

# III. Convergence and macroeconomic imbalances

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*This section looks at the relationship between convergence patterns across the euro area and dynamics following the unwinding of imbalances. It compares the main features of convergence within the euro area with that of other country groups. It looks at both 'sigma' and 'beta' convergence, in relation to output and total factor productivity (TFP), conditioning on relevant variables that affect long-run growth. Expected convergence paths for euro area countries are estimated using growth regressions run on a large panel of advanced and emerging market economies. Our findings suggest that macroeconomic imbalances such as high private and government debt or strong growth in the non-tradables sector can hamper economic convergence. Overall, the analysis underscores the importance of conditions that ensure macro stability and resilience for economic convergence.*

## III.1. Introduction

In the run-up to the economic and monetary union (EMU), the Maastricht criteria emphasised nominal convergence as a requirement for achieving a stable common currency. This implied convergence in nominal variables including inflation, interest rates, deficits and debts. At the same time, academic debate was largely focused on the desirable characteristics of countries sharing a common currency. In line with the optimal currency area (OCA) theory (Mundell, 1961), countries ought to be sufficiently similar and integrated to reduce the likelihood of asymmetric shocks. They should also, have flexible product and labour markets to lower the costs of adjusting to asymmetric shocks in the absence of nominal exchange rates<sup>(103)</sup>. In this respect, the emphasis was more on real convergence, whereby poorer countries grow faster than richer ones. In the process, these countries undergo a structural transformation, making them more like countries with a high per-capita income. This limits the occurrence of asymmetric shocks and reduces adjustment costs in a monetary union<sup>(104)</sup>.

During the first decade of EMU nominal convergence appeared to go hand in hand with real convergence. Nominal interest rates converged on the back of financial integration and a reduction in perceived risks. Capital flowed from richer countries in the euro area 'core' to the euro area 'periphery'. Current account divergences (a gradual

build-up of surpluses in the core and deficits in the periphery) were generally seen as supportive of this convergence process<sup>(105)</sup>.

The financial crisis led to a reversal of the current account deficits accumulated in the euro area periphery during the first years of EMU and to a subsequent period of nominal and real divergence. This was driven by increased interest rate spreads and deep and protracted recessions in the countries most affected by the crisis.

To better understand these developments and their causes, this article intends to shed more light on the relationship between real convergence patterns in the euro area and dynamics following the unwinding of imbalances. It goes a step forward than existing companion analyses in several respects<sup>(106)</sup>. First, it assesses convergence patterns in the euro area against the experience of benchmark country groups. Second, it considers convergence along different dimensions, not only in terms of per-capita GDP but also in terms of per-capita capital stock, TFP and GDP per employee. Third, it estimates expected convergence paths for euro area countries, and connects the distance from these paths to the presence of macroeconomic imbalances.

<sup>(103)</sup> Mundell, R. A. (1961), 'A theory of optimum currency areas', *The American Economic Review*, 51(4), 657-665. See also Artis, M. J. (2003), 'Reflections on the optimal currency area (OCA) criteria in the light of EMU', *International Journal of Finance and Economics*, 8(4), 297-307.

<sup>(104)</sup> This concept differs from that of convergence towards efficient economic structures introduced in Berti, K. and Meyermans, E. (2017), 'Sustainable convergence in the euro area: A multidimensional process', *Quarterly Report of the Euro Area*, 3.

<sup>(105)</sup> There were nevertheless signs of concern. See European Commission (2006), 'Focus: Widening current account differences within the euro area', *Quarterly Report of the Euro Area*, 4, pp. 25-37.

<sup>(106)</sup> Recent analyses on convergence in the EU and euro area are found in Sondermann, D. (2014), 'Productivity in the euro area: any evidence of convergence?', *Empirical Economics*, 47(3), 999-1027; Estrada, Á. and López-Salido, D. (2013), 'Patterns of convergence and divergence in the euro area', *IMF Economic Review*, 61(4), 601-630; ECB (2015), 'Real convergence in the euro area: evidence, theory and policy implications', in *European Central Bank Economic Bulletin* 2015(5); and Berti and Meyermans (2017) op. cit.

Section I.2 of the article documents the main patterns observed in euro area convergence, both nominal and real. Section I.3 presents the main insights into real convergence patterns measured in terms of ‘sigma’ convergence, i.e. based on dispersion across countries (see Box III.1), by comparing different country groups, and studying the behaviour of variables beyond per-capita GDP. It also analyses ‘beta’ convergence — when countries with lower income per capita tend to grow faster, based on growth regressions (Barro and Sala-i-Martin, 2004) — run on a large panel of advanced and emerging market economies<sup>(107)</sup>. These growth regressions are used to estimate expected convergence paths. Section I.4 then focuses on investigating whether ‘convergence gaps’, i.e. deviations from these estimated paths, are associated with a set of variables that measure the presence of macroeconomic imbalances<sup>(108)</sup>.

Results show differences in convergence patterns within the euro area, as convergence among the founding members, excluding Luxembourg (EA-11), appears to be less strong than among the euro area as a whole. Growth rates below expected convergence paths also tend to be associated with high initial stocks of private debt, both for euro area and non- euro area countries. Government debt and strong growth in the non-tradable sector also reduce convergence in the euro area. The effect of the latter confirms that interest rate differentials prior to the crisis led to an excessive expansion of the non-tradable sector in the euro area periphery, which did not support convergence (Buti and Turrini, 2015)<sup>(109)</sup>.

<sup>(107)</sup> Barro, R. J., and Sala-i-Martin, X. (2004), *Economic Growth*, MIT Press, Cambridge, Massachusetts.

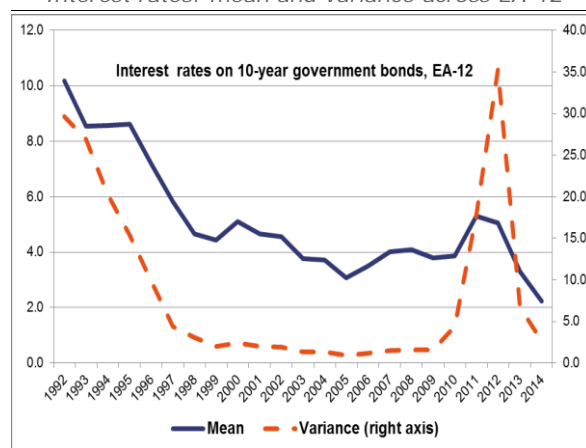
<sup>(108)</sup> Previous literature has analysed the link between business cycle synchronisation and variables related to macroeconomic imbalances (see Inklaar, R., Jong-A-Pin, R., de Haan, J. (2008), ‘Will business cycles in the euro area converge? A critical survey of empirical research’, *Journal of Economic Surveys*, 22 (2), 234-273.). More recently, Lukmanova, E., and Tondl, G. (2017), ‘Macroeconomic imbalances and business cycle synchronisation. Why common governance is imperative in the Eurozone’, *Economic Modelling*, 62, 130-144, find an important role for differences in government and private debt in lowering the degree of business cycle synchronisation in the euro area. The present focuses on the role of imbalances in explaining the pace of convergence rather than business cycle synchronisation.

