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Europe's income convergence and the latest global financial crisis

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ABSTRACT

This paper examines the effects of the 2008 financial crisis on economic growth and convergence across European countries from 1973 to 2012. Employing cross-sectional and dynamic panel data techniques, the results show that the global financial crisis has brought a greater absolute convergence rate rather than divergence, affected richer members more heavily and, presumably, allowed less developed members to recover more quickly. We find evidence that creating the European Union has contributed toward economic growth and convergence; meanwhile, no similar evidence is found concerning the European Monetary Union. Moreover, we present evidence that both the average output per capita and the rate of convergence during the financial crisis fell around 7%.

1. Introduction

Ten years ago, the global financial crisis triggered the deepest recession in the EU's history. Five years after the event, by the end of 2012, the size of the EU's GDP was still smaller than that registered at the end of 2007. There is no doubt that the recession deeply affected the EU's members, but did so differently, depending on their level of development and the extent of their economic integration. Across the ten newest EU's member states, the average GDP 10 newest EU member states, average GDP growth rate fell 5.68%, from 5.86% to 0.18%, in the five post-crisis years (2008–2012) relative to the five preceding years (2003–2007).[1] Meanwhile, the 15 original members' average growth rate fell 3.38%, from 2.83% to −0.55%. For the same periods, the 17 members of the Economic and Monetary Union (EMU) observed a fall of 3.9%, from 3.54% to −0.367%; while non-EMU members had a fall of 5.14%, from 5.12% to −0.024%.[2] Following these dissimilar impacts on economic growth, this paper asks: How has the recent financial crisis affected income convergence in the EU?

While the five convergence criteria established by the EU (price stability, long-term interest rate, exchange rate stability, and public deficits) do not address, for obvious reasons, income convergence, this is a desirable and expected outcome

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[1] Because our period of analysis runs from 1973 to 2012, the last three recently incorporated countries of the European Union (Bulgaria, Romania, and Croatia) are not included in the analysis.

[2] Currently, there are 19 members of the Economic and Monetary Union; however, because Latvia and Lithuania entered it in 2014 and 2015, respectively, they are not considered as part of the EMU in this paper.

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from taking part in the union for any of its members, especially the less well-off. Indeed, convergence plays a central role in the EU integration debate. Undeniably, new members expect to gain from accession by boosting economic growth and converging toward EU income levels in the long-run.

Fig. 1 shows one of the most basic notions of convergence. It plots the average GDP per capita growth rate, measured as log difference, against the log of the initial GDP per capita for the 15 former EU members under different time periods. On panel (a) for the full sample period 1973–2012, we observe a positive slope in the linearly fitted regression, which suggests income divergence. On panels (b) to (e), we split the sample into different sub-periods (1973–1989, 1990–1998, 1999–2007, and 1999–2012). In nearly all cases, except for the 1990s, the positive slopes in the regression joining the scattered dots indicate that GDP per capita was diverging rather than converging across the EU. Intuitively, those countries observing the higher (lower) GDP levels also experience larger (smaller) GDP per capita growth rate.

By the 1990s, a mild convergence pattern could be seen with a slightly negative, nearly flat line in panel (c). However, this trend changes again in the most recent years of the sample, particularly following the financial crisis. Panels (d) and (e) compare the periods 1999–2007 and 1999–2012. In both sample periods, we observe a positive slope (i.e., income divergence), particularly in panel (e), when we include the post-crisis period in the analysis. In line with what could be expected, the divergence pattern rose significantly across the EU's 15 oldest members following the financial crisis. In contrast, analyzing the 10 newest EU members, we observe a convergence pattern, which is reinforced (i.e., a steeper slope) after the financial crisis. Panels (d') and (e') in Fig. 2 show how strong the convergence is among these countries. Following the financial crisis, these countries seem to be accelerating their income convergence, which is presumably due to their links with other EU members.

The empirical literature so far suggests that a convergence process seems to be taking place in the EU in later years (see, for instance, Crespo-Cuaresma et al., 2008, and Monfort, 2008). This convergence process is observed in panels (d'') and (e'') in Fig. 3 when analyzing all 25 countries together. As we have previously described, this positive assesment seems to be mainly driven by the recently incorporated members of the EU. In fact, panel (e'') shows how the convergence pattern is slightly more pronounced when the post-crisis period is incorporated.

Existing empirical evidence is, however, not free from controversy and seems to be dependent on factors such as the period under investigation, the number of countries considered in the analysis, the size of the regions or territories observed, and econometric problems such as heterogeneity and endogeneity. There is empirical evidence of convergence before the 1980s (see, for instance, Armstrong, 1995, and Fagerberg and Verspagen, 1996), divergence in the 1980s (see, for instance, Bianco et al., 1997, and Button and Pentecost, 1995), and convergence again since the 1990s (see, for instance, Cavenaile and Dubois, 2011, and Eckey et al., 2009). In this same vein, Barry (2003) identifies three eras with different patterns of convergence for cohesion countries. First, a period of convergence from 1960 to 1973 in which Greece, Spain, Portugal, and Ireland were converging to the living standards of EU-15. A second period, from 1974 to 1986, was characterized by divergence and, third, a post-1986 period in which convergence was resumed. In all the studies listed above, the number of members considered also differs depending on the period in which the assessment was conducted.

The size of the regions under study seems to be another controversial issue. Petrakos and Artelaris (2009) suggest that when regions are appropriately weighted by their size, evidence of divergence rather than convergence is observed across the period 1990–2000. There is also disagreement about the proper territorial size at which researchers should be examining convergence. Boldrin et al. (2001) suggest that while the analysis of NUTS 2 and 3 has been the norm, many NUTS 2 and nearly all NUTS 3 regions are neither large enough nor reasonably heterogeneous in their endowment of factors to be treated as independent economic areas. Similar critics for NUTS 2 and 3 desegregation are found in Davies and Hallet (2002). They suggest that "in statistical terms, levels of disparities almost invariably increase at more disaggregated levels. It is thus far from evident which spatial level is the most appropriate for analyzing real convergence" (page 10).

