Output gap and non-linear economic convergence[*]

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Abstract

We apply unit root tests in a multivariate TAR model with bootstrapping simulations to assess the influence of short-run economic conditions on long-run economic convergence. We use two different groups of countries which members share important business cycle characteristics over the period 1953-2010, and show that per capita income convergence is not uniform along the business cycle. Our analysis reveals that measures to improve the implementation of the Euro as well as growth-led actions are vividly advised not only to overcome the current crisis but also to foster real economic convergence within the Euro zone.

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1. Introduction

Even though *income* convergence and *business cycle* conformity between groups of countries have been profusely analysed over the last two decades, the possible connections between the two concepts still remain largely unexplored. On the one hand, the works focusing on income convergence have ignored the influence of the cyclical phases on it[1] and, on the other hand, business cycle conformity has been investigated without considering its effects on income convergence[2].

However, there are abundant economic reasons to believe that short-run conditions have an impact on long run convergence, although the size and sign of the ultimate effect cannot be predetermined. Let us imagine for instance the influence of an expansionary phase on economic convergence. If economic recovery is led by increases of investments in R&D and/or export impulses based on competitive gains, this will have effects not only on short term economic conditions but also on economic growth in the short, medium and long run and on long run convergence. In this paper we empirically assess the role of short-term economic conditions on long run income convergence assuming that the convergence process is essentially non linear, so that it may accelerate under certain economic conditions or regimes, and slow down or even fall into divergence, during other regimes. For that purpose, we need to apply a two-regime econometric model because, since the convergence process may not be uniform, the application of

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[1] To our knowledge, María-Dolores and Sancho-Portero (2004) is the first attempt to address this issue. By applying Hamilton (1989)'s switching regime methodology, these authors showed that the speed of convergence of Spain towards the EU increases during the expansionary phases of the Spanish business cycle. García-Solanes and María-Dolores (2002) investigated the contribution of the European structural funds to income convergence in the EU-15, and Proudman, Redding and Bianchi (1997) emphasised the relevance of economic openness in promoting income convergence, in both cases independently of the cyclical conditions.

[2] Papers on cyclical conformity typically focus on the factors that favour synchronised cycles without examining further implications on economic convergence. For instance, Frankel and Rose (1998) emphasised the relevance of closer integration, and Camacho, Pérez-Quirós and Saiz (2006a) showed the positive influence of macroeconomic variables, the direction of trade and the size of the public sector.

linear panel data models, as made in previous literature, may produce misleading results. We adopt and adapt here the methodology of Beyaert and Camacho (2008) consisting of a panel data threshold autoregressive (TAR) specification in which the series of the panel may exhibit unit roots. In other words, we apply unit root tests in a multivariate TAR model (with bootstrapped critical values) to test per capita income convergence. Our tests take into account simultaneously that the countries might converge within one regime and diverge under the other and that their data are contemporaneously correlated.

This kind of analysis requires that the set of countries under study share important characteristics of their business cycles. Otherwise, an empirical rejection of convergence would be hard to interpret. It would be difficult to discriminate between rejection due to strong differences in short-run economic conditions and rejection reflecting correctly that the countries diverge in the long run. Additionally, it is important that the length of the sample period be sufficiently long to uncover both long-term trends and short-run fluctuations. For these reasons, we base our analysis on two clusters, delimited by Camacho, Pérez-Quirós and Saiz (2006b)[3] for which the available data cover a long enough period. Each of them includes richer and poorer countries that share moreover cycle similarities in duration, deepness and shape. One of the cluster contains the majority of EU-15 countries. In each cluster, we work on the per capita GDP in PPP terms for the period 1950-2010. Furthermore, in order to assess the likely impact of the current financial crisis on convergence processes, our empirical tests are applied on two different sample periods: 1953-2006 and 1953-2010.

To advance some of our results, first of all we detect an impact of the short-run conditions on the long-run convergence process. In one cluster, convergence is present only when the short run economic conditions are sufficiently favourable, and it seems

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[3] Clusters A and B in this study coincide with clusters 3 and 2, respectively, of Camacho, Pérez-Quirós and Saiz (2006b).

that the financial crisis does not impact the convergence trend. In the other cluster, which contains many countries belonging nowadays to the Eurozone, convergence generally takes place independently of the short-run conditions in groups of relatively rich countries with flexible exchange rates. Interestingly enough, convergence between countries that share the Euro is more difficult, or even switches from absolute to only conditional convergence.

The rest of the paper is organised as follows. Section 2 explains briefly the econometric methodology that we apply in our empirical tests; section 3 presents the empirical results; section 4 explains some implications for policy guidance, and section 5 summarises the main theoretical and empirical findings.

2.   Brief summary of the econometric methodology

The econometric methodology used in this paper is inherited from Beyaert and Camacho (2008).   These authors develop a panel data methodology aimed at testing real convergence in a non-linear framework. They combine three approaches: the threshold (TAR) model, panel data unit root tests and the use of bootstrap simulation techniques to compute critical values that are able to take into account the possible contemporaneous correlations between countries.

