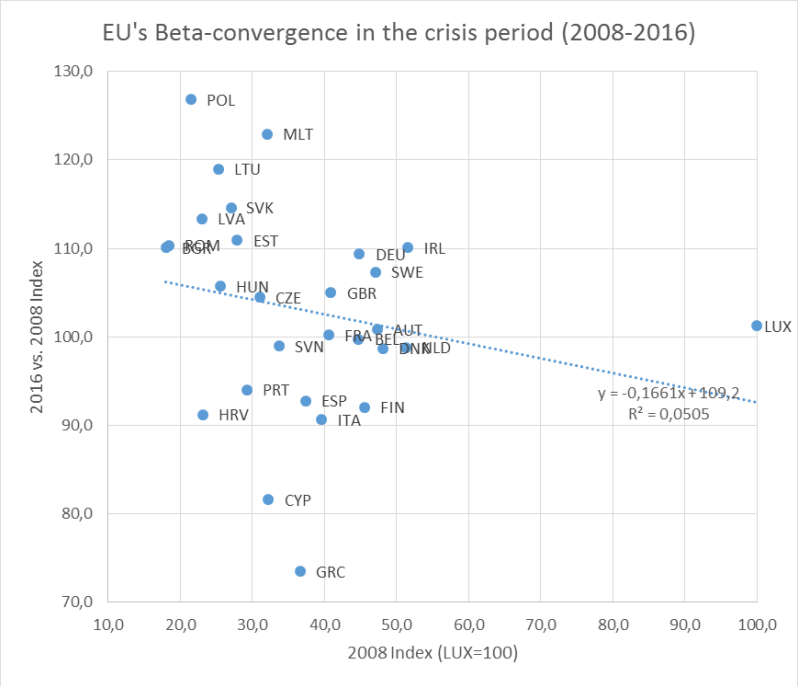



**Figure 4**

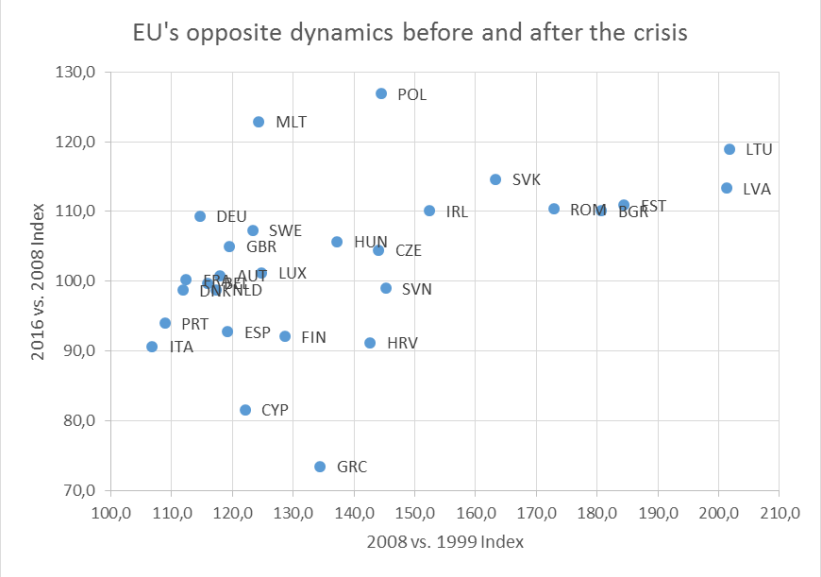



Now, leaving out the first six years preceding the start of EMU, Figures 3 and 4 exhibit a similar beta-convergence for the initial euro period (1999-2008) and for the crisis period (2009-2016), respectively. While the pattern in the initial euro period (Figure 3) is similar to what found for the full period, in the most recent period (Figure 4) convergence appears less intense and significant. This is especially caused by the slow growth of some middle-income or low-income countries, hurt by the sovereign debt crisis. In particular, there has been an absolute reduction in per capita income in the

following countries (in decreasing order of income loss): Greece, Cyprus, Italy, Croatia, Finland, Spain, Portugal (while some other three or four countries almost returned to pre-crisis levels).