As first pointed out by Caselli et al. (1996), many economic growth studies are affected by the presence of endogenous regressors and heterogeneity problems that are not correctly handled. These problems have also been observed in the literature about convergence in Europe. Examining the impact of European structural funds, Dall'erba and Le Gallo (2008) give an account of the theoretical arguments to consider explanatory variables as endogenous and of the problems encountered when dealing with such inconsistency. In terms of heterogeneity, Battisti and Di Vaio (2008) suggest that an absolute convergence test is plausible when the objective of the study is within-country because "regions share a common steady-state, being affected by similar saving rates, preferences, governmental policies, property rights, infrastructures, and so on"; however, that is unrealistic while testing between-convergence because countries might show different steady states. They suggest that empirical models that do not account for heterogeneity and spatial effects may present severe misspecification problems.

This paper revisits the convergence debate in Europe, paying special attention to the effects of the recent financial crisis of 2008. Employing a sample comprising 25 former European members over the period 1973–2012, we find that rather than leading to divergence, the financial crisis reduced the convergence rate across the EU. We argue that while the financial crisis was undoubtedly harmful to growth in Europe, it reduced the gap in output per capita of the EU's members. This is explained mainly by the richer members —which are principally the 15 oldest EU members— who were not just the most affected but also the ones that recovered less rapidly. Our results show that the recent incorporation of countries to the EU seems to have contributed toward absolute and conditional convergence across all its members. We also find no evidence

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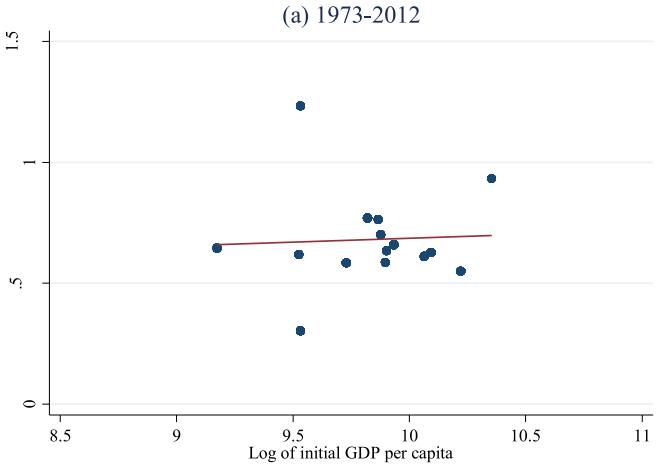
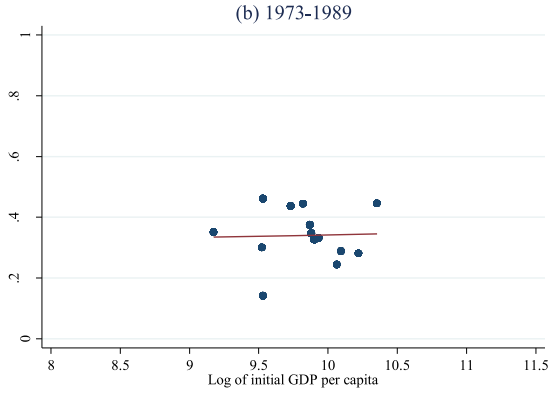
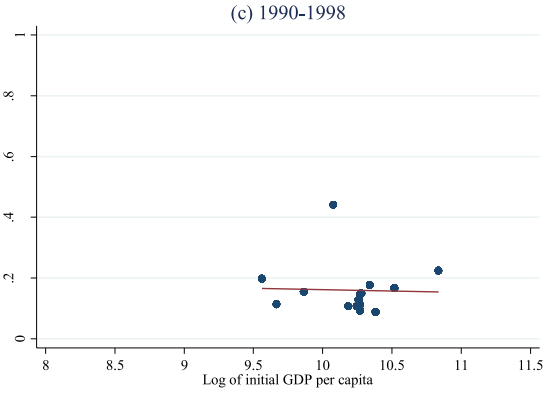


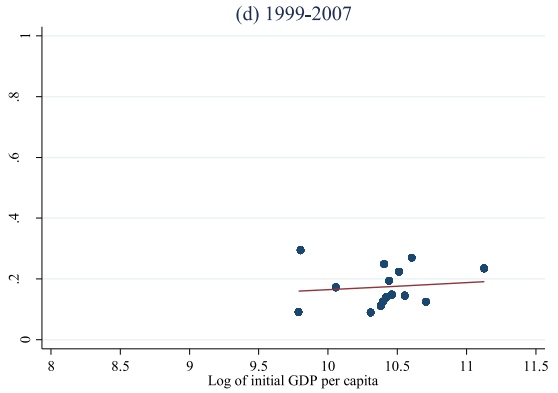
$$\log y_{2012} - \log y_{1973} = 0.371 + 0.032 \log y_{1973}$$



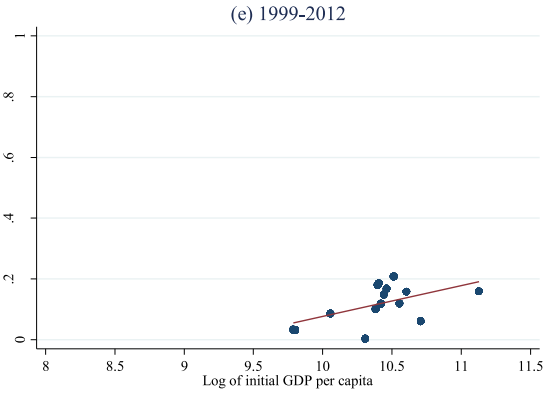
$$\log y_{1989} - \log y_{1973} = 0.255 + 0.009 \log y_{1973}$$



$$\log y_{1998} - \log y_{1990} = 0.251 - 0.009 \log y_{1990}$$



$$\log y_{2007} - \log y_{1999} = -0.066 + 0.023 \log y_{1999}$$



$$\log y_{2012} - \log y_{1999} = -0.939^{***} + 0.102 \log y_{1999}^{****}$$

Fig. 1. Graphic analysis of divergence and convergence for the 15 former EU members.
Notes: The red line represents the linearly fitted values. The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.