Let $Y_{n,t}$ be the per-capita income of country n in year t in real terms. Define

$g_{n,t} = y_{n,t} - \bar{y}_t$, where $y_{n,t} = \log(Y_{n,t})$ and $\bar{y}_t = \frac{1}{N} \sum_{n=1}^{N} y_{n,t}$ is the cross-country average log of per capita income at time t . The fundamental equation of Beyaert and Camacho (2008) is:

$$\Delta g_{n,t} = \left[\delta_n^I + \rho_n^I g_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}^I \Delta g_{n,t-i} \right] I_{\{z_{t-1} < \lambda\}} +$$
$$+ \left[\delta_n^{II} + \rho_n^{II} g_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}^{II} \Delta g_{n,t-i} \right] I_{\{z_{t-1} \geq \lambda\}} + \varepsilon_{n,t} \tag{1}$$

with $n = 1, \cdots, N$ and $t = 1, \cdots, T$ and where $I\{x\}$ is an indicator which takes value 1 when

x is true and zero otherwise. It therefore acts as a dummy variable that takes a unit value

if the condition $z_{t-1} < \lambda$ is fulfilled. So, when $z_{t-1} < \lambda$, the model is

$\Delta g_{n,t} = \delta_n^I + \rho_n^I g_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}^I \Delta g_{n,t-i} + \varepsilon_{n,t}$ and the economy is in "Regime I"; otherwise, the

model is $\Delta g_{n,t} = \delta_n^{II} + \rho_n^{II} g_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}^{II} \Delta g_{n,t-i} + \varepsilon_{n,t}$ and the economy stands in "Regime

II". The parameter λ is called the "threshold parameter" and the variable z is the

transition variable that pushes the economy at t into one or the other regime depending on

the value it took at *(t-1)* compared to the threshold parameter. As usual in this type of

frameworks, the value of the threshold parameter is unknown and has to be estimated

along with the other coefficients of the model. By the same token, the transition variable

can be fixed from outside by the analyst or, alternatively, be determined endogenously

among a list of possible variables, as part of the estimation process.

In our case, since we are interested in determining whether short-term economic

conditions, related to business cycles, might affect the possible real convergence process

of the economies, the transition variable must capture the short-run economic conditions

of the group of countries among which convergence is tested (see the empirical section

for a description of how we build this short-run variable).

In model (1), divergence takes place in both regimes if $\rho_n^I = \rho_n^{II} = 0$ for all n.

Alternatively, real convergence takes place in both regimes if

$0 < -\rho_n^i < 1, \ i = I, II, \ \forall n = 1, \cdots, N$. Partial convergence (or partial divergence) takes place whenever the countries converge under one regime but not under the other.

In (1), p is assumed to be high enough so that the error is a white noise process for each n. So serial correlation is excluded, but cross-country contemporaneous correlation is not.

Following Beyaert and Camacho (2008), model (1) is estimated by least squares combining a Feasible Generalized Least Squares procedure with a grid-search procedure[4].

The testing procedure runs then as follows. First, a linearity test is carried out in order to check whether Model (1) is preferable to a linear model, in which all the coefficients would be equal under both regimes. This test is based on the likelihood-ratio principle, with critical values obtained by bootstrap simulation. Additionally, since the simple running of the linearity test is not sufficient to unravel whether the countries converge or diverge, it is carried out under both hypotheses, obtaining therefore two values of the test statistics and two bootstrap probability values (see Beyaert and Camacho, 2008, for details and explanations).

If the linear model is rejected, the next step consists of testing convergence against divergence in (1). On the contrary, if the linear model is accepted, convergence is tested in a linear framework, as developed by Evans and Karras (1996) and extended with bootstrap simulations by Beyaert (2006). Note here that confirmation of the non-linear model implies that the short-run economic conditions have some influence on the convergence process between economies. On the contrary, if the linear model is accepted the conclusion is that the cyclical conditions have no effect on convergence.

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[4] The interested reader should consult Beyaert and Camacho (2008).

To test convergence against divergence, we apply the tests t_1 and t_2 of Beyaert and Camacho (2008). A large value of t_i is a favourable sign of convergence under Regime i ($i =I, II$).

Finally, the last step consists of testing absolute against conditional convergence for the regime under which convergence is established. For that purpose, the tests Φ_b and Φ_c of Beyaert and Camacho (2008) are used. In all the tests, the critical values are computed by bootstrap simulation.

3.   Empirical results

In this section we describe the empirical results obtained with the explained econometric methodology. As indicated above, our analysis is applied to two clusters of countries that share important business cycle features, delimited in Camacho, Pérez-Quirós and Saiz (2006b). Cluster A comprises Austria, Canada, Denmark, Finland, Luxemburg, Spain, Sweden and the USA. Cluster B is made of Belgium, France, Great Britain, Greece, Italy, Japan, Netherlands, Norway and Portugal The data are expressed in 2010 constant and international Geary Khamis (GK) PPP dollars and cover the period 1950-2010. They have been derived from the database of the University of Groningen (Groningen Growth and Development Centre and The Conference Board, Total Economy Database, http://www.ggdc.net).

It has to be borne in mind that the non-linear unit root tests are applied on country deviations of income per capita from the panel average income per capita. This implies that if one country diverges from the others, the whole panel of country deviations presents a unit root (see Beyaert, 2006 for details). So, the first step of the empirical strategy consists of detecting a small group of converging countries, followed by

subsequent moves in which other countries are added to this starting group in order to appropriately evaluate their convergence properties.