<sup>(109)</sup> Buti, M., and Turrini, A. (2015), ‘Three waves of convergence. Can Eurozone countries start growing together again?’ *Vox*, EU, 17.

### III.2. Main patterns in euro area convergence

The Maastricht criteria mainly focused on nominal convergence. Fast convergence was achieved in the run-up to the launching of the euro in January 1999 for nominal interest rates. In anticipation of a stable currency and no redenomination risks, both the mean and the variance of 10-year government bond rates across EA-12 countries dropped significantly between 1994 and 1997 (see Graph III.1). This convergence lasted for about a decade, but was interrupted by the European sovereign debt crisis of 2010-2012, during which the variance of 10-year government bond rates across the EA-12 spiked to levels last seen only prior to the 1990s.

Graph III.1: **Nominal convergence**  
Interest rates: mean and variance across EA-12



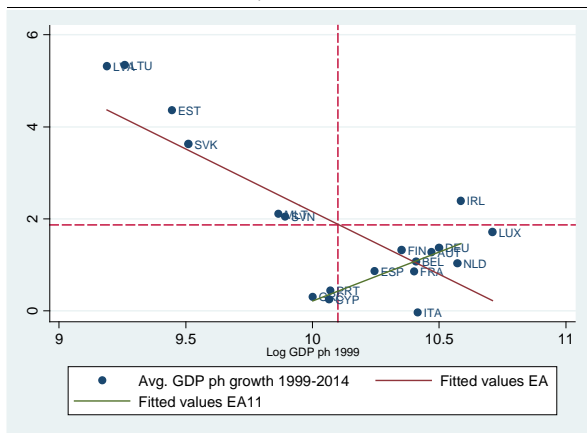
Source: AMECO database, European Commission

Regarding real convergence - the convergence of GDP per capita - conclusions are less clear-cut. Without conditioning on other factors, convergence is present in the euro area. In other words, on average poorer countries have grown faster than richer countries in the period 1999-2014. However, among the EA-11 (founding members excluding Luxembourg), divergence occurred instead (see Graph III.2). Recent analyses have also highlighted this finding (ECB, 2015; Berti and Meyermans, 2017)<sup>(110)</sup>.

<sup>(110)</sup> Op. cit.

Graph III.2: **Real convergence**

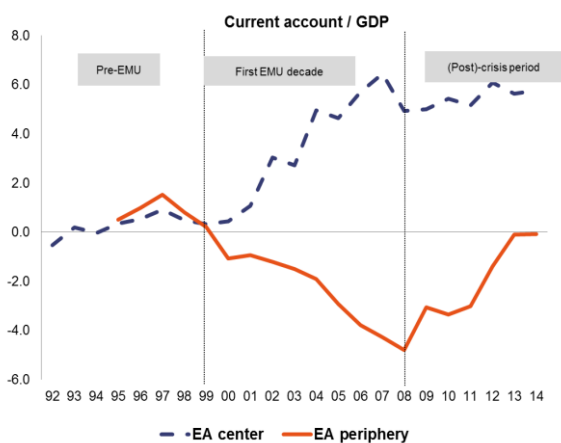
Real GDP growth vs initial log GDP per capita in euro area, 1999-2014



Source: Penn World Tables 9.0

Graph III.3: **External balances**

Current account average for euro area centre vs periphery (weighted average)



(1) Centre: BE DE LU NL AT FI. Periphery: EE IE EL ES FR IT CY LV LT MT PT SI SK. Centre and periphery euro area countries grouped according to their external position over the 1999-2009 period.

Source: Eurostat

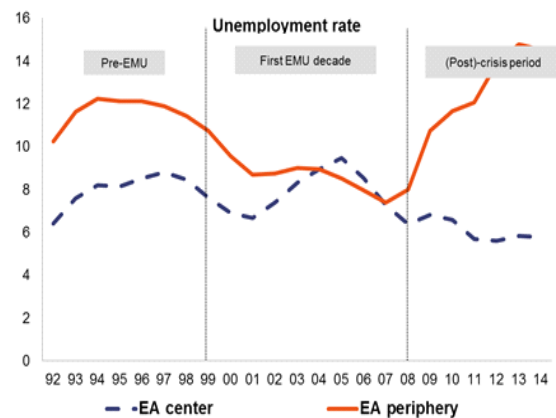
During the first decade of EMU, capital flows in fact supported convergence. The euro area was an exception to the Feldstein-Horioka puzzle, as capital flowed from relatively high-income countries to relatively low-income ones<sup>(11)</sup>. This translated into a positive and growing current account balance in the rich centre of the euro area and a negative and growing current account deficit in the poorer periphery (see Graph III.3).

<sup>(11)</sup> Feldstein M. and Horioka, C. (1980), 'Domestic Saving and International Capital Flows', *Economic Journal*, 90 (358): 314-329. In this paper, the authors observed that savings are usually invested in the country where they occur and not where the highest rates of return on capital are observed.

Prior to the crisis, the flow of investment to the periphery was channelled primarily to the non-tradable sector. This meant that persistent real interest rate differentials did not only shape cyclical positions according to the Walters' critique of EMU but also economic structures (Buti and Turrini, 2015)<sup>(12)</sup>. The growth of the non-tradable sector in the euro area periphery - in some cases the counterpart of large-scale housing market bubbles - was generally accompanied by cost competitiveness losses, and worsened the prospects for a more durable growth engine based on exports.

Graph III.4: **Unemployment developments**

Average for euro area core versus periphery (weighted average)



(1) Centre and periphery defined as before.

Source: Eurostat

The global financial crisis implied a re-appraisal of risk and a sudden withdrawal of capital from the periphery, forcing this group of countries to contract. This market reaction reversed the trend on the current account deficits of the euro area periphery. However, it did not impose the same symmetric adjustment on the euro area centre. 'Sudden stops' such as these tend to affect deficit countries more than surplus countries, as surplus countries redirect their savings to other locations. Growth slowed significantly in the periphery, in light of a sudden contraction in demand, stalling the convergence process.