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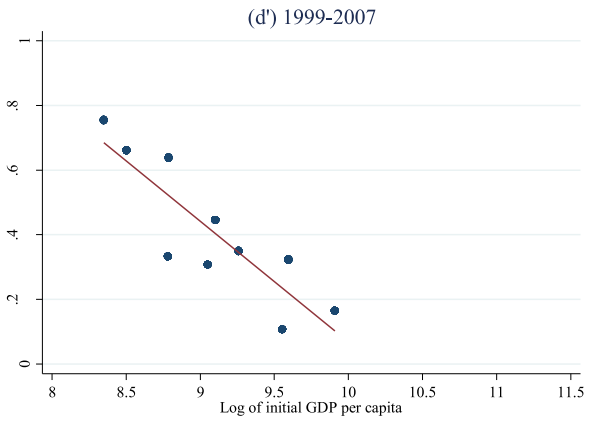
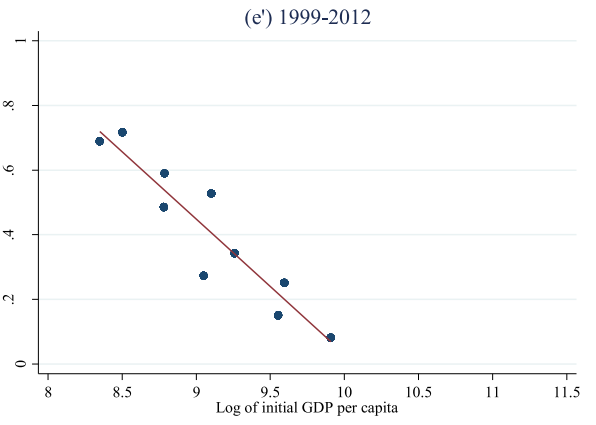
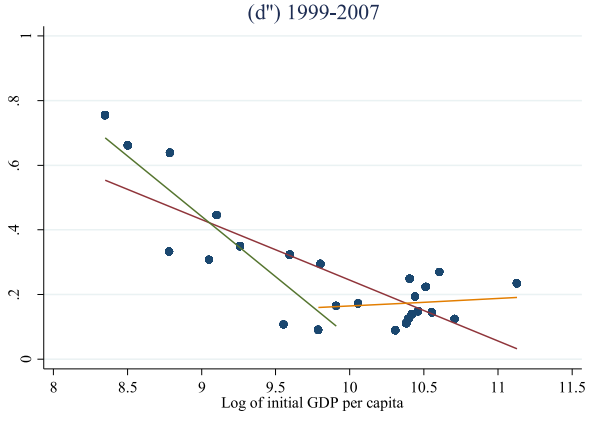


$$\log y_{2007} - \log y_{1999} = 3.801^{***} - 0.373 \log y_{1999}^{***}$$

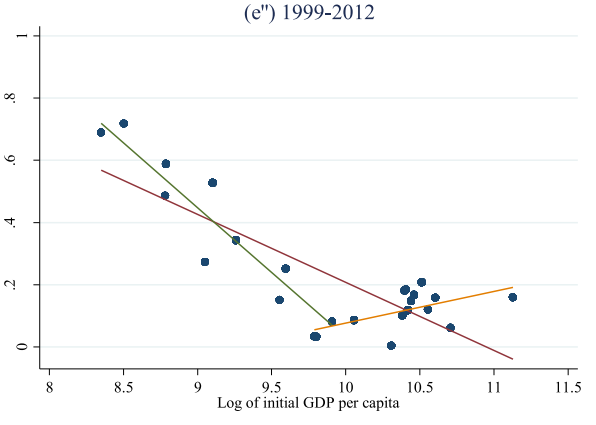


$$\log y_{2012} - \log y_{1999} = 4.204^{***} - 0.417 \log y_{1999}^{****}$$

Fig. 2. Graphic analysis of divergence and convergence for the 10 newest EU members.
Notes: The red line represents the linearly fitted values. The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.



$$\log y_{2007} - \log y_{1999} = 2.119^{***} - 0.187 \log y_{1999}^{***}$$



$$\log y_{2012} - \log y_{1999} = 2.393^{***} - 0.218 \log y_{1999}^{****}$$

Fig. 3. Graphic analysis of divergence and convergence for the former 25 EU members.
Notes: The red line and the estimations represent the linearly fitted values for the complete sample. The green and yellow lines represent the linearly fitted values for the 10 newest EU members and for the 15 former EU members, respectively. The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

that the EMU has contributed toward convergence or divergence. In this sense, our findings are akin to the differentiated effect proposed by Baumol (1986) and Borsi and Metiu (2015).

This paper contributes to the literature in at least three important ways. First, as far as we know, this is one of the few studies that have tried to look at the effects of the recent financial crisis on income convergence by contrasting the effects of the 15 oldest EU members and the newest 10 members (EU 25). A recent paper by Archibugi and Filippetti (2011) studying the innovative performance of EU members suggests that despite the convergence on innovative potential they observe over the period 2004–2008, disparities and divergence in innovative capabilities are expected following the financial crisis, and that "these might lead to divergence also in income and well-being." We therefore assess the effects of the financial crisis from a broader perspective. Second, our paper revisits the convergence debate in the EU taking into account some of the econometric weakness encountered in previous studies such as heterogeneity and endogeneity problems. Finally, by looking at the national level (NUTS 0), rather than small regional territories, we are able to follow the debate at the more macro level at which the financial crisis has been examined since its occurrence.