The selection of countries for the starting group, as well as the countries to be added afterwards in each cluster, is to be guided by the objective of the study. In our case, we want to test in a first step whether the cyclical position of the economies affects to some extent their convergence properties and, in a second step, how the convergence process is altered as we enlarge the initial group by adding countries with different economic characteristics, particularly related to exchange rates regimes and/or to income levels. So, the starting group has to be formed exclusively by relatively richer and converging countries that exhibit flexible exchange rates. Countries with lower income levels and or different exchange rate regimes are added later on.

As we will see, an intermediate procedure might also consist of adding rich countries to the core of starting converging countries before adding poorer. Different period lengths will be considered in order to detect a possible impact of the international financial crisis and/or the creation of EMU on convergence processes.

For an initial illustration of the relative positions of the countries in each cluster over the period 1950-2010, we present in Figures 1 and 2 the evolution of the real per capita income in PPP of the countries in Cluster A and Cluster B, respectively.

In Figure 1, Luxemburg is the richest country, and since its distance to the others increases over time, we opted to exclude it from the study. The second richest is USA. The poorest is Spain. In the case of Finland and Sweden, their per capita income falls substantially at the beginning of the nineties, very likely as a result of the impact on these two Scandinavian countries of the fall of the communist block. These income decreases are therefore more structural than cyclical. In order to avoid possible ambiguities in the empirical results, these two countries were not considered in the convergence study. Fo

all these reasons, we considered as initial core group, with flexible exchange rates between its members, the three following countries: Canada, Sweden and Denmark.

Insert Figure 1

In Figure 2, it is easy to appreciate that the poorer countries at the end of the period are Italy, Greece and Portugal. On the opposite, Norway is the richest one and its distance from the others increases over time. A possible converging core, with flexible exchange rates between them, is formed by Belgium, Great Britain and Japan. So it makes sense to start with this group and to exclude Norway from the convergence study.

Insert Figure 2

In order to apply the TAR panel unit root tests on these data, we need to make a decision concerning the transition variable. This variable must be I(0) and, according to our objective, it has to be related with the short-run economic conditions of the countries. In this paper, the variable deemed to capture these short-run economic characteristics is the size of the output gap in percentage of the potential output:

$$OG_{n,t} = \frac{Y_{n,t} - Y_{n,t}^*}{Y_{n,t}^*} \times 100 \ ,$$

where $Y_{n,t}$ is total real GDP in PPP for country n in year t and $Y_{n,t}^*$ is potential output for country n in year t. So for each group of countries, for which we want to study

convergence, the variable z_{t-1} will be $OG_{n,t-d}$ for some country n and some positive lag d [5]. Potential output is computed using a left-sided Hodrick-Prescott filter [6].

In what follows, we apply the TAR unit root tests of Beyaert and Camacho (2008) on subgroups of countries of Clusters A and B. The question to be answered is twofold. First, we ask whether there is an effect of the short-run economic conditions on the convergence process. If the answer is affirmative, the second question is how they affect this process. The reply to the first question is provided by the result of the linearity test, which is part of our econometric methodology. The answer to the second question is afforded by the results of the two-regime TAR panel unit root test. After examining the results for the core countries, we apply the same methodology for several enlarged groups.

The results for Cluster A are presented in Table 1. The transition variable is the output gap of an individual country belonging to the group; this country is endogenously selected. For the reasons explained above, the initial core is made of three relatively richer countries: Canada, Sweden and Denmark. They exhibit flexible exchange rates between them. The starting core is subsequently widened with the USA, and three alternative relatively poorer countries: Austria, Finland and finally Spain. For each group, we analyse convergence using two time spans, 1953-2006 and 1953-2010, in order to allow the data to reveal whether the international financial crisis has an effect on the convergence processes.

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[5] Where n and d are endogenously determined and automatically selected by the inferential procedure of Beyaert and Camacho (2008).

[6] Using a left-sided filter offers at least two advantages. The first one is that it avoids endogeneity problems in the estimation process, since the transition variable only depends on past values of the dependent variable, excluding present or future values of it. The second one is that the type of information used to evaluate the output gap is similar to the one used by the policy-makers when they decide which economic policy to carry out.