<sup>(12)</sup> The economic structure shapes the way the economy responds to shocks. For instance, the excessive weight of the construction sector left several economies particularly vulnerable to the credit crunch experienced in the global financial crisis.

### Box III.1: Concepts of convergence

#### Beta convergence

*Unconditional beta convergence* is observed when the growth rate of real per capita GDP is negatively related to the starting level of real per capita GDP. This type of convergence implies that poorer economies eventually catch up with richer ones, by growing faster. Hence the parameter  $\beta$  in equation (1) is expected to be negative and statistically different from zero.

$$\Delta \log Y_{it} = \alpha + \beta \log Y_{it-1} + u_{it} \quad (1)$$

where, the average growth rate of country  $i$  over a time period  $t$  is approximated by the log difference of GDP per capita,  $\Delta \log Y_{it}$ . On the right hand side is the level of GDP per capita at the start of the period,  $Y_{it-1}$ , and a random disturbance  $u_{it}$  with mean zero and constant variance, uncorrelated with  $Y_{it-1}$ .

*Conditional beta convergence* is observed when the growth rate of real per capita GDP is negatively related to the initial level of real GDP per capita, holding fixed other variables that may affect growth, such as population growth, investment, or the initial level of human capital. Formally, the right hand side of equation (1) is extended to account for the effect of a vector of control variables  $Z_{it}$ .

#### Sigma convergence

The concept of sigma convergence relates to the cross-sectional dispersion of income. There is sigma convergence if income dispersion, measured by the standard deviation of the logarithm of GDP per head across a specific group of countries, declines over time. In the absence of shocks in per capita income and with a common steady-state, beta convergence tends to result into sigma convergence. Abstracting from the set conditioning variables  $Z$ , equation (1) can be rewritten as follows (see Barro Sala-i-Martin, 2004).

$$\Delta \log Y_{it} = \alpha - (1 - e^{-\lambda}) \log Y_{it-1} + u_{it} \quad (2)$$

If  $\lambda > 0$ , equation (2) implies that poorer countries grow faster than richer ones ( $\beta = -(1 - e^{-\lambda}) < 0$ , beta convergence). Defining the variance of  $\log Y_{it}$  as  $\sigma_t^2$ , equation (2) also implies equation (3), where  $\sigma_u^2$  is the variance of  $u_{it}$ :

$$\sigma_t^2 = e^{-2\lambda} \sigma_{t-1}^2 + \sigma_u^2 \quad (3)$$

Equation (3) also implies that the speed of convergence depends on the degree of dispersion in per capita GDP. The higher the dispersion that faster the speed of convergence.

Equation (3) is a first-order difference equation with a solution given by equation (4).

$$\sigma_t^2 = \mu + (\sigma_0^2 - \mu) e^{-2\lambda t} \quad (4)$$

where  $\mu = \sigma_u^2 / (1 - e^{-2\lambda})$  is the steady-state value of  $\sigma_t^2$  and  $\sigma_0^2$  is the variance of the initial levels of income. Equation (4) shows that the dispersion in per-capita income across countries depends on whether the initial value of sigma is above or below the steady-state value. Therefore,  $\lambda > 0$  ( $\beta < 0$ ) is a necessary but not a sufficient condition for a declining sigma. However, notice that the conditions on the error term will be violated if, for instance, there is an additional common disturbance  $S_t$  affecting countries differently depending on their level of income. In this case, equation (3) becomes:

$$\sigma_t^2 = e^{-2\lambda} \sigma_{t-1}^2 + \sigma_u^2 + \sigma_\eta^2 S_t^2 + 2S_t e^{-\lambda} \text{cov}[\log Y_{it-1}, \eta_i] \quad (5)$$

where  $\sigma_\eta^2$  is the variance of the coefficient  $\eta_i$  determining the impact of  $S_t$  in each region. In this case, temporarily large or small realisations of  $S_t$  can move  $\sigma_t^2$  temporarily above or below its long-run value  $\sigma^2$ , interrupting the sigma convergence process.

The dispersion in cyclical positions across the euro area observed from 1999 is mirrored in diverging unemployment trends (see Graph III.4). From 1999 to 2007, the periphery experienced a prolonged expansion, which resulted in unemployment falling sharply. On the other hand, the euro area centre experienced a slowdown between 2000 and 2005, with increasing unemployment. As the crisis unfolded,

unemployment shot up in the periphery along with the deep recession. In the centre, where output started to recover much faster, it even slightly declined. This pattern in unemployment reflects the evolution of external positions during the first decade of EMU (Graph III.3). A key lesson from the crisis was that macroeconomic imbalances matter greatly for the stability of EMU, while the

focus on growth before the crisis led to an attitude of benign neglect.

### III.3. Real convergence in the euro area

Real convergence across the euro area is first assessed in terms of sigma convergence, using time plots of the standard deviation of the logarithm of GDP per capita, capital per capita, TFP, and other real variables (see Box III.1 for definitions). Insights from sigma convergence help distil a number of stylised facts. Beta convergence is analysed instead using growth regressions, which condition on a number of variables that determine differences in steady states, in addition to the initial level of income or TFP. These growth regressions are used to estimate expected convergence paths and to compare deviations from these paths to variables that measure the presence of macroeconomic imbalances.

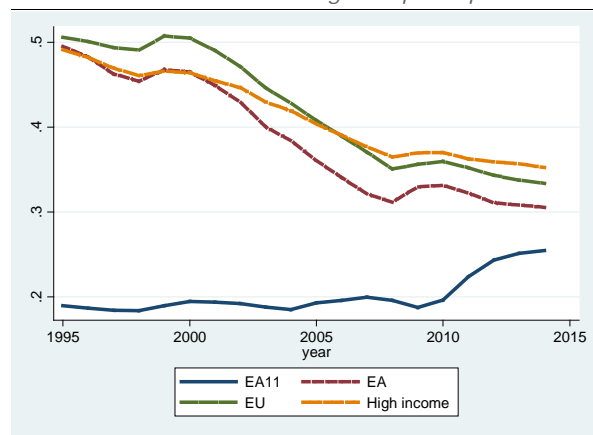
#### III.3.1. Sigma convergence

Sigma convergence requires a decline in cross-country variation of income per capita over time. To assess sigma convergence, Graph III.5 shows the standard deviation of log GDP per capita for the euro area and three other country groups, including the EA-11 - the euro area founding members including Greece and excluding Luxembourg -, the EU and high-income countries. The graph displays data from 1995 to avoid missing data for former transition countries.