The rest of this paper proceeds as follows. Section 2 describes the dataset and presents some descriptive statistics of the main variables used in the paper. Section 3 introduces the empirical models employed to test for absolute and conditional convergence. Section 4 discusses the findings from both the cross-section and panel data estimations. Finally, Section 5 provides some concluding remarks and future research considerations.

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Table 1
Mean of the main indicators for the 25 European Union Member States, 1973–2012.

Country	GDP pc growth	Investment Ratio	Population growth	Years of schooling	Spending ratio	Trade openness	Political rights
Austria **	2.0	25.9	0.3	8.6	18.4	75.4	100.0
Belgium *	1.8	23.3	0.3	9.6	21.9	122.8	100.0
Cyprus N	3.7	25.3	1.5	9.0	16.4	103.8	93.6
Czech Republic N	1.7	29.2	0.2	11.5	20.2	101.2	62.9
Denmark **	1.5	21.9	0.3	9.6	24.6	74.5	100.0
Estonia N	5.4	30.6	−0.1	10.0	19.2	129.2	94.8
Finland **	2.2	25.5	0.4	8.6	20.4	62.3	95.0
France *	1.6	22.8	0.5	8.2	21.9	46.4	100.0
Germany *	1.9	23.0	0.1	9.2	19.5	52.7	100.0
Greece **	1.0	27.3	0.6	8.5	17.4	44.0	91.8
Hungary N	2.0	23.8	−0.1	10.1	22.4	116.8	70.7
Ireland **	3.3	22.8	1.0	10.3	18.3	126.8	100.0
Italy *	1.6	22.0	0.2	8.0	18.3	43.9	98.2
Latvia N	2.8	29.0	−0.4	8.4	15.6	101.8	90.3
Lithuania N	2.3	21.8	−0.2	8.9	19.4	111.3	98.1
Luxembourg *	2.6	19.3	1.1	9.2	15.2	223.0	98.2
Malta N	4.2	22.5	0.8	8.8	18.0	162.1	96.8
Netherlands *	1.7	22.3	0.6	10.3	22.6	112.3	100.0
Poland N	3.8	20.8	0.4	9.5	19.4	62.5	68.9
Portugal **	1.9	26.1	0.5	6.1	16.3	59.4	92.1
Slovakia N	4.2	28.4	0.4	11.1	20.0	129.2	95.0
Slovenia N	2.5	26.5	0.4	10.6	18.7	113.2	98.7
Spain **	1.8	25.1	0.8	8.0	16.0	43.3	91.1
Sweden **	1.7	24.2	0.4	10.7	25.4	68.3	99.6
United Kingdom **	1.8	20.1	0.3	9.6	19.5	52.6	100.0
EU-25 (1973–2012)	2.3	24.1	0.4	9.3	19.4	90.7	93.1
EU-15 (1999–2012)	1.1	22.2	0.6	10.3	20.5	107.9	99.6
EU-10 (1999–2012)	3.3	24.8	−0.1	11.2	19.4	121.7	99.3
EMU (1973–2012)	1.9	23.8	0.5	8.7	18.8	84.3	97.1
EMU (1999–2012)	1.1	22.6	0.6	10.1	19.8	104.6	99.7

Notes: The symbol * identifies the six founder European Union members and ** denotes the additional nine members incorporated from 1973 to 1995. These two groups compose the 15 former European Union members (EU-15). Superscript N indicates the 10 newest European Union members (EU-10), incorporated after 2004. The GDP per capita is measured in constant 2005 US$ as published by the World Bank; investment-to-output ratio is the percentage that gross capital formation represents of GDP; population growth is the annual growth rate of total population; education level is measured through years of schooling; government size is represented through the general government final consumption expenditure as percentage of the GDP; trade openness is the sum of exports and imports of goods and services measured as a share of the GDP; and political rights are a proxy variable for political stability.

2. Data

The data were obtained from three commonly used sources. The socioeconomic variables were retrieved from the World Bank (2018) dataset (World Development Indicators (WDI)), the average years of schooling were taken from Barro and Lee (2013), and political variables were gathered from the Freedom House (2018) database.[3] Table 1 lists the 25 EU member states considered in the analysis as well as the mean of the main variables employed over the examined sample period (1973–2012). In Table 1, the superscript * identifies the six European Union founder members and ** the additional nine members incorporated from 1973 to 1995. These two groups constitute the block of 15 former European Union members (EU-15). Superscript N indicates the 10 newest European Union members (EU-10), which incorporated to it after 2004. The lower part of Table 1 also contains statistics for these groups of countries and the European Monetary Union during some periods. For example, we present the average GDP per capita growth rate across the 25 EU members, which is 2.3%. Regarding this variable, Estonia shows the highest value (5.4%) while Greece is listed with the lowest (1.0%). As we can expect, there is some degree of heterogeneity across the EU members in all the variables.

The investment-to-GDP ratio is, on average, 24.1% and, again, Estonia presents the largest value (30.6%) while Luxembourg has the lowest (19.3%). In terms of human capital, the country with the highest average population growth rate in the sample is Cyprus with an average annual rate of 1.5%, whereas Latvia has the lowest (−0.4%). Concerning the education level, the average years of schooling across the sample is 9.3: the Czech Republic has the highest average with 11.5 and Portugal the lowest with 6.1. Sweden has the largest government sector, with public expenditure representing 25.4% of its GDP, and Latvia the smallest with 15.6%. The average trade openness among EU members is, on average, 90.7% of their GDP. In this aspect, Luxembourg presents the highest ratio (223.0%) while Spain has the lowest (43.3%). Finally, political rights, on average, are generally high among all the countries (93.1), ranging from 62.9 in the Czech Republic to 100 in 8 of the 25 listed countries (Austria, Belgium, Denmark, France, Germany, Ireland, Netherlands, and the United Kingdom). At the bottom of Table 1, when comparing the 15 former EU members and the 10 newest during the period 1999–2012, we find that

[3] The original variables from the Freedom in the World (FIW) report are transformed to a 0–100 scale.

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Table 2
Pairwise correlation coefficients.