Table 1 Countries of Cluster A. Threshold variable: country percentage output gap (endogenously selected)								
Group of countries		Linearity tests (unrestricted and restricted tests) (1)	TAR panel convergence tests					
			Country of transition variable	Threshold value; % of data below it	Cvgce in Reg.1 (below threshold) (2)	Cvgce in Reg.2 (above threshold) (2)	Abs. cvgce reg.1 (3)	Abs. cvgce reg.2 (3)
A1	Canada, Sweden, Denmark 1953-2006	**0.028** **0.035**	Canada	-0.3150 21.15%	0.9640	**0.0440**	-	**0.8780**
	Canada, Sweden, Denmark 1953-2010	**0.004** **0.008**	Canada	0.0231 26.79%	0.9090	**0.0380**	-	**0.8040**
A2	Canada, Sweden, Denmark, USA 1953-2006	0.9460 0.8110	linear convergence test: 0.0810					
	Canada, Sweden, Denmark, USA 1953-2006	0.8530 0.7240	linear convergence test: 0.1870					
A3	Canada, Sweden, Denmark, Austria 1953-2006	**0.015** **0.0300**	Denmark	-1.3556 15.38%	0.2860	*0.0550*	**-**	*0.9980*
	Canada, Sweden, Denmark, Austria 1953-2010	**0.051** **0.058**	Sweden	0.7615 37.04%	0.0862	0.4940	0.5900	-
A4	Canada, Sweden, Denmark, Finland 1953-2006	**0.0460** **0.0390**	Sweden	-1.7994 17.65%	0.1480	0.1990	**-**	**-**
	Canada, Sweden, Denmark, Finalnd 1953-2010	**0.051** **0.058**	Sweden	-1.7994 16.36%	0.1570	0.2030	-	-
A5	Canada, Spain, Sweden, Denmark 1953-2006	**0.013** **0.012**	Spain	2.9131 46.15%	0.6220	**0.0200**	**-**	**0.8490**
	Canada, Spain, Sweden, Denmark 1953-2010	**0.007** **0.004**	Spain	2.9131 46,43%	0.4570	**0.034**	**-**	**0.7870**
(1) A p-value below 0.05 implies rejection of linearity at 5%. (2) A p-value below 0.05 implies convergence at 5% under the corresponding regime. (3) If divergence has been rejected, a p-value below 0.05 implies conditional convergence at 5%.								

For the core countries (Canada, Sweden and Denmark), linear convergence is clearly rejected in favour of the TAR non-linear one for each period (see column 2 of Table 1). This means that the cycle does have an effect on convergence. According to the TAR

convergence tests (columns 3 to 8 of the Table 1), the transition variable is the output gap of Canada for the two sample periods, with a threshold value estimated at -0.3150 in the pre-crisis time span and at 0.0231 for the whole period. The portion of the sample corresponding to Regime *I* (below the threshold) compounds a relatively low percentage in each sample period: 21.15% and 26.79%, respectively. According to the tests, there is no convergence under Regime *I*, but absolute convergence takes place under Regime *II*, which broadly includes the upper part of the cyclical phase. Since the results are very similar in the two periods, it turns out that the financial crisis does not seem to modify the characteristics of the convergence process for these countries. Figure 3 offers an ocular inspection of these results. What the results indicate is that convergence takes place when the short-run economic conditions are sufficiently good. The recent crisis, with a strong worsening of the short-run conditions, has also altered the long run convergence process, but not differently from other crisis periods.

Insert Figure 3

The addition of the USA to this core group modifies the results substantially, in the sense that now the analysis does not require non-linear methods (see column 2 of table 1 for group A2), so it seems that the relative long-term positions of these four countries are not influenced by their cycle. But the test of linear convergence offers an unambiguous result: there is no evidence of convergence between these four countries neither till 2006, nor till 2010. In other words, these countries do not converge in the long run, and their short-run conditions do not make any difference. So, the USA is extracted form the group and we add instead another, relatively poorer, country.

Results presented in Table 1 indicate that when the core is enlarged with poorer countries (groups 3, 4 and 5), the cycle always matters, but absolute convergence is not guaranteed. For the sake of brevity, let us concentrate on the enlargement that includes Spain. Linearity is rejected (see results for group A5 in Table 1), and the transition corresponds to the Spanish output gap, with positive value in both periods: 0.6220 and 0.4570, respectively, with approximately 46% of the sample below these levels. There is no convergence in Regime *I*, but absolute convergence is evidenced under Regime *II* of both periods. Spain stood in this regime almost 54% of the time. The results are very similar for both time periods, so the last crisis (with the data available so far) does not seem to have altered substantially the process. But the results clearly indicate that the short-run economic situation has to be sufficiently favourable to guarantee that Spain converge to the other countries. The graphical representation of the results is presented in Figure 4.

Insert Figure 4

Let us now examine convergence among countries of Cluster B, where several Euro members are included. The results are presented in Table 2. Again, the transition variable between regimes is determined endogenously by the testing procedure. The initial core is made of three countries (Belgium, Great Britain and Japan). Then the Netherlands is added. The periods 1953-2006 and 1953-2010 are analysed. The most interesting aspect of this cluster is that convergence can be studied on several countries of cluster B who share the Euro, in contrast with other groups that do not share a common currency. To ascertain whether EMU has affected the convergence process among its members and whether the recent crisis has affected the process, we apply our tests to three alternative period lengths in this case: 1953-1999, 1953-2006 and 1953-2010.

For the core countries (Belgium, Great Britain and Japan), the linearity tests reject again a linear approach to convergence in favour of the TAR non-linear one for each period (see column 2 of Table 3, for group B1). So the first conclusion is again that the cycle does have an effect on convergence. As far as the TAR convergence tests are concerned, the transition variable is the percentage output gap of Japan, and the threshold value is estimated at -0.1371 in each time span, which corresponds to a slightly negative output gap. Regime *I*, below this threshold, includes approximately 41% of the sample data, and the remaining data (above the threshold) correspond to Regime *II*. According to the tests, absolute convergence takes place under both regimes. However, since the estimated convergence coefficient ρ of equation (1) is higher under Regime *II* (0.97) than under Regime *I* (0.83), with small standard deviations in each case, the results suggest that the upper cyclical phase brings about more convergence than the lower part of the cycle.