The dynamics of income dispersion indicate that sigma convergence has been faster in the EU and the euro area than among other high-income countries. This confirms previous studies that regard the EU as a ‘convergence club’ (see Schadler et al., 2006, and Böwer and Turrini, 2010)<sup>(113)</sup>. However, this convergence has concerned mostly Member States from central and eastern Europe that joined the EU more recently. Consistently, the EA-11 group displays virtually no convergence pattern until the financial crisis, as well as divergence after this period.

<sup>(113)</sup> Schadler, S, Mody, A, Abiad, A and Leigh, D. (2006), ‘Growth in the central and in eastern European countries of the European Union’, IMF Occasional paper no 252, International Monetary Fund, Washington D.C.  
 Böwer, U. and Turrini, A. (2010), ‘EU Accession: A Road to Fast-track Convergence?’ *Comparative Economic Studies*, 52, 181-205.

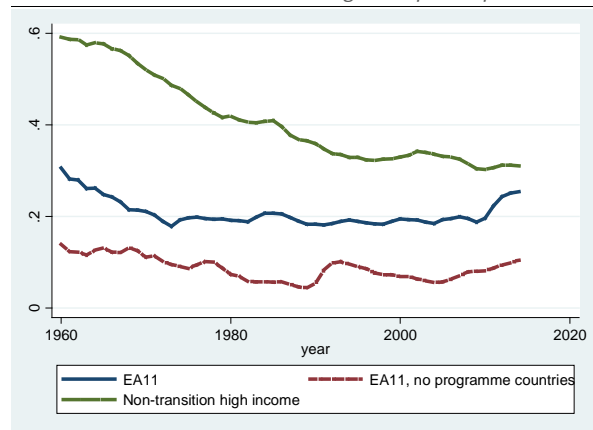
Graph III.5: **Sigma convergence: euro area vs other country groups**  
 Standard deviation log GDP per capita



Source: Penn World Tables 9.0

Graph III.6 displays convergence patterns over a longer period to provide better insight into what could drive the result for the EA-11. The graph displays a comparison of the EA-11 with (i) a larger group of advanced, non-transition economies, and (ii) the EA-11 excluding the countries that underwent the most notable recessions after the financial crisis, i.e. countries that received official financial assistance.

Graph III.6: **Sigma convergence: EA-11 vs other country groups**  
 Standard deviation of log GDP per capita



Source: Penn World Tables 9.0

When measured over a longer period, sigma convergence reveals that the EA-11 countries experienced convergence at similar rates to those of the larger group of advanced economies from the 1960s to the early 1970s. In the second half of the 1970s, convergence stalled for the EA-11, and slowed down for the non-transition advanced economies. The exclusion of programme countries from the EA-11 reduces in the degree of income



### Box III.2: Data Sources

An important data source for the study is the Penn World Table (PWT), release 9.0. PWT is a dataset of real GDP and its components, including also growth accounting. Quantities in this database are converted into a common currency using purchasing power parities (PPP) to make them comparable across a large group of countries. PPP attempt to measure the relative price level of an economy and tend to be different from market exchange rates because they cover not only the price of traded but also of non-traded goods and services. PPP-converted GDP per capita of low-income countries tends to be higher than exchange-rate-converted GDP per capita, because their prices of non-traded products tend to be lower and vice-versa for high-income countries. For this, PWT uses the results of detailed price surveys from the International Comparison Program and other sources. The 9.0 release of the PWT represents a substantial change to previous versions. The changes can be classified into four broad categories:

- (1) the incorporation of new PPP data from the 2011 International Comparison Program (previously the reference year was 2005). In the 2011 release, run by the World Bank, a number of methodological issues were addressed. The most important related to the selection of a more representative global product basket.
- (2) the incorporation of revised and extended National Accounts data, covering the period up until 2014
- (3) improvements in the data sources and compilation methods for factor inputs, which improved estimates of the labour shares, TFP, and human capital
- (4) The number of countries included in the database has been increased from 162 to 182 and the share of world population covered increased from 96.9 to 98.5%

The PWT 9.0 data was complemented with data from other sources. A detailed list is provided below:

Variable	Description	Source
GDP per head PPP	GDP per capita PPP	PWT 9.0
Schooling	Human capital index using years of schooling and rates of return on education	PWT 9.0
Investment/GDP	Investment at constant national prices, divided by GDP	PWT 9.0
Population growth	Rate of change in population	PWT 9.0
Openness	5-year average of the ratio of imports plus exports to GDP	Eurostat, WEO
Fraser index	Index of economic freedom	Fraser Institute
Private debt/GDP	NFCs and household loans and debt securities, non-consolidated, divided by GDP	Eurostat, BIS
Government debt/GDP	General government debt, divided by GDP	AMECO, WEO
NIIP/GDP	Net international investment position, divided by GDP	Eurostat
Credit flow/GDP	Proxied by change in total private debt (%GDP)	Eurostat, BIS
Current account gap	Difference between the current account (%GDP) and a country-specific benchmark based on fundamentals	Coutinho et al. (2018)
Construction VA share	Share of construction sector value added in total value added (NACE 2)	AMECO

#### Country groups:

- EA: 19 euro area countries (fixed composition)
- EA-11: founding euro area countries, excluding Luxembourg
- High income: high income countries in the sample according to World Bank definition
- Non-transition high income: high income countries in the sample according to World Bank definition, excluding transition countries in Eastern Europe, as well as Luxembourg, Malta and Cyprus

dispersion and slows down the rate of convergence over the 1960s and 1970s, but also the rate of divergence over the post-crisis period.

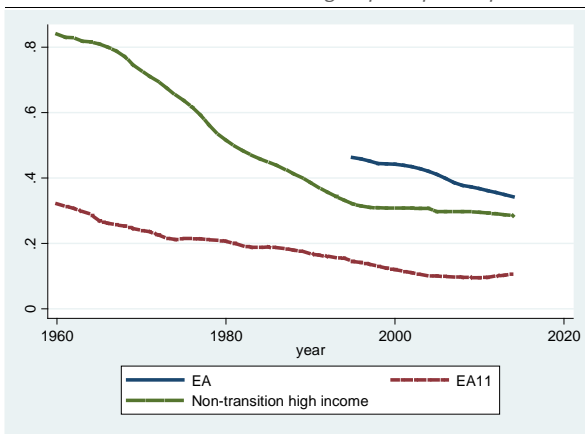
Overall, it appears that the slow convergence process within the EA-11 could be due, among other things, to the fact that the EA-11 was already characterised by a low degree of dispersion in per-capita income in the 1960s. The result follows mechanically, as the rate of convergence is expected to be faster the higher the initial degree of dispersion in income conditions (see Box III.1).