The need to distinguish between the two sub-periods is clear from the Figure 5, that shows on the two axels total per capita income growth in the second sub-period versus the corresponding growth in the initial sub-period. While in 1999-2008 such growth ranged from 7% (Italy) to over 100% (Latvia and Lithuania), in 2009-2016 it varied from -27% (Greece) to +27% (Poland).

**Figure 5**




In the first sub-period the fastest growth was shown, in general, by non euro countries (including the countries that joined later the euro club) and the slowest dynamics by the euro countries: all of them, with the exception of Ireland, are below the median growth rate.[17] In the second (crisis) sub-period, a dividing line crosses the Eurozone itself, because the lowest rates of growth (actually negative growth) were shown by the peripheral countries[18], while other euro countries recorded a good performance (particularly the NMS recently adopting the euro).

[17] Detailed tables are available resources request.

[18] In particular, the "Pigs" (Portugal, Italy, Greece, Spain), hurt by the sovereign debt crisis, with the addition of Cyprus and Finland; on the contrary, Ireland – initially assimilated to the Pigs after the burst of the crisis – reached the first ten positions, as for the growth in this sub-period, thanks to the strong recovery after 2012.

## 4. An econometric investigation of economic convergence in the EU and the Eurozone

### *4.1. Methodology*

We specify a benchmark dynamic univariate model for estimating "conditional" convergence of real per capita GDP, for different groups of European countries (following the spirit of Barro & Sala-i-Martin, 2004, and Mankiw, et al., 1992, adapting it to panel data). Let $y_{i,t}$ indicate real per capita GDP for country $i = 1,\ldots N_g$ at time $t = 0,\ldots T_i$. $N_g$ is the number of countries belonging to group $g$. The length of time series $T_i$ differs for countries, according to the initial year of observation, t=0, which is 1995 for most countries except for Bulgaria, Croatia, Malta and Ireland, whose initial year of GDP observation starts a bit later on. The benchmark model for panel data is in equation (1).

$$(1)\quad \Delta lny_{i,t} = \alpha_0 + \alpha_1 lny_{i,0} + \sum_{l=1}^{L} \delta_l \Delta lny_{i,t-l} + \sum_{k=1}^{K} \gamma_k x_{i,k} + \omega_i + \varepsilon_{i,t}$$

The dependent variable in eq.(1) is the annual growth rate of real per capita GDP for each country. Among the regressors we have the initial level of the real per capita GDP (in logs), lags of the dependent variable (test for optimal length L indicates that two lags are sufficient), a set of explanatory variables which characterize the heterogeneity of each country. This set includes openness to trade – measured by the ratio of imports and exports volumes to GDP - technological progress/innovation activity – measured by Research and Development expenditures as a percentage of GDP. Investments intensity of Physical Capital, the share of population with Secondary and/or Tertiary degree as a measure of human capital, and the net migration rate of each country/year are also conditional variables.

We use the Random-effects estimator (RE) to derive $\hat{\alpha}_1$, the parameter of interest in eq.(1). The Hausman specification test cannot reject our preference of RE versus Fixed-effects within-group estimator. Moreover, estimated residuals are tested for normality with no significant autocorrelation for each panel. Finally, the issue of potential endogeneity of some explanatory variables will be tackled in subsequent steps. In model (1) current error terms are not correlated to initial condition $lny_{i,0}$.