As illustrated in figure 6, convergence takes place along the whole cycle of Japan, and seems to increase under Regime *II* in each of the time spans. Finally, our tests show that the convergence process is not altered by the financial crisis. This is similar to what we observed in Cluster A.

Insert Figure 6

Once we add the Netherlands to this core group (group B2), the influence of the cycle on convergence is confirmed because linearity is rejected again in all cases. The convergence results are similar: there is absolute convergence under both regimes, with no obvious or detectable differentiated effect of the last crisis.

Table 2 Countries of Cluster B Threshold variable: country percentage output gap (endogenously selected)								
			TAR panel convergence tests					
Group of countries		Linearity tests (1)	Country of transition variable	Threshold value; % of data below it	Reg.1 (below threshold) (2)	Reg.2 (above threshold) (2)	Abs. cvgce reg.1 (3)	Abs. cvgce reg.2 (3)
B1	Belgium, UK, Japan, **1953-2006**	**0.000** **0.000**	Japan	-0.137 41.82%	**0.009**	**0.052**	**0.6720**	**0.4620**
	Belgium, UK, Japan, **1953-2010**	**0.000** **0.000**	Japan	-0.137 41.18%	**0.010**	**0.032**	**0.5740**	**0.3790**
B2	Belgium, UK , Netherlands, Japan, **1953-2006**	**0.000** **0.000**	NL	1.6257 70.90%	**0.001**	**0.012**	**0.9410**	**0.5240**
	Belgium, UK, Netherlands, Japan, **1953-2010**	**0.000** **0.010**	NL	1.6257 68.63%	**0.003**	**0.0220**	**0.9870**	**0.5640**
B3	Belgium, Italy, The Netherlands, Portugal, France, Greece **1953-1999**	**0.6520** **0.4490**	**Test of linear convergence:** **0.0410**				Test of absolute against conditional linear convergence: **0.4630**	
	Belgium, Italy, The Netherlands, Portugal, France, Greece **1953-2006**	**0.0950** **0.1010**	[France]	[-1.1504 19.61%]	[0.8180]	**[0.0230]**	-	**[0.1760]**
	Belgium, Italy, The Netherlands, Portugal, France, Greece **1953-2010**	**0.0030** **0.0010**	France	0.3944 40.38%	0.6160	**0.0140**	-	0.0730

(1) A p-value below 0.05 implies rejection of linearity at 5%.

(2) A p-value below 0.05 implies convergence (as opposed to divergence) at 5% under the corresponding regime.

(3) If divergence has been rejected, a p-value below 0.05 implies conditional convergence at 5% (as opposed to absolute convergence).

Given that this cluster contains a majority of Euro countries, it seems justified to apply our convergence tests to the whole set of countries of the sample that share the Euro, instead of adding new Euro countries to the core group. This strategy allows us to empirically test and verify the conventional wisdom according to which sharing the same currency might make the convergence process among countries with different economic conditions more difficult. The Euro countries of this cluster are Belgium, Italy, France, the Netherlands, Portugal and Greece. They correspond to group B3 in Table 2. We apply the linearity and convergence tests to the 1953-1999 pre-Euro period, the 1953-2006 pre-crisis period and the whole sample period 1953-2010.

As far as the 1953-1999 period is concerned (row 7), the linearity test does not reject the linear approach (p-value up to 65%) and excludes the TAR cyclical one. Moreover, the linear convergence tests provide evidence in favour of absolute convergence among the countries. In other words, till 1999, these countries were converging in the long run, without detectable influence of the short-run economic conditions on this process. Things look rather different when the sample extends to years after the implementation of the Euro. According to the results in row 8 of Table 2, referred to the period 1953-2006, there are symptoms that the cycle affected the convergence process: linearity is still accepted at a 5% level, but it can be rejected at a 10% level (the p-value falls to 9.5% as compared with 65.20% when the sample stops in 1999). Under this hypothesis, the TAR convergence tests indicate non-convergence under Regime *I*, which takes place when France stands in the lowest part of its cycle. This is in sharp contrast with the overall convergence results obtained till 1999. The divergence is even stronger when the sample covers the full period till 2010 because, in this case, linearity is severely rejected, even at a 1% probability level, and convergence takes place only if good short-run economic conditions prevail, which corresponds roughly to 60% of the sample.

Last but not least, when convergence takes place within the group of Euro members in the enlarged period, there are some signal that this convergence is much closer to be conditional than absolute (the p-value is 0.0730, so that absolute convergence would be rejected at 10% -although accepted at 5%-, which strongly diverges from the rest of results, in which the absolute convergence p-values are very high). Figure 6 clearly illustrates two important features; firstly the share of observations with convergence properties is higher during the pre-Euro sample and, secondly, the years of the financial crisis have a negative impact on the convergence within this group of Euro countries. Given that the test results change so drastically when the Euro period is introduced in the sample, and taking into account that this period is relatively short, it seems reasonable to conclude that the implementation of the Euro has altered the convergence process.