Moreover, the divergence pattern observed over the post-crisis period appears to be partly related to the dismal growth of a limited number of countries heavily affected by the financial crisis.

In the neoclassical growth model (Solow, 1956; Swan, 1956), output convergence is driven by convergence in the capital stock. Incentives to invest are higher in countries with a relatively low capital stock and higher marginal productivity of

capital<sup>(114)</sup>. Graph III.7 looks at convergence patterns in the capital stock per capita to check whether the neoclassical model prediction matches the data. The graph compares the EA-11 group and the larger group of advanced non-transition economies since 1960 and the euro area since 1995 (due to missing data). It appears that convergence is much more visible when looking at capital per capita rather than GDP per capita, including for the EA-11 group. This confirms the standard mechanism of convergence from neoclassical growth theory.

Graph III.7: **Sigma convergence: capital per capita in EA-11 and other country groups**  
Standard deviation of log capital per capita



Source: Penn World Tables 9.0

Dynamics in GDP per capita may differ from those in capital per capita because of the impact of TFP<sup>(115)</sup>. In the neoclassical growth model, TFP growth is exogenous. In modern growth theory, where TFP growth is the result of a process of innovation — the introduction of new technologies — and gradual adoption of new vintage technologies (Aghion and Howitt, 2006), income convergence can be also driven by TFP convergence<sup>(116)</sup>. In this framework, TFP growth depends on both the rate of innovation and the rate at which ‘state-of-the-art’ technologies are adopted or imitated. The weight of these

<sup>(114)</sup> Solow, R. (1956), ‘A contribution to the theory of economic growth’, *Quarterly Journal of Economics*, 70 (1) (1956), 65-94. Swan, T. (1956), ‘Economic growth and capital accumulation’, *Economic Record*, 32 (63), 334-361.

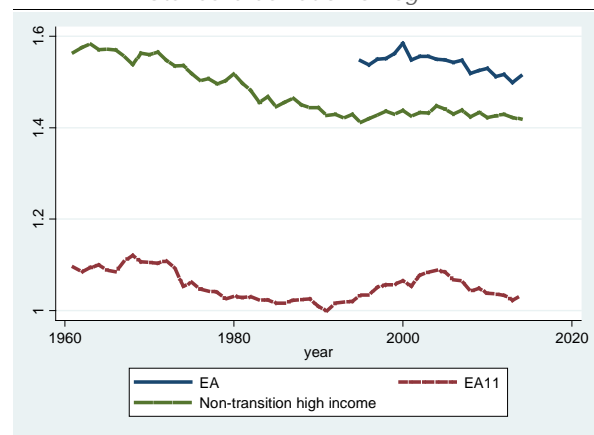
<sup>(115)</sup> Using a standard Cobb-Douglas production function, with capital and labour as inputs, capital per capita is expressed as  $\frac{Y}{L} = A \left(\frac{K}{L}\right)^\alpha$ , where  $Y$ ,  $L$ ,  $K$  stand, respectively, for output, labour and capital inputs, while  $A$  is TFP.

<sup>(116)</sup> Aghion, P., and Howitt, P. (2006), ‘Joseph Schumpeter lecture appropriate growth policy: A unifying framework’, *Journal of the European Economic Association*, 4(2-3), 269-314.

components in each country depends on its distance from the ‘technology frontier’. For countries closer to the frontier, TFP growth generally comes from the introduction of new technologies. For countries further away from the frontier, TFP growth generally comes from the adoption of state-of-the-art technologies.

A convergence process for TFP is therefore expected as countries further away from the frontier have more room to grow by simply adopting better technologies that already exist. Graph III.8 shows the standard deviation of TFP in the EA-11. Some limited convergence seems to have played a role up until the 1990s. However, TFP dispersion fluctuated afterwards. There is more evidence of steady convergence for the broader set of non-transition advanced economies as well as for the euro area, despite the short time series available for the latter. Also noticeable is the very narrow dispersion of TFP levels across the EA-11 group compared to other country groups.

Graph III.8: **Sigma convergence: TFP in EA-11 and other country groups**  
Standard deviation of log TFP



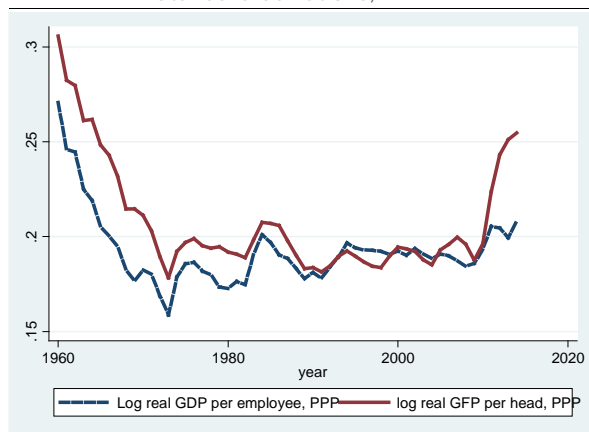
Source: Penn World Tables 9.0

The analysis so far does not distinguish between population and employment. It follows the standard assumption in empirical growth literature that long-run dynamics in GDP per capita tend to coincide with those in GDP per employee.

However, this assumption may not be satisfactory over periods where employment rates fluctuate significantly. Graph III.9 compares sigma convergence for GDP per capita with GDP per employee in the EA-11. It clearly shows that dispersion in the two variables co-moves up to the crisis. However, there is an upward spike in the dispersion of GDP per capita after the crisis, which

is not observed in GDP per employee. This finding allows us to better interpret the divergence process in the post-crisis period as a phenomenon that was not caused by strong divergence in capital per employee or TFP, but rather by a very large divergence in employment rates, reflected also GDP per capita figures.

Graph III.9: **Sigma convergence: GDP per capita vs GDP per employee**  
Standard deviations, EA-11



Source: Penn World Tables 9.0

Overall, there is evidence of sigma convergence in the euro area occurring at rates similar to those observed across other country groups. For the EA-11, sigma convergence appears to have occurred until the 1970s at slow rates. The relatively slow rate of convergence in GDP per capita is partly due to the EA-11 group being highly homogenous in terms of income conditions. An additional factor that underpins the stall in income convergence is the lack of TFP convergence in recent decades. The divergence in income per capita in the post-crisis period is mainly linked to divergent employment rates. This phenomenon is likely transitory and concentrated in the few countries most affected by post-crisis recessions, induced by the unwinding of macroeconomic imbalances and debt crises.