In cross-sectional studies, the usual specification to test for (conditional) β-convergence is

$$(2)\ \frac{1}{T} ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha_0 + \alpha_1 lny_{i,0} + \sum_{k=1}^{K} \gamma_k x_{i,k} + \varepsilon_{i,T}$$

The dependent variable in the latter equation is the average annual growth rate of real per capita GDP between initial year t=0 and final year of observation T=2016. It is possible to demonstrate (see for example Batog & Batog, 2015) that the coefficient $\alpha_1 = -(1 - e^{-\beta T})$, and that $\beta$ is our parameter of interest capturing (conditional, long-run) speed of convergence across countries (in percentage points per year). We need to assume that per capita GDP differentials across countries diminishes at rate $e^{-\beta T}$. From this assumption, the rate of conditional convergence is derived using the formula

$$(3)\ \beta = -\frac{1}{T} ln(1 + \alpha_1)$$

where T = length of time series (20 years in our case). If $\alpha_1 < 0$ per capita GDP of countries converges over time (since the initial year), at speed $\beta$. If $\alpha_1 > 0$ countries' GDP diverges.[19]

It is also possible to calculate the "half-life" of convergence $T_{1/2}$ i.e. number of years at which the convergence process is half way between an initial level and the steady state level:

$$(4)\ T_{1/2} = \frac{ln2}{\beta}$$

We adapt this approach to exploit the panel dimension of our data, measuring the dependent variable – growth rate of real per capita GDP with respect to the initial condition – as a function of the initial condition of per capita GDP, and the other explanatory variables as in eq.(5).

$$(5)\ \frac{1}{(t-0)} ln\left(\frac{y_{i,t}}{y_{i,0}}\right) = \alpha_0 + \alpha_1 lny_{i,0} + \sum_{l=1}^{L} \delta_l \frac{1}{(t-l-0)} ln\left(\frac{y_{i,t-l}}{y_{i,0}}\right) + \sum_{k=1}^{K} \gamma_k x_{i,k} + \omega_i + \varepsilon_{i,t}$$

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[19] Let's derive the parameter measuring the speed of convergence $\beta$ from our model specification (as a function of our estimated coefficient $\hat{\alpha}_1$). The average rate at which GDP grows in the long-run is can be written as:

$$\frac{1}{T}[\ln(y_T) - \ln(y_0)] = -(1 - e^{-\beta T})\ln(y_0)$$

Therefore, our estimated coefficient of the initial condition is equal to

$$\hat{\alpha}_1 = -\left(1 - e^{-\hat{\beta} T}\right)$$

And the speed of convergence in terms of the estimated coefficient is

$$\ln(1 + \hat{\alpha}_1) = -\hat{\beta} T$$

$$\hat{\beta} = -\frac{1}{T}\ln(1 + \hat{\alpha}_1)$$

(t-0) indicates the length of time in which we build the "progressive" growth rate of per capita GDP. In other words, we calculate the growth rate of per capita GDP at each year t = 1…$T_i$ with respect to initial year 0. The coefficient $\hat{\alpha}_1$ now is the convergence coefficient taking time elapsing into account. We then estimate eq.(5) by taking elapsing time and change in EU geography into account, by adding countries as they joined the European Union. Unfortunately, the convergence coefficients resulting from this approach are too low, with a consequent speed of convergence too low to be credible. These results are not reported but they are available upon request.

Finally, we also estimate a dynamic model of per capita GDP growth at time t with respect to previous year t-1 as a function of the first lag of (ln-)per capita GDP level and the other observables (see e.g. Bonnefond, 2014, Caselli et al., 1996). This standard specification is shown in eq.(6) and the results reported in Table 3.

$$(6)\quad \Delta lny_{i,t} = \alpha_0 + \alpha_1 lny_{i,t-1} + \sum_{l=1}^{L} \delta_l \Delta lny_{i,t-l} + \sum_{k=1}^{K} \gamma_k x_{i,k} + \omega_i + \varepsilon_{i,t}$$

Such model allows to test for the neoclassical growth model prediction that countries relatively close to their steady state level of output, experience a slowdown in growth (Caselli et al., 1996). It allows as well to test for the presence of unit root in the panel using e.g. Augmented-Dickey Fuller test (McKinnon, 2002) or Phillips-Perron test for panel unit root (Phillips & Perron, 1988). When the level of per capita GDP across panels does not contain a unit root (i.e. it is stationary), then countries can converge to a steady state growth path (see for example Yorucu and Mehmet, 2014).