Country	GDP pc growth	Investment ratio	Population growth	Years of schooling	Spending ratio	Trade openness	Political rights
GDP pc growth	1.000						
Investment ratio	0.261	1.000					
Population growth	−0.062	**0.019**	1.000				
Years of schooling	−0.056	−0.179	−0.167	1.000			
Spending ratio	−0.162	−0.337	−0.251	**0.431**	1.000		
Trade openness	0.115	−0.135	0.163	0.399	−0.125	1.000	
Political rights	0.034	−0.275	−0.029	0.191	0.368	0.137	1.000

Notes: Values in bold show the highest and lowest absolute pairwise correlation coefficients.

the recently incorporated countries present higher growth rate, investment-to-output ratio, years of schooling, and trade openness. On the other hand, the 15 former countries have higher population growth rates, spending ratio, and political rights.

Finally, Table 2 describes the correlation measure across the variables listed in Table 1. We can observe that in general, there is no high correlation between them. The pairwise correlation coefficients range between 0.019 and 0.431. Our measures of spending ratio and years of schooling present the highest absolute correlation coefficient while population growth and the investment-to-output ratio present the lowest. Regarding how much the explanatory variables are correlated with our dependent variable, the correlation of the investment-to-output ratio is the highest (0.261).

3. Empirical model and methodology

3.1. Unconditional convergence

Our first approach to analyze convergence follows Mankiw et al. (1992) original approach to study absolute (or unconditional) convergence. The empirical model is provided in Eq. (1):

$$\Delta y_i = \alpha + \beta_u y_{i,0} + \nu_i, \tag{1}$$

where Δy_i denotes the log difference of GDP per capita in country i over some specific period and $y_{i,0}$ is the log of the GDP per capita at the initial year of that period. The coefficient β_u is of particular importance in our analysis. Under this approach, a negative coefficient would suggest convergence while a positive one implies divergence. The implicit rate of convergence λ_u is calculated as the negative of the log of $(1+\beta_u)$ divided by the size of the period.

The model employed in Eq. (1) to test for unconditional or absolute convergence has a parallel with Mankiw et al. (1992) empirical treatment of the Solow (1956) growth model. Defined in logs, a benchmark empirical equation we use to test for unconditional convergence is given by Eq. (2):

$$y_{i,t} = \alpha + \beta_c y_{i,t-1} + \nu_{i,t}, \tag{2}$$

where $y_{i,t}$ is the log of income per capita in country i in year t and $y_{i,t-1}$ represents the log of income per capita in country i at the beginning of the period under study. Here the coefficient β_c for the lagged per capita output is the key parameter to estimate the rate of convergence. Following Islam (1995), under panel data methods, the implicit rate of convergence λ_c is calculated as the negative of the log of the lagged dependent variable coefficient divided by the size of the period. Then, intuitively we can say unconditional convergence exists if $0 < \beta_c < 1$, whereas $\beta_c > 1$ suggests divergence.

3.2. Conditional convergence

After the analysis of absolute convergence through cross-sectional procedures, we investigate the existence of conditional convergence. The empirical model to test for conditional convergence follows the adaptation of the Solow (1956) growth model developed by Islam (1995) to work under panel data methods. Departing from Eq. (2), our first specification adds the presence of the traditional control variables of the Solow growth model: log of investment-to-output ratio ($s_{i,p}$), log of population growth ($n_{i,p}$), and log of human capital ($h_{i,p}$). In addition, μ_i and η_p are country- and time-specific effects, respectively. Eq. (3) gives account of the proposed empirical model:

$$y_{i,p} = \mu_i + \eta_p + \alpha y_{i,p-1} + \beta_0 + \beta_1 s_{i,p} + \beta_2 n_{i,p} + \beta_3 h_{i,p} + \beta_4 EU_{i,p} + \beta_5 EMU_{i,p} + \beta_6 FC_{i,p} + \nu_{i,p.} \tag{3}$$

where $y_{i,p}$ is the log of income per capita in country i in period p.[4] In our main augmented specification, we control for shocks corresponding to the formation of the EU and EMU and to the financial crisis through EU_{ip}, EMU_{ip}, and FC_{ip}. These dummy variables take values of unity after a country becomes part of the European Union, adopts the euro as its own currency, or is going through the financial crisis period (2008–2012); otherwise, the value is zero for each variable.[5]

[4] Each period consists on a five-year average of all our series because it helps avoid any cycling pattern within the long-term process.

[5] In the case where a country presents any of these features three or more years within a period, dichotomous variables will account for the feature across the whole five-year period.

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Traditionally, most panel data studies have employed five-year averages to estimate empirical approximations of the neoclassical growth model (see, for instance, Arnold et al. (2011), Grier and Grier (2007), Mollick and Cabral (2011), and Owen et al. (2009), among others). Although we tried also taking averages of three and four years, we found that five-year averages work best for our time span, particularly to control accurately for the number of lags in our instruments under Generalized Method of Moments (GMM).[6] Five-year averaging also allows us to specify the financial crisis effect as a dummy variable that takes the value of unity during the last period observed in our sample (2008–2012 average).

It is well known that estimates of a dynamic model under OLS are biased because they contain lags of the dependent variable that are ultimately correlated with the error term. Therefore, we use the GMM estimator, which solves the consistency problem of OLS estimators by taking first-differences and removing the state effects (μ_i), producing an equation that is estimable using instrumental variables in which endogenous explanatory variables are instrumented with suitable lags of their own. Blundell and Bond (1998) propose a model in which lagged differences are employed in addition to the lags of the endogenous variables, producing more robust estimations when the autoregressive processes become persistent. GMM estimators are said to be consistent if there is no second-order autocorrelation and if the instruments employed are valid.

In what follows, when dealing with conditional convergence, we report the Arellano-Bond test of second-order autocorrelation and the Hansen test of overidentifying restrictions to examine the correct specification of the dynamic system GMM. We also take advantage of this estimation method to instrument other potential endogenous variables on the right-hand side of Eqs. (2) and (3) such as investment-to-output ratio, population growth, or our human capital measures.