4.   Discussion for policy guidance

Our empirical tests applied to the first cluster, made of countries with flexible exchange rates, provided three main results. First, short-run economic conditions do affect long-run convergence; second, countries diverge in bad economic times, with the important particularity that good short-run conditions are necessary but not sufficient to converge; and three, the results are not altered when data of the recent and profound crisis are added.

These findings can be interpreted in terms of policy implications. The main message is that structural policies and reforms, which are always advised to improve the long-run level of per capita income, must be combined with stabilisation actions aimed at shortening the stay of countries in the bad regime in order to mitigate the negative impact of this regime on convergence with richer countries. This is especially relevant under the

current financial crisis. If the authorities of these countries do not adopt short-run efficient policies to overcome rapidly the recessive phase, undesirable results will emerge not only in terms of internal imbalances and unemployment, but also in terms of increasing divergence with respect to richer countries that take part of the same or similar negative phase.

As far the cluster B is concerned, the main result is, once more, that the cyclical phase matters for convergence among the members of the cluster, when the sample period includes the years elapsed since the launching of the Euro. However, the requirement for convergence is less strict than in cluster A because now convergence takes place under each regime. Nonetheless, since good economic conditions intensify convergence, the authorities of countries of cluster B are again advised to implement stabilisation policies to overcome the recessionary period as soon as possible.

On the other hand, our empirical analysis referred to the Euro countries is especially relevant to evaluate the implications of sharing the same currency on the convergence process within this area. The influence that we detect with the data gathered up till now is negative. In fact, whereas in the pre-Euro era (1953-1999) convergence was always present in absolute terms, and not influenced by the short-run conditions, during the longer period that includes the Euro (1953-2010) convergence tended to be conditional – instead of absolute – and existed only under good short-run economic conditions[7]. This implies that the implementation of the Euro has altered and worsened the convergence process among its member countries.

Consequently, two important policy implications can be derived. The first one is that the European authorities must implement structural reforms and institutional changes to

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[7] The general trend towards economic convergence that we find among the countries of the Euro zone agrees with the convergence results of Maza and Villaverde (2011), circunscribed to European regions.

avoid the evolution towards different national steady states. In the absence of these actions, inequalities between countries and regions of the EZ will irremediably grow over time and the survival of the Euro zone will be in danger[8]. The second policy implication is that, as in the other cluster and groups of countries analysed above, stabilisation policies are necessary to increase the probability – and the number of years - of staying in Regime *II* (good economic conditions), which is the one that enhances long-term convergence.

The latter consideration leads us to evaluate the implications of the current financial crisis on the process of economic convergence within the EZ. Our econometric tests reveal that the crisis impacts negatively because it reduces the share of observations with convergent properties (the number of years of Regime *II*). Moreover, since national policy actions have proven to be ineffective to solve the tremendous problems created by the financial crisis, a European supranational approach is imperative. This important message agrees with the analysis of De Grauwe (2011) on the differentiated impact that the financial crisis infringes to countries that loose the capacity of issuing debt in domestic currency. According to this author, the solution to this problem requires higher degree of political integration and additional steps of economic coordination.

5.   Summary and concluding remarks

In this paper we have analysed the extent to which long-run per-capita GDP convergence is affected by the business cycle. For this purpose, we have used two clusters composed of countries whose business cycles share important common characteristics. The

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[8] Real convergence is indeed necessary to safeguard both the cohesion within the Euro zone and the credibility on the euro, for the same reasons argued by Beine and Hecq (1998) in the pre-Euro era, within the EMS regime.

underlying motivation is that the convergence process is neither linear nor gradually decreasing as stipulated in the traditional theory of economic growth. Rather, we should expect that economic convergence within groups of countries that have common business cycle characteristics be affected differently by distinct short-run economic conditions. To deal correctly with this issue, we have applied unit root tests and bootstrapping in a multivariate TAR model, to each cluster during the period 1953-2010.

We obtain that in both clusters business cycle does affect long-run convergence, to the extent that it takes place only under good short-run economic conditions. Our special analysis restricted to a subgroup of countries that share the Euro indicates that the implementation of the common currency affected the convergence process negatively, since convergence switched from being absolute and independent of the short-run conditions till 1999, to be much closer to conditional convergence and present only if the short-run economic conditions are favourable when the data are extended till 2010.

One important implication of our empirical results is that, although growth-led actions that increase economic growth, such as generalised R&D and human capital investments, are advised in each cluster during any phase of the business cycle – as emphasised by Salinas-Jiménez, Álvarez-Ayuso and Delgado-Rodríguez (2006), among others -, they are particularly advisable for countries which are most affected by the current financial crisis and/or plunged on convergence process of conditional nature. Moreover, short-run counter-cyclical policy responses and actions are also vividly advised not only to overcome the current crisis but also to foster real economic convergence in each cluster and, particularly, within the Euro zone.