Given the correlation between the lagged level of the dependent variable and the random effects $\omega_i$, we use a different estimation approach in this case. Endogeneity of the lagged per capita GDP (and potentially of other explanatory variables) calls for a GMM-estimator for panel data (Arellano & Bond, 1991).[20]

In the end, whether the best specification is eq.(1), (5) or (6) depends on whether we tackle different caveats, as explained above, and what time horizon we prefer to look at.

[20] We use lags of other available measures as additional instruments (lags of unemployment/employment rates, especially for female).

### *4.2. Data*

The European Statistical Institute (Eurostat) provides the most complete time series for the variables of interest in this research, for European Union countries. We inspected other sources, such as the CESifo-DICE Database for Institutional Comparisons in Europe, which refers to data from the OECD Economic Outlook. The problem with this source is that it comprises data only until November 2014. A more updated source is the *Total Economy Database* (TED) of The Conference Board (November 2016). The problem with this source is that real per capita GDP is measured in US dollars (in constant 2015 price levels). However, we cannot extract data for our explanatory variables using the same unit of account.

We then build an unbalanced panel in the time range 1995-2016 for the 28 countries currently forming EU. For example, the "initial" year of observation for per capita GDP differs for few countries.[21]

We use GDP in 1995 as an initial condition, because of data availability and also because it is a crucial year in the process of reaching the European monetary union; in fact, it is in the middle between the definition of the criteria for entering the EMU (Maastricht Treaty, signed in 1992 and ratify by each country in 1993) and the reference year (1997) for respecting parameters for the first group of 11 and the start of Eurozone (1-1-1999).

Per capita GDP in real terms measures euro per capita, based on chain linked volumes (2010). Exports and imports, components of the "openness" variable, measure the amount of goods and services exported or imported as a percentage of GDP. Technological progress or innovation activity is proxied by gross domestic expenditures on Research and Development (R&D). R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications (Frascati Manual, 2002, §63). Physical capital investments are the Gross Fixed Capital Formation as a

[21] GDP is available starting from: Bulgaria (1996), Croatia (2000), Denmark (1989), Finland (1989), France (1989), Germany (1991), Greece (1995-2015), Ireland (1998), Malta (2000), Sweden (1993). Therefore, only Bulgaria, Croatia, Ireland and Malta are affected by our choice of "initial year" for real per capita GDP level (1995).

percentage of GDP. Human capital stock is measured by the share of 15-64 years old individuals, with upper secondary and post-secondary non-tertiary education (corresponding to ISCED 2011 levels 3-4). Moreover, we also used the share of 15-64 years old individuals with Tertiary education (corresponding to ISCED 2011 levels 5-8). Net migration rate is *crude* rate of net migration plus adjustment (per 1000 inhabitants).[22]

### *4.3. Results*

Table 1 shows the estimation results of eq.(1) for countries belonging to the European Union (EU). Column 1 includes the former 15 countries that formed the EU in 1995. As evident, $\hat{\alpha}_1$ is not significant nor negative, it appears that per capita GDP of the 15 seems to diverge (slightly) over time. When we enlarge the set of countries to 25, as happened in 2004, we obtain the results in column 2. The convergence coefficient turned negative, but not statistically significant (-0.362). This means that at a rate of convergence equal to 2.37% per year, they would take 29.3 years to reach half-life convergence. Column 3 reports the results when two other countries joined EU in 2007 (Romania and Bulgaria). If we take the data for those 27, then the convergence coefficient is negative and slightly significant at 10% (-0.569). This implies a speed of convergence of 4.44% and a half-life convergence of 15.6 years. Column 4 reports the results for all countries currently in EU, after adding Croatia, which entered EU in 2013. Again, the convergence coefficient is equal to -0.596 and slightly significant. The consequent rate of convergence is 4.77% and one year less in terms of half-life gap reduction (14.5 years).