4. Empirical results

4.1. Unconditional (absolute) convergence

In Fig. 1, we graphically observe different patterns of absolute convergence across different periods for the EU-15. Nevertheless, a more formal statistical approach to analyze convergence is to estimate the cross-section regression proposed above. Table 3 presents the estimations of unconditional convergence using Eq. (1). Panel (A) presents the estimation results corresponding to the analysis of absolute convergence. Similarly, the basic specification of conditional convergence in Eq. (2) is presented for comparison purposes in panel (B) of the same table. Notice that both panels (A) and (B) yield, as expected, similar empirical results.

Column (a) presents the estimates of absolute convergence for the EU's 15 oldest members, excluding from the sample the years after the financial crisis (2008–2012), and column (b) presents the full period (as in panel (a)) in Fig. 1. The implied rates of convergence for the two periods are different and not statistically significant. The indicator goes from a positive rate of convergence (0.166%) to a negative one of −0.081% (i.e., divergence) when we include the post-crisis period.

Similar to this effect, when we study all 25 former EU members (as shown in Fig. 3), we identify a relatively high rate of convergence (6.714%) in column (a'), which is reduced to (6.01%) when the crisis period is included in column (b'). This result confirms our argument that the financial crisis, at least in the first five years, might have led to divergence by reducing the gap in output per capita of the EU members. As in Fig. 1, in columns (c)–(f) of Table 3, we partition the sample in three periods: the 1980s before the fall of the Berlin wall (1980–1989 in column (c)), the 1990s under a EU with free movement of labor (1990–1998 in column (d)), and the euro era (1999–2012). The latter is presented in columns (e) and (f), where column (e) excludes the years after the financial crisis, only covering from 1999 to 2007. The rates of convergence in columns (c)–(f) correspond to panels (b)–(d) in Fig. 1. According to these estimations, within the 15 former EU members, we only find convergence in the 1990s ($\lambda = 0.113\%$), after near stagnation in the 1980s ($\lambda = -0.056\%$). We also observe how the financial crisis intensified the divergence rate. Moreover, the negative rate of convergence falls from −0.284% to −0.747% when we include the post-crisis period (see columns (e) and (f)).

Next, columns (c') to (f') of Table 3 are presented to analyze the evolution of the convergence pattern by decade while considering the incorporation of 10 new members to the EU. Presumably, changes in convergence rates might be due to higher integration but could also be due to the inclusion of additional member states, which in most cases were those with economies less-developed than the initial 15 members. Overall, in these columns, one can clearly identify an increase in the rate of convergence as new members entered the union and confirm that the rate of convergence is reduced due to the financial crisis. A potential critic to these results is that even 25 observations might be too few to assume normality. To explore these initial results more extensively and deal with potential normality problems, we extend the analysis to assess conditional convergence while employing GMM panel data techniques.

4.2. Conditional convergence

Table 4 presents the estimations corresponding to the conditional convergence model defined in Eq. (3). Columns (a) and (b) present the estimates of the traditional Solow growth model devoid of and with human capital, respectively. We employ

[6] For other empirical analysis of the Solow growth model employing averages of five-year periods, see Cravo et al. (2012) and Vu and Noy (2009).

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Table 3
Absolute convergence analysis with OLS regression for the former EU 15 and the incorporation of countries to the EU.

	Former EU 15						Incorporation to the EU					
Period of study	(a) 1973–2007	(b) 1973–2012	(c) 1973–1989	(d) 1990–1998	(e) 1999–2007	(f) 1999–2012	(á) 1973–2007	(b́) 1973–2012	(ć) 1973–1989	(d́) 1990–1998	(é) 1999–2007	(f́) 1999–2012
Panel (A)												
Dep. Var:* Log *difference GDP pc												
Initial Ln (GDP pc)	−0.055	0.032	0.009	−0.009	0.023	0.102***	−0.898***	−0.904***	0.019	−0.009	−0.188***	−0.219***
	(0.212)	(0.205)	(0.080)	(0.051)	(0.068)	(0.030)	(0.016)	(0.014)	(0.085)	(0.051)	(0.039)	(0.035)
Constant	1.279	0.371	0.255	0.251	−0.066	−0.939***	9.473***	9.478***	0.148	0.251	2.120***	2.394***
	(2.100)	(2.043)	(0.798)	(0.533)	(0.717)	(0.308)	(0.121)	(0.103)	(0.841)	(0.533)	(0.396)	(0.346)
Implied $\lambda_{MRW} = -[\frac{\ln(1+\beta)}{\tau}]$	**0.166%**	**−0.081%**	**−0.056%**	**0.113%**	**−0.284%**	**−0.747%**	**6.714%**	**6.009%**	**−0.118%**	**0.113%**	**2.603%**	**1.901%**
R^2	0.007	0.002	0.001	0.001	0.014	0.293	0.990	0.990	0.005	0.001	0.615	0.661
Panel (B)												
Dep. Var: Final* Ln *(GDP pc)												
Initial Ln (GDP pc)	0.945***	1.032***	1.009***	0.991***	1.023***	1.102***	0.102***	0.096***	1.019***	0.991***	0.812***	0.781***
	(0.212)	(0.205)	(0.080)	(0.051)	(0.068)	(0.030)	(0.016)	(0.014)	(0.085)	(0.051)	(0.039)	(0.035)
Constant	1.279	0.371	0.255	0.251	−0.066	−0.939***	9.473***	9.478***	0.148	0.251	2.120***	2.394***
	(2.100)	(2.043)	(0.797)	(0.533)	(0.717)	(0.308)	(0.121)	(0.103)	(0.841)	(0.533)	(0.396)	(0.346)
Implied $\lambda_{Islam} = -[\frac{\ln(\beta)}{\tau}]$	**0.166%**	**−0.081%**	**−0.056%**	**0.113%**	**−0.284%**	**−0.747%**	**6.714%**	**6.009%**	**−0.118%**	**0.113%**	**2.603%**	**1.901%**
R^2	0.675	0.704	0.926	0.929	0.965	0.980	0.556	0.530	0.934	0.929	0.968	0.961
Observations	15	15	15	15	15	15	25	25	12	15	25	25
τ	34	39	16	8	8	13	34	39	16	8	8	13

Notes: Robust standard errors in parentheses. Coefficients are rounded to three digits. The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.