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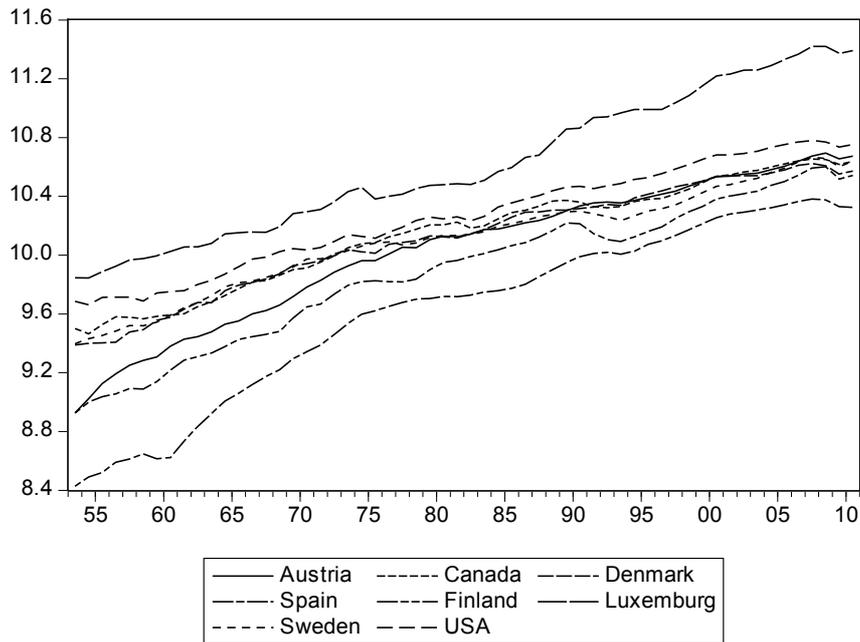Figure 1: Per capita GDP in PPP of countries of cluster A (logarithms)

Austria	Canada	Denmark
Spain	Finland	Luxemburg
Sweden	USA	

Figure 2: Per capita GDP in PPP of countries of cluster B (logarithms)

Belgium	France
Great britain	Greece
Italy	Japan
Netherlands	Norway
Portugal	
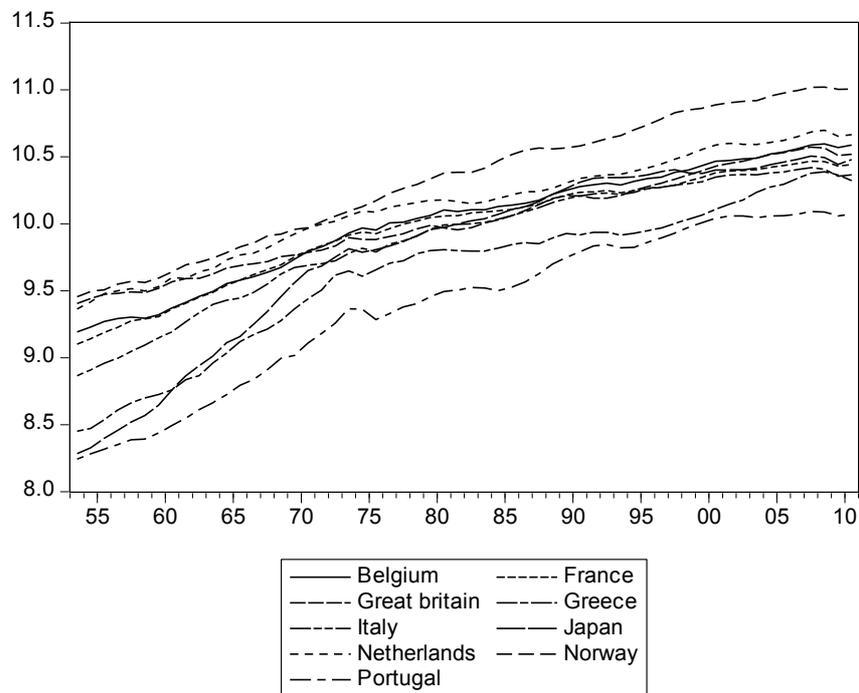
Figure 3: Group A1 - Canada, Sweden and Denmark
Output gap: Canada
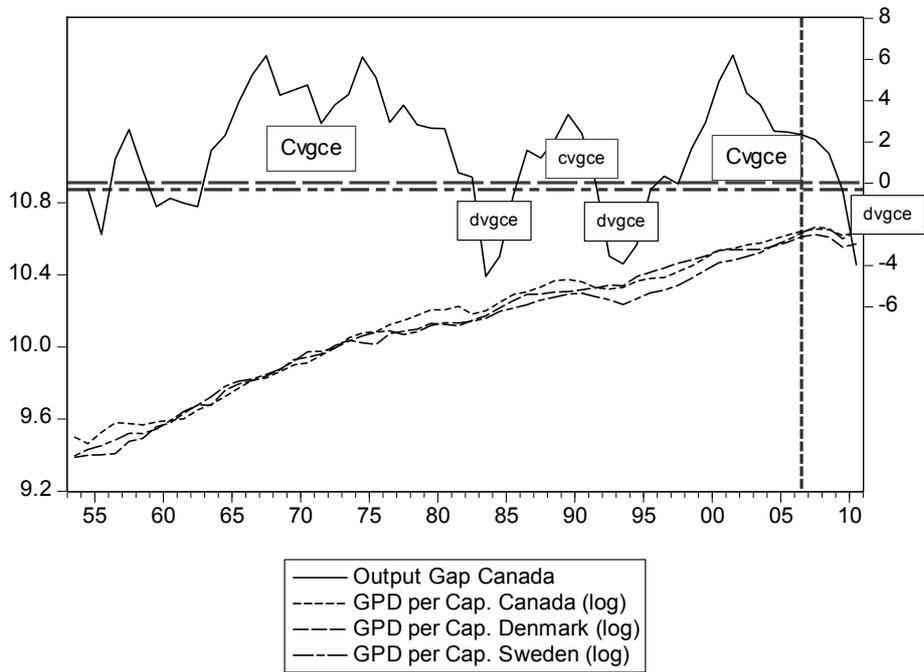