Interestingly, if we consider those 9 EU countries which are not in the Euro Area (column 5), we get a significant negative coefficient. Their speed of convergence is 7.13% per year and their half-life gap reduction would employ about 9.7 years. Last column of Table 1 shows results of eq.(1) when

[22] Net migration rate (nmr) = immigrants-emigrants; if nmr >0 means that the country has more immigrants; if nmr <0 the country has more emigrants. The indicator is the ratio of net migration (including statistical adjustment) during the year to the average population in that year. The value is expressed per 1000 persons. Net migration plus adjustment is calculated as the difference between the total change and the natural change of the population.

we consider only those 22 EU countries belonging to OECD group of the world richest. Interestingly, their convergence coefficient is not statistically significant even if it remains negative. They present a speed of convergence equal to 1.12% per year and they would employ about 62 years to reach half of their steady-state equilibrium.

When we estimate the model specification (6), taking endogeneity of the lagged level of the dependent variable into account through a GMM method, the convergence parameter turns out to be negative and statistically significant for all groups of EU countries. The rate of convergence for the former 15 EU countries is 1.67% per year, and the half-life parameter is 41.5 years. On the other hand, when we take the 25 countries forming the EU in 2004, their rate of convergence is higher (1.92%) and their half-life parameter substantially lower (36.1 years). The whole EU has a rate of convergence equal to 2.10% per year and a half-life gap reduction of 32.9 years. These estimates are more conservative and less optimistic than the ones from Table 1. They indicate that at a speed of 2.1% per year, European Union countries will reach their half way to steady state path in 2028. The last column, however, indicates that EU countries belonging to OECD group would take 36.8 years before reducing their half-life gap (contrary to Table 1, which predicts 57 years) with a speed of convergence equal to 1.89% per year.

Table 3 reports the GMM estimation results of eq.(6) for Euro Area countries. Column 1 refers to the former 11 countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain). Adjacent columns report results for larger set for countries, as they joined the monetary union. For all groups of countries, the estimated convergence coefficients are negative and statistically significant. This means that there has been a tendency to converge, in terms of per capita GDP, since the start. Both the speed of convergence and the half-life parameters change over time, increasing in 2007 and 2009 to 1.96% per year, and 2011 and 2015 above 2%. Accordingly, the number of years needed to reach half-life may vary from 32.7 up to 41.8. This is quite awkward if compared to that for the EU as a whole.

**Table 1. Conditional convergence RE estimation of eq.(1) for EU countries**

| | (1) EU_former_15 | (2) EU_2004_25 | (3) EU_2007_27 | (4) EU_2013_28 | (5) EU_not_in_EA | (6) EU_also_in_OECD |
|---|---|---|---|---|---|---|
| $\ln Y_{i,0}$ | 0.954§ | -0.362 | -0.569§ | -0.596§ | -0.742* | -0.191 |
| | (0.511) | (0.331) | (0.315) | (0.315) | (0.377) | (0.382) |
| $\Delta \ln Y_{i,t-1}$ | 0.437*** | 0.459*** | 0.424*** | 0.425*** | 0.296*** | 0.471*** |
| | (0.0781) | (0.0534) | (0.0527) | (0.0506) | (0.0531) | (0.0641) |
| $\Delta \ln Y_{i,t-2}$ | -0.128*** | -0.223*** | -0.179** | -0.171** | 0.0424 | -0.234** |
| | (0.0292) | (0.0629) | (0.0671) | (0.0661) | (0.0603) | (0.0759) |
| Openness | -0.000670 | 0.00437* | 0.00439** | 0.00477** | 0.0000356 | 0.00228 |
| | (0.00260) | (0.00178) | (0.00167) | (0.00166) | (0.00748) | (0.00180) |
| R&D | -0.0845 | -0.147 | -0.0915 | -0.0429 | 0.0424 | -0.213 |
| | (0.140) | (0.218) | (0.212) | (0.205) | (0.287) | (0.236) |
| Investment | 0.144* | 0.184*** | 0.160*** | 0.161*** | 0.0798 | 0.172** |
| | (0.0648) | (0.0484) | (0.0442) | (0.0443) | (0.0513) | (0.0611) |
| Net migration | -0.0409 | -0.0684* | -0.0566§ | -0.0567§ | -0.0922** | -0.0396 |
| | (0.0270) | (0.0349) | (0.0316) | (0.0314) | (0.0348) | (0.0343) |
| Secondary education | -0.000839 | 0.0133 | 0.00864 | 0.00343 | -0.0557 | 0.0238 |
| | (0.0157) | (0.0167) | (0.0160) | (0.0161) | (0.0360) | (0.0166) |
| Constant | -11.59* | 0.298 | 2.866 | 3.098 | 8.730* | -1.220 |
| | (4.909) | (3.743) | (3.560) | (3.567) | (3.974) | (4.579) |
| Observations | 268 | 442 | 476 | 489 | 157 | 394 |
| Countries | 15 | 25 | 27 | 28 | 9 | 22 |
| Speed % | - | 2.366 | 4.435 | 4.774 | 7.125 | 1.117 |
| Half life | - | 29.30 | 15.63 | 14.52 | 9.728 | 62.07 |
| $R^2$ overall | 0.223 | 0.334 | 0.325 | 0.320 | 0.268 | 0.335 |
| $R^2$ within | 0.216 | 0.253 | 0.228 | 0.226 | 0.169 | 0.266 |
| $R^2$ between | 0.441 | 0.806 | 0.849 | 0.835 | 0.840 | 0.795 |