Table 4
Dynamic estimates controlling for EU, EMU, and financial crisis shocks.

Dependent variable: Ln (GDP pc)	(a)	(b)	(c)	(d)	(e)	(f)
Lagged Ln (GDP pc)	0.903***	0.843***	0.808***	0.849***	0.862***	0.861***
	(0.028)	(0.0439	(0.051)	(0.039)	(0.030)	(0.041)
Ln (investment ratio)	0.089	0.180*	0.245*	0.189*	0.056	0.061
	(0.098)	(0.105)	(0.130)	(0.118)	(0.125)	(0.154)
Ln (population growth)	0.012	−0.003	−0.008	−0.002	0.009	0.009
	(0.015)	(0.014)	(0.016)	(0.014)	(0.016)	(0.017)
Ln (years of schooling)		0.254**	0.288**	0.266*	0.283***	0.286**
		(0.127)	(0.142)	(0.148)	(0.105)	(0.118)
EU entry dummy			0.064*			0.002
			(0.037)			(0.034)
EMU entry dummy				−0.011		−0.001
				(0.031)		(0.025)
FC dummy					−0.095***	−0.095***
					(0.024)	(0.026)
Constant	0.810	0.537	0.557	0.429	0.701	0.686
	(0.551)	(0.600)	(0.682)	(0.762)	(0.569)	(0.696)
Implied impacts						
EU entry dummy			**6.61%***			**0.20%**
EMU entry dummy				**−1.09%**		**−0.10%**
FC dummy					**−9.06%*****	**−9.06%*****
Implied $\lambda_{Islam} = -[\frac{\ln(\beta)}{\tau}]$	**2.04%*****	**3.42%*****	**4.26%*****	**3.27%*****	**2.97%*****	**2.99%*****
Observations	124	124	124	124	124	124
Countries	22	22	23	22	22	22
Instruments	29	29	29	29	29	29
Hansen test	0.69	0.62	0.75	0.64	0.83	0.89
AB(2) test	0.45	0.66	0.70	0.72	0.04	0.09
Wald χ^2	1701.0	1703.9	1206.1	1809.0	2451.8	2982.8

Notes: System GMM regressions with robust standard errors in parentheses.
The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.

these specifications as a starting point and benchmark for the rest of the estimation results. Then, columns (c)–(e) present regressions of the model with human capital along with each of the individual shocks (i.e., EU, EMU, and FC). Finally, column (f) shows the estimations of the model with all the shocks jointly. In general, the results in Table 4 present Hansen tests that are consistent with the hypothesis that the model is correctly specified and we observe no serial correlation of second-order. Looking first at our benchmark estimates in columns (a) and (b), we can observe how both models present the expected positive signs for lagged output per capital and the investment-to-GDP ratio. In column (b), a 1% increase in the investment-to-output ratio is statistically related to a 0.18% increase in output per capita. As in most empirical economic growth models, population growth has the negative expected sign but is not statistically significant. Meanwhile, education, as a measure of human capital, presents an expected and statistically significant positive coefficient as in Arnold et al. (2011) findings. Regarding convergence, the lagged output coefficients in columns (a) and (b) suggest an average convergence rate of 2.04% and 3.42%, respectively. These are notably smaller than those rates observed under absolute convergence (see column (b') of Table 3, for instance).

In columns (c)–(f) we present the augmented versions of the model controlling for the entry to the EU and the EMU, as well as for the financial crisis shock. It is clear that the EU seems to contribute toward convergence. Column (c) shows a positive coefficient of 0.064, which is statistically significant at the 10% level, implying that entry to the EU is associated with a 6.61% higher GDP per capita. In column (d), the EMU dummy coefficient presents a negative sign but is not statistically significant. Meanwhile, in column (e), the financial crisis dummy shows the expected negative and statistically significant sign at the 1% level, implying a 9.06% lower GDP per capita. Finally, in column (f), we control for all three shocks simultaneously. Here, we observe that once we control for the financial crisis shock, the positive effect of entry to the EU and the adverse effect of entry into the EMU remain but are not statistically significant. Meanwhile, the financial crisis dummy variable coefficient remains unchanged and equally statistically significant.

In Table 4, the average rate of convergence fluctuates between 2.97% and 4.26% across comparable specifications (columns (b)–(f)). For the complete specification in column (f), we find that the EU converges over the period at a rate just below 3%, slightly larger than that reported in other previous studies (see, for instance, Armstrong 1995; and Neven and Gouyette, 1995). In this table, we can also identify that when controlling for the entry to the EU, the rate of convergence increases significantly, from 3.42% in column (b) to 4.26% in column (c). On the other hand, a contrary effect occurs when controlling for entry to the EMU. In this case, the rate of convergence falls to 3.27% in column (d). Meanwhile, when controlling for the financial crisis shock only, we observe a more significant fall in the rate of convergence (i.e., 2.97% in column (e)). Finally, the financial crisis can be associated with a 9.06% lower average GDP per capita when controlling for both the entry of the countries to the EU and to the EMU.

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Table 5
Dynamic estimates controlling for EU, EMU, financial crisis shocks, and domestic variables.