The absence of sigma convergence does not imply absence of beta convergence. In other words, it does not exclude that in general countries with relatively low income per capita have witnessed faster growth, as the occurrence of certain types of shocks can produce dispersion (see Box III.1). The next section investigates beta convergence, which is the notion of convergence most often used in empirical analysis as it enables researchers to assess growth patterns in a more comprehensive

framework. This analysis will also allow us to estimate expected convergence paths.

### III.3.2. Beta convergence

Beta convergence takes place when countries with a lower income per capita grow faster over a medium to long-term period. Graph III.2 shows prima facie evidence of beta convergence in the euro area. A more rigorous analysis also needs to take into account that growth rates across countries not only vary because of different initial income conditions, but also because of other factors that explain the growth performance over the medium to long term.

Growth regressions traditionally rely on cross-section variation. However, more recent applications build on panel data to also exploit time series variation and qualify if convergence rates differ over different time periods. The dataset used in this analysis is a large panel of advanced and emerging economies, obtained mostly from the Summers-Heston Penn World Tables (PWT) version 9. These contain comparable information on variables expressed in purchasing power parity for many countries and years (see Box III.2).

With this data, the methodology described in Box III.3 is used to estimate growth regressions, with the results displayed in Table III.1. In addition to initial income per capita, growth rates are put in relation to other explanatory variables that help determine growth. The results should therefore be interpreted as a test for 'conditional' beta convergence i.e. convergence to steady-state growth rates that differ across countries.



### Box III.3: Empirical methodology

To test for beta convergence and estimate a ‘normal’ convergence path, regression (1) is estimated using the large panel of 66 countries: <sup>(1)</sup>

$$\Delta_5 \log Y_{it} = \alpha + \beta \log Y_{it-5} + \beta Z_{it} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

where the dependent variable  $Y_{it}$  is either output per capita (in PPP) or TFP.  $Z_{it}$  is a vector of control variables. The subscript  $i$  refers to countries, while  $t$  is the time period over which growth rates are computed. Such regression has been typically estimated in the cross section, with growth rates computed over relatively long time periods. This analysis makes use of a panel dimension to use of variation in the time series and allows us to estimate convergence paths over different time periods. Following standard practice in the estimation of growth regressions with panel data, annual observations are converted into averages over 5-year, non-overlapping sub-periods to avoid short-term disturbances affecting the results (see Barro Sala-i-Martin, 2004).

The set of control variables includes: average schooling over the 5-year period; investment-to-GDP ratio (instrumented with the deflator for investment, lagged 5 periods); average population growth over the 5-year period; the average Fraser index of Economic Freedom over the 5-year period (to capture the role of institutional quality); and average openness (exports + imports/GDP) over the 5-year period.

The terms  $\gamma$  and  $\delta$  are region and time effects, respectively. The literature has advocated including regional effects to control for common shocks like climate change and regional spillovers, which are difficult to model and could lead to cross-sectional correlation. Regional dummies can also be seen as an alternative to including country-specific fixed effects. The latter can exacerbate the problem of measurement errors, when these errors are not persistent, by throwing away all the between-country variation (see Temple, 1999, and references therein, also for a discussion on the broader choice of explanatory variables). <sup>(2)</sup> The regressions are estimated using ordinary least squares (OLS), with robust (clustered) standard errors. However, the results do not vary significantly when instrumental variables are used, and exogeneity tests indicate that investment can be treated as exogenous for this sample (see Table I.1). The investment-to-GDP ratio is instrumented with the deflator for investment, following the literature and tests reported in Table I.1 confirm the validity of this instrument.

Predictions from regression (1) are used to estimate “normal growth” paths, which are plotted in Graph B.1 together with actual growth. The deviations between the two series (residuals from the panel regression) are then used to infer the role of macroeconomic imbalances in explaining these deviations. The advantage of this two step approach is that ‘normal’ convergence paths can be inferred from a larger panel of 66 countries, providing estimates that are more unbiased than those which would be obtained from the more limited sample of variables linked to imbalances (516 versus 200 observations). To formally test for the role that imbalances have played in the convergence process, regression (2) is estimated, also using OLS:

$$\varepsilon_{it} = \alpha + \lambda IMB_{it-5} + \gamma_i + \delta_t + u_{it} \quad (2)$$

where  $\varepsilon_{it}$  are the residuals obtained from the large panel regression (less biased in principle than residuals resulting from smaller samples), either using GDP growth or TFP as the dependent variable. The vector  $IMB$  contains a set of variables associated with macroeconomic imbalances, including private and government debt-to-GDP ratios, financial sector credit as a ratio to GDP, the NIIP in percent of GDP, the share of construction sector GVA in total GVA, and the current account gap. The latter is estimated as the difference between the observed current account and the current account that can be explained by the country’s fundamentals, estimated as described in Coutinho et al. (2018). The regression uses robust (clustered) standard errors and time and region effects when applicable.