Dep. Var. = Growth rate of per capita GDP = $\Delta \ln Y_{it}$. Random-effects estimator with robust variance. Initial value $\ln Y_{i,0}$ refers to 1995 or the first available observation. Standard errors in parentheses. § $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

**Table 2. Conditional convergence GMM estimation of eq.(6) for EU countries**

| | (1) EU_former_15 | (2) EU_2004_25 | (3) EU_2007_27 | (4) EU_2013_28 | (5) EU_not_in_EA | (6) EU_also_in_OECD |
|---|---|---|---|---|---|---|
| $lnY_{i,t-1}$ | -0.284*** | -0.319*** | -0.346*** | -0.344*** | -0.279*** | -0.314*** |
| | (0.0332) | (0.0376) | (0.0437) | (0.0424) | (0.0790) | (0.0356) |
| Openness | 0.000693*** | 0.00145*** | 0.00157*** | 0.00157*** | 0.00206*** | 0.00152*** |
| | (0.000163) | (0.000233) | (0.000257) | (0.000252) | (0.000574) | (0.000272) |
| R&D | 0.0123 | 0.0330** | 0.0373** | 0.0361** | -0.0212 | 0.0281* |
| | (0.00821) | (0.0124) | (0.0135) | (0.0132) | (0.0138) | (0.0127) |
| Investment | 0.00542*** | 0.00694*** | 0.00707*** | 0.00701*** | 0.00614*** | 0.00688*** |
| | (0.000935) | (0.00113) | (0.000996) | (0.000960) | (0.00171) | (0.00123) |
| Net migration | -0.000153 | -0.000592 | -0.000141 | -0.000144 | 0.00100 | -0.000801 |
| | (0.000454) | (0.000651) | (0.000587) | (0.000584) | (0.000941) | (0.000860) |
| Secondary education | 0.00203* | 0.00271* | 0.00279§ | 0.00274§ | 0.000978 | 0.00257* |
| | (0.000812) | (0.00137) | (0.00147) | (0.00145) | (0.00154) | (0.00117) |
| Observations | 279 | 449 | 481 | 493 | 154 | 403 |
| Countries | 15 | 25 | 27 | 28 | 9 | 22 |
| Speed % | 1.669 | 1.918 | 2.120 | 2.104 | 1.635 | 1.885 |
| Half-life (years) | 41.52 | 36.14 | 32.69 | 32.94 | 42.40 | 36.76 |
| Hansen test | 2.507 | 0.855 | 0.0419 | 0.0766 | 0.854 | 0.757 |
| p-value | 0.113 | 0.355 | 0.838 | 0.782 | 0.355 | 0.384 |
| $R^2$ | 0.400 | -0.0295 | -0.155 | -0.121 | 0.203 | 0.0197 |

Dep. Var. = Growth rate of per capita GDP = $\Delta lnY_{it}$. Standard errors in parentheses. § $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Instrumented variable: first lag of the level of the dependent variable. Excluded instruments: first lag of the dependent variable, first lag of the female employment rate. Hansen test the validity of all instruments. P-value of this test is reported.