Dependent variable: Ln (GDP pc)	(a)	(b)	(c)	(d)	(e)	(f)
Lagged Ln (GDP pc)	0.940***	0.890***	0.856***	0.904***	0.910***	0.897***
	(0.034)	(0.045)	(0.055)	(0.046)	(0.029)	(0.047)
Ln (investment ratio)	0.070	0.127	0.202*	0.146	−0.007	0.057
	(0.067)	(0.088)	(0.111)	(0.107)	(0.102)	(0.115)
Ln (population growth)	−0.005	−0.019	−0.028*	−0.019	−0.003	−0.010
	(0.012)	(0.015)	(0.016)	(0.016)	(0.011)	(0.013)
Ln (years of schooling)		0.358**	0.387**	0.410*	0.268**	0.321*
		(0.159)	(0.191)	(0.212)	(0.132)	(0.186)
EU entry dummy			0.088*			0.045
			(0.053)			(0.058)
EMU entry dummy				−0.023		−0.011
				(0.034)		(0.025)
FC dummy					−0.077***	−0.067***
					(0.023)	(0.024)
Constant	1.128	1.862	2.410	1.831	2.881	3.015*
	(1.319)	(1.764)	(2.064)	(1.861)	(1.539)	(1.618)
Domestic variables	Yes	Yes	Yes	Yes	Yes	Yes
Implied impacts						
EU entry dummy			**9.20%***			**4.60%**
EMU entry dummy				**−2.27%**		**−1.09%**
FC dummy					**−7.41%*****	**−6.48%*****
Implied $\lambda_{Islam} = -[\frac{\ln(\beta)}{\tau}]$	**1.24%*****	**2.33%*****	**3.11%*****	**2.02%*****	**1.89%*****	**2.17%*****
Observations	121	121	121	121	121	121
Countries	21	21	21	21	21	21
Instruments	29	29	29	29	29	29
Hansen test	0.74	0.65	0.67	0.77	0.76	0.75
AB(2) test	0.53	0.40	0.50	0.48	0.85	0.85
Wald χ^2	2913.7	3091.6	2845.7	3950.7	7544.7	7573.9

Notes: System GMM regressions with robust standard errors in parentheses.
The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.

4.3. Robustness check

The estimates in Table 4 closely follow the specification of the neoclassical growth model in the same fashion as in the seminal papers by Mankiw et al. (1992) and Islam (1995). The model excludes other relevant internal and external determinants of economic growth that have been incorporated more recently in the literature. Therefore, Table 5 presents some regressions corresponding to the specification in Eq. (3) by adding some control variables commonly used in the economic growth literature to analyze patterns of convergence across economies such as government size, openness, and political stability (see, for instance, Mathonnat and Minea (2018), Oto-Peralías and Romero-Ávila (2013), and Sakyi et al. (2015), among others).

For all the estimations shown here, the lag of output per capita presents a positive, smaller than unity, statistically significant coefficient at the 1% level. Coefficients of the lagged GDP per capita are slightly higher, on average, than those in Table 4 by about 5%. Therefore, the convergence pattern is preserved. In columns (b) to (f) we again follow a sequential approach. Overall, we find robust results for our main variables of interest. In line with other studies, we also find little statistical significance on the additional control variables when estimating a similar dynamic specification of the Solow growth model.[7] Presumably, the limited statistical significance of the new controls is due to the presence of our lagged dependent variable, which accounts for as much real variation as the control variables.

As for the shock variables, we observe that entry to the EU presents a statistically significant positive effect. Column (c) reports a positive coefficient of 0.088, which is statistically significant at the 10% level, implying that entry to the EU is associated with a 9.20% higher GDP per capita. In column (d), the EMU coefficient presents a negative sign but is not statistically significant. Meanwhile, in column (e), the financial crisis dummy shows the expected negative and statistically significant sign at the 1% level, implying a 7.41% lower GDP per capita. Finally, in column (f), we control for all three shocks simultaneously. Here, we observe again that the positive effect of entry to the EU and the negative effect of entry to the EMU remain with the same sign, but they are not statistically significant. On the other hand, the financial crisis shock remains a statistically significant effect, which is slightly lower than in column (e).

With regard to the rates of convergence, these are reduced, on average, to two-thirds of the values in Table 4 and present a milder fluctuation, from 1.89% to 3.11%, across comparable specifications (columns (b)–(f)). For the complete specification in column (f), we find that the EU converges over the period at a rate of 2.17%. When controlling for entry to the EU, the rate of convergence increases substantially, from 2.33% in column (b) to 3.11% in column (c). On the other hand, a contrary effect

[7] See for instance Di Liberto et al. (2008) and Mollick and Cabral (2011).

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occurs when controlling for entry to the EMU. In this case, the rate of convergence falls to 2.02% in column (d) and, when controlling for the financial crisis shock, we observe a more significant fall in the rate of convergence to 1.89% in column (e). Moreover, the financial crisis can be associated with two main economic effects: a 6.48% lower average GDP per capita when controlling for both entry of the countries to the EU and entry to the EMU, and a 0.16% lower rate of convergence when comparing the downfall from 2.33% to 2.17% in columns (b) and (f) in Table 5.

All in all, the results in Tables 4 and 5 confirm the EU has contributed toward regional economic growth and convergence, and that the financial crisis has had a considerable negative impact on both the rate of convergence and GDP per capita.

5. Conclusion

This paper investigated the effects of the recent global financial crisis on EU income per capita convergence. By using alternative econometric techniques, it was possible to establish that the financial crisis brought a reduction in output per capita growth and lower income convergence across the EU. Our results show that EU membership seems to have contributed toward absolute and conditional convergence, mainly driven by new EU members. We find that this is consistent with our hypothesis that the crisis reduced the gap in GDP per capita and led to convergence. On the other hand, the integration of the EMU seems not to have any statistical relationship toward convergence or divergence.

The evidence that we put forward should, however, be revisited as additional data become available in order to gain a more detailed understanding of the full effect of the financial crisis and to see whether the effects we present here can be confirmed in the long-run. While looking at a more disaggregated regional level such as NUTS 2 or 3 was not the purpose of this paper, it would be interesting to see whether the convergence patterns reported here are present also at those levels. We leave this task as a direction for future research.

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