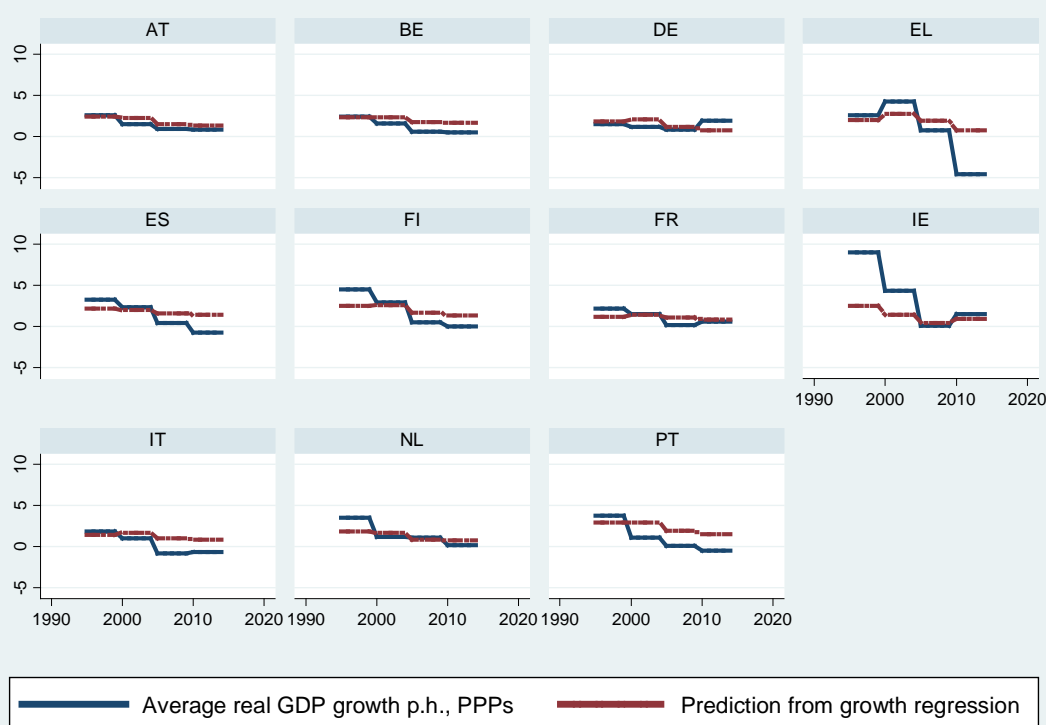
(1) The set of countries includes: Albania, Argentina, Australia, Austria, Belgium, Bulgaria, Brazil, Canada, Switzerland, Chile, China, Colombia, Costa Rica, Cyprus, Czechia, Germany, Denmark, Egypt, Spain, Estonia, Finland, France, United Kingdom, Greece, Guatemala, Hong Kong, Croatia, Hungary, Indonesia, India, Ireland, Iceland, Israel, Italy, Japan, Korea, Republic of, Sri Lanka, Lithuania, Luxembourg, Latvia, Morocco, Mexico, Malta, Malaysia, Netherlands, Norway, New Zealand, Pakistan, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Singapore, Serbia, Slovakia, Slovenia, Sweden, Thailand, Tunisia, Turkey, Ukraine, Uruguay, United States of America, South Africa.

(2) Temple, J. (1999), “The new growth evidence. *Journal of economic Literature*”, 37(1), 112-156.

(Continued on the next page)

Box (continued)

Graph B.1 Actual growth rates in GDP per head and predictions from growth regressions



Following standard practice, variables are averaged over 5 years to remove cyclical effects and eliminate autocorrelation. Initial conditions are lagged by 5 years to capture those at the start of each of the 5-year growth periods (see Box III.3). A number of control variables capture factors that affect steady-state growth in the neo-classical growth model. Population growth, which accounts for the dilution of capital stock per capita, is associated with an expected negative coefficient. The average share of investment in GDP serves as a proxy for the savings rate relevant to investment. This is expected to be associated with faster capital accumulation and will therefore have a positive coefficient. Human capital — an index based on years of schooling and return to education — is also included to account for investment in skills. This is also expected to have a positive coefficient through improvements in labour input<sup>(117)</sup>. Two

additional variables aim to control for factors that may affect TFP growth. Openness to trade — imports plus exports as a share of GDP — is included to account for the fact that open economies can borrow abroad and import technology and know-how (Edwards, 1998; Frankel and Romer, 1999)<sup>(118)</sup>. Moreover, the quality of institutions, as measured by the Fraser index of economic freedom, aims to take into account the fact that good institutions are

<sup>(117)</sup> In the PWT 9.0, the average years of schooling combine data from Barro, R. J. and Lee, J.-W. (2013), 'A new data set of educational attainment in the world, 1950-2010' *Journal of Development Economics*, 104: 184-198; and Cohen, D. and Leker L. (2014), 'Health and Education: Another Look with the Proper Data', mimeo Paris School of Economics. Rates of return

on education are from Psacharopoulos, G. (1994), 'Returns to investment in education: A global update', *World development*, 22(9):1325-1343. See also Feenstra, R. C., Inklaar, R., et Timmer, M. P. (2016), 'What is new in PWT 9.0?', The University of Groningen. On the reason for the inclusion of this variable, see Mankiw, N. G., Romer, D. and Weil, D. N. (1992), 'A contribution to the empirics of economic growth', *Quarterly Journal of Economics* 107, 407-437.

<sup>(118)</sup> Edwards, S. (1998), 'Openness, productivity and growth: what do we really know?' *The Economic Journal*, 108(447), 383-398. Frankel, J. A., and Romer, D. H. (1999), 'Does trade cause growth?' *American Economic Review*, 89(3), 379-399.

Table III.1: Conditional beta convergence: output per capita

Dep var: GDP p.h. growth, year averages	(1) All sample	(2) All sample, IV	(3) EU	(4) EA	(5) EA11	(6) EU>1999	(7) EA>1999	(8) EA11>1999	(9) EU>2007	(10) EA>2007	(11) EA11>2007
Ln GDP p.h. PPP, 5 lags	-2.207** [-6.53]	-2.035** [-4.22]	-3.018** [-6.39]	-2.695** [-6.01]	-0.853 [-0.95]	-3.643** [-6.51]	-3.684** [-5.54]	-2.706+ [-1.98]	-1.030 [-1.28]	-1.036+ [-1.82]	6.670 [1.05]
Human capital, 5 lags	0.435 [1.18]	0.359 [0.81]	0.286 [0.93]	0.382 [1.25]	-0.311 [-0.44]	1.309** [3.07]	1.403** [3.18]	1.526+ [2.18]	2.345** [4.44]	2.563** [4.04]	-0.524 [-0.21]
I/GDP, avg	9.982** [5.91]	6.845 [0.90]	8.337** [3.29]	5.933* [2.44]	3.835 [1.10]	3.921 [0.69]	5.611 [0.78]	8.598 [0.68]	10.518 [1.07]	19.206* [2.22]	17.225 [0.88]
Pop growth, avg	-0.555** [-2.81]	-0.571** [-2.84]	-0.518+ [-2.05]	-0.718* [-2.81]	-0.049 [-0.18]	-0.592+ [-1.73]	-0.723+ [-1.80]	0.319 [0.68]	-1.794** [-4.19]	-2.246** [-11.30]	-1.984 [-0.52]
Economic freedom, 5 lags	0.537** [3.82]	0.552** [3.75]	1.031** [3.78]	0.516 [1.30]	0.371 [0.68]	1.225* [2.60]	2.184** [3.24]	1.658+ [1.98]	3.111** [2.92]	2.965* [2.48]	2.810 [1.07]
Openness, avg	0.810* [2.42]	0.946+ [1.84]	0.842+ [1.83]	1.350** [3.07]	2.129 [1.69]	1.399** [2.83]	1.351* [2.57]	1.426 [1.12]	1.591** [2.94]	1.544* [2.25]	-1.530 [-0.55]
Observations	516	516	203	143	99	84	57	33	28	19	11
Countries	66	66	28	19	11	28	19	11	28	19	11
R-squared	0.41	0.40	0.58	0.65	0.64	0.72	0.75	0.57	0.74	0.88	0.78

(1) Constant time effects and regional effects included, but estimated coefficients omitted. Robust (clustered) t-statistics in brackets. \*\*p<0.01, \*p<0.05, +p<0.1. I/GDP instrumented with investment deflator (5 lags). IV tests: Kleibergen-Paap rk LM statistic p-value: 0.0005; Kleibergen-Paap rk Wald F statistic: 36.5210; Exogeneity test (Hausman type) p-value: 0.6647.