**Table 3. Conditional convergence GMM estimation of eq.(6) for Euro Area countries**

| | (1) EA_former_11 | (2) EA_2001_12 | (3) EA_2007_13 | (4) EA_2008_15 | (5) EA_2009_16 | (6) EA_2011_17 | (7) EA_2014_18 | (8) EA_2015_19 |
|---|---|---|---|---|---|---|---|---|
| $lnY_{t-1}$ | -0.296*** | -0.293*** | -0.325*** | -0.282*** | -0.327*** | -0.336*** | -0.296*** | -0.345*** |
| | (0.0394) | (0.0347) | (0.0387) | (0.0374) | (0.0496) | (0.0477) | (0.0392) | (0.0432) |
| Openness | 0.000570*** | 0.000653*** | 0.000811*** | 0.000592*** | 0.000844*** | 0.000924*** | 0.00106*** | 0.00143*** |
| | (0.000149) | (0.000147) | (0.000170) | (0.000115) | (0.000191) | (0.000200) | (0.000212) | (0.000252) |
| R&D | 0.0193* | 0.0202* | 0.0274** | 0.0212* | 0.0154 | 0.0416** | 0.0373** | 0.0464*** |
| | (0.00974) | (0.00968) | (0.0102) | (0.00938) | (0.0107) | (0.0127) | (0.0122) | (0.0136) |
| Investment | 0.00400*** | 0.00573*** | 0.00629*** | 0.00528*** | 0.00314** | 0.00558*** | 0.00636*** | 0.00739*** |
| | (0.000964) | (0.000980) | (0.00101) | (0.000885) | (0.00118) | (0.00143) | (0.00123) | (0.00125) |
| Net migration | 0.0000461 | -0.000428 | -0.000351 | -0.0000983 | 0.000908 | -0.000229 | -0.000593 | -0.000789 |
| | (0.000522) | (0.000469) | (0.000495) | (0.000412) | (0.000603) | (0.000852) | (0.000696) | (0.000692) |
| Secondary education | 0.000986 | 0.00227* | 0.00290** | 0.00107 | 0.00231 | 0.00188 | -0.000257 | 0.00271 |
| | (0.000870) | (0.00102) | (0.00109) | (0.000924) | (0.00143) | (0.00150) | (0.00150) | (0.00200) |
| Observations | 202 | 221 | 239 | 267 | 285 | 303 | 321 | 339 |
| Countries | 11 | 12 | 13 | 15 | 16 | 17 | 18 | 19 |
| Speed % | 1.758 | 1.737 | 1.968 | 1.657 | 1.976 | 2.044 | 1.757 | 2.115 |
| Half-life (years) | 39.43 | 39.91 | 35.22 | 41.84 | 35.07 | 33.91 | 39.45 | 32.77 |
| Hansen test | 1.901 | 4.654 | 2.265 | 5.760 | 6.482 | 3.836 | 2.643 | 0.628 |
| p-value | 0.168 | 0.0310 | 0.132 | 0.0164 | 0.0109 | 0.0502 | 0.104 | 0.428 |
| $R^2$ | 0.421 | 0.443 | 0.419 | 0.400 | 0.0859 | 0.0200 | 0.0926 | -0.0804 |

Dep. Var. = Growth rate of per capita GDP = $\Delta lnY_{it}$. Standard errors in parentheses. § $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Instrumented variable: first lag of the level of the dependent variable. Excluded instruments: first lag of the dependent variable, first lag of the female employment rate. Hansen test the validity of all instruments. P-value of this test is reported.

## 5. Conclusions and policy implications

As we have discussed in Section 2, OCA's theories (together with the empirical evidence of other working monetary unions in the world) maintain that a functioning monetary union requires at least three key elements: (i) similarity in economic and institutional structures; (ii) an adequate degree of market flexibility and labour mobility; (iii) fiscal transfers stemming from a centralized budget.