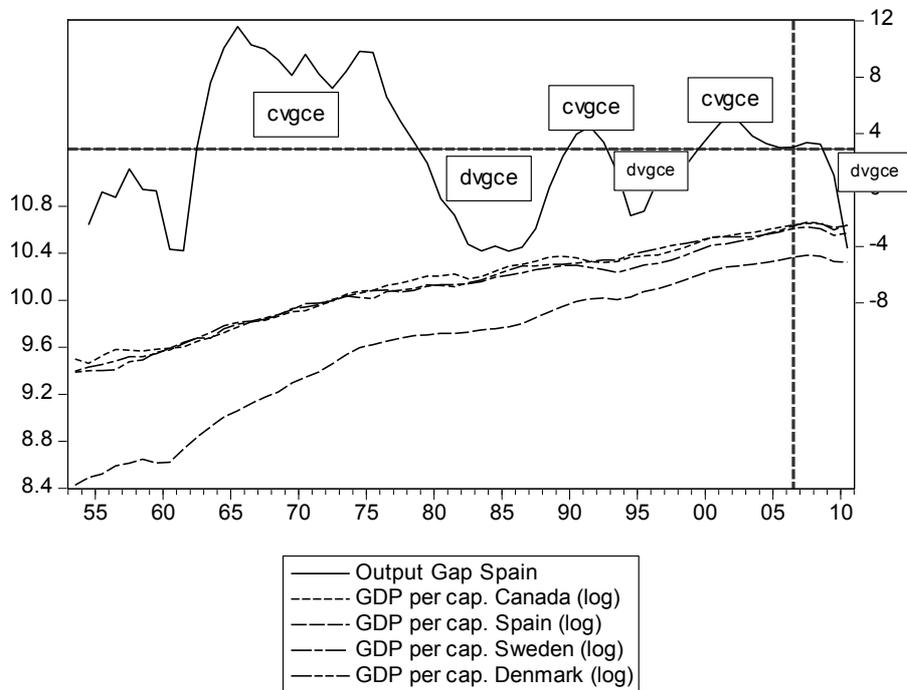Figure 4: Group A5: Canada, Sweden, Denmark and Spain. Output gap: Spain

Figure 5: Group B1: Belgium, United Kingdom and Japan
Output gap: Japan

GDP per cap. Belgium (log)
GDP per cap. United Kingdom (log)
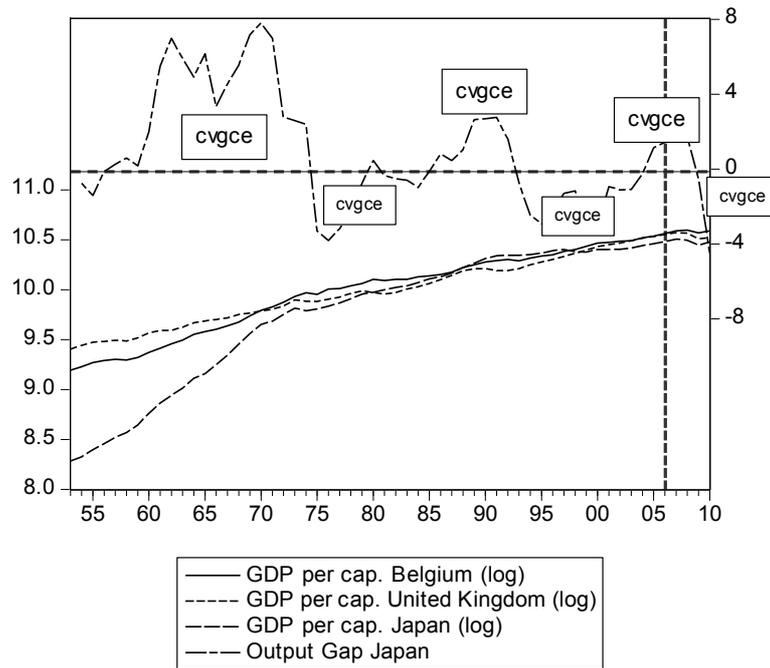GDP per cap. Japan (log)
Output Gap Japan

Figure 6: Group B3: Belgium, Italy, Netherlands, Portugal, France and Greece.

Output gaps: France 1953-2006 and 1953-2010

GDP per cap. Belgium (log)
GDP per cap. Italy (log)
GDP per cap. Netherlands (log)
GDP per cap. Portugal (log)
GDP per cap. France (log)
GDP per cap. Greece (log)
Output gap France (till 2006 and 2010)