Source: Authors calculations

associated with stronger incentives to innovate and take risks (e.g. Glaeser et al. 2004)<sup>(119)</sup>.

The control variables generally have the expected signs, even though some coefficients are not significant for all regions and samples. A typical difficulty when estimating growth regressions is the possible endogeneity of the investment variable – investment not only affects growth, but is also driven by expected growth rates. However, the issue does not seem to be relevant in these estimates, as the coefficient of the investment variable is qualitatively unchanged when using instrumental variables (IV) estimation, i.e. instrumenting investment with the price of investment goods as customary in related literature. Exogeneity tests also indicate that investment can be treated as exogenous for this sample<sup>(120)</sup>. Under exogeneity conditions, ordinary least squares (OLS) is consistent and more efficient than IV estimates.

For the whole sample of countries, there is evidence of beta convergence as the coefficient on the logarithm of the initial GDP per capita is negative and statistically significant, in support of

catching-up. This is also the case for the EU (column 3) and for the euro area (column 4), but not for the EA-11 (column 5). Looking only at the period after euro adoption (columns 6-8), the same results still hold for the euro area, the EU and the EA-11. However, looking at the period after 2007, which includes mostly the global financial crisis and the European sovereign debt crisis, evidence of convergence for the euro area and the EU becomes weaker (columns 9 and 10). There is evidence of divergence for the EA-11 after 2007, where the coefficient becomes positive, although insignificant in column 11. However, it is important to note that the number of observations is considerably smaller in this subsample, leaving only a few degrees of freedom for the estimation<sup>(121)</sup>.

Growth regressions have also been run to test for convergence in TFP growth. Table III.2 shows the estimation results. Initial TFP, human capital, investment, institutions (Fraser index) and openness have been included as control variables. Initial TFP is expected to be negatively associated with TFP growth as laggard countries have more room to grow out of the adoption of up-to-date technologies. Human capital, as measured by the PWT 9.0 index of human capital, allows to control for the fact that countries with a more educated

<sup>(119)</sup> Glaeser, E. L., La Porta, R., Lopez-de-Silanes, F., and Shleifer, A. (2004), 'Do institutions cause growth?', *Journal of Economic Growth*, 9(3), 271-303.

<sup>(120)</sup> The orthogonality is test C statistic, which is numerically equal to a Hausman test statistic under conditional homoscedasticity and has a p-value of 0.66. It therefore cannot reject the null hypothesis that investment can be treated as exogenous in this sample. See Baum, C. F., Schaffer, M. E. and Stillman, S. (2003), 'Instrumental variables and GMM: Estimation and testing', *Stata Journal* 3: 1-31. Tests for the validity of instruments are also reported in Table I.1.

<sup>(121)</sup> The estimation results for the shorter sample starting after 2007 are only indicative, as the number of observations is small. In particular, inference for this sample should be viewed with caution.

Dep var. TFP growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All sample	All sample	EU	EA	EA11	EA 1999-2007	EA>2007	EA11, 1960-2007	EA11>2007
Log TFP level PPP, 5lag	-1.663** [-4.79]	-1.599** [-4.62]	-2.488** [-4.16]	-2.817** [-3.06]	0.562 [1.60]	-4.122** [-3.85]	-2.824* [-2.31]	0.266 [0.66]	2.112 [1.03]
Avg. schooling, 5 lags	0.164 [0.80]								
1/GDP, avg	-1.253 [-0.92]								
Fraser index, avg.	0.301** [2.74]	0.311** [3.10]	0.569** [4.89]	0.429+ [2.03]	0.843** [4.64]	0.415 [0.83]	2.424+ [2.03]	0.815** [4.76]	1.742 [1.54]
Openness, avg.	0.246 [0.83]								
Observations	502	502	203	143	99	38	19	88	11
Countries	64	64	28	19	11	19	19	11	11
R-squared	0.25	0.25	0.33	0.40	0.59	0.60	0.29	0.58	0.71

(1) Constant, time effects and region effects included, but coefficient results omitted. Robust (clustered) t-statistics in brackets. \*\* p<0.01, \* p<0.05, + p<0.1

Source: Authors' estimations.

population tend to innovate more. The variable that measures institutional quality accounts for different incentives for innovation and entrepreneurship. Openness controls for the degree of impediments to technology absorption. Apart from initial TFP levels and institutions, other control variables are statistically insignificant in explaining TFP growth (column 1). The absence of insignificant control variables in column 2 does not affect the significant coefficients. Columns 3-9 therefore use the restricted specification, controlling only initial TFP and institutions.

Results provide evidence that TFP convergence exists among the whole sample of countries (columns 1 and 2), as well as for the EU and the euro area (columns 3 and 4). There is no evidence of convergence for the EA-11, where TFP appears to diverge after the financial crisis (columns 5, 8 and 9). On the other hand, convergence exists in the EU as a whole even for the post-crisis subsample (columns 6 and 7)<sup>(122)</sup>.

Overall, the evidence of beta convergence from growth regressions indicates that the euro area is not faring worse in terms of output convergence than other country groups<sup>(123)</sup>. Instead, there is no significant evidence of conditional output convergence for the EA-11, where income per

capita appears to have been diverging over the post-crisis period. Regarding TFP convergence, the euro area as a whole is not faring worse than other country groups. However, there is no evidence of TFP convergence among the EA-11.

#### III.4. Deviations from convergence paths: a role for macroeconomic imbalances?

EA-11 countries appear not to have followed a convergence pattern like that of countries in the comparator groups. What factors could have been responsible for this lack of convergence? Inspired by the stylised facts presented earlier regarding macroeconomic imbalances across the euro area, namely swallowing current account deficits in the euro area periphery fuelled by public and private debt and housing investment, the aim of this section is to investigate more systematically whether these can account for lack of convergence in some countries.