As for point (i), similarity in economic and institutional structures is more likely in a group of countries with a similar level of development. The optimistic view taken by the European institutions in the '90s insisted that it was the adoption of a common currency that would likely determine a convergence in economic structures, institutions and even in the development levels (endogeneity of OCA's criteria proposition). Has this been the case?

In this paper, we have seen that this was partly true.

In the econometric part, we specify a benchmark dynamic univariate model for estimating "conditional" convergence of real per capita GDP, for different groups of European countries (following the spirit of Barro & Sala-i-Martin, 2004, and Mankiw, et al., 1992, adapting it to panel data) and we find mixed results according to the specification adopted and the country group. Results are still preliminary.

In any case, Eurozone's countries have performed quite differently from one another (as shown in the detailed analysis of Section 3). Most of the NMS have exhibited higher rates of growth, both in the period of accession to the Eurozone and after the adoption of the euro. The initial countries belonging to the euro club (since 1999), have on the contrary shown a slower growth and more differentiated within the group. In particular, the peripheral countries hurt by the sovereign debt crisis (the "Pigs" and few other) have recorded widespread falls of income in the recent period.

Regarding the crisis period, the stagnation of many Eurozone's countries – with a double recession and weak recovery – has been aggravated by the mistakes or delays in EU policymaking,

that followed a "too little too late" approach, with initial failures in the management of the crisis and wrong macroeconomic policies.[23] While the monetary policy has become increasingly accommodative[24] (also in this case with some delay compared to the US case), fiscal policies were constrained by the EU's rules (the Stability and Growth Pact and the Fiscal Compact). The austerity proved to be deleterious for many countries, because the reduction of public debts has been almost impossible in presence of income losses and deflation (or zero inflation). On the other hand, most peripheral countries of the Eurozone adopted after the crisis an "internal devaluation" strategy, with the compression of wages and prices. Thus, the second element above considered (see ii above) has partly been realized and the competitiveness gap of such countries has been reduced.

With reference to the third element (point iii above), it is important to note that the insistence by the EU institutions on structural reforms to support economic growth is partly misplaced. Of course, structural reforms are necessary in many cases, to hold up economic growth in the long run (although they should be integrated by innovative industrial policies); however, in the Eurozone there has been for many years a clear lack of aggregate demand, as shown by the persisting output gaps. There is an urgent need of fiscal stimuli, at least to sustain the component of aggregate demand that has collapsed in the crisis period: investments, both private and public.[25]

As a consequence, a larger EU budget, including a separate and specific budget for the Eurozone, would be important not only to provide adjustment mechanisms useful after asymmetric shocks (for example a European unemployment insurance system), but also to favour economic

[23] To avoid new crises in future or to lessen their negative impact, a principle should be accepted: risk reduction should be accompanied by risk sharing. On all these issues, see Marelli and Signorelli (2017).

[24] Many decisions taken by the ECB, under Draghi's presidency, have been fundamental to "save euro", in particular the Outright Monetary Transactions plan adopted in 2012 (that caused a significant reduction of the spreads of the "Pigs"); although the lasting survival of the euro will depend by the completion of the "economic union" (as discussed in the next paragraph). Despite the more recent and stronger unconventional measures (like the Quantitative Easing), ECB's monetary policy has been less effective in ending stagnation, strengthening the recovery and contrasting deflation.

[25] The Juncker plan has been a very partial experiment in this sense (see Marelli, 2017).

growth and convergence in the long run.[26] Otherwise, wise plans like the Europe 2020 strategy, without adequate resources, cannot be really effective.

In other words, the monetary union should be completed with an "economic axis" (Delors, 2013) and EMU should really become an "economic and monetary union", as originally foreseen 25 years ago but, so far, not yet accomplished.

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[26] In particular, structural and cohesion funds (now about 0.4% of EU's GDP) should be significantly increased, in order to support investment, infrastructure, R&D, human capital, etc.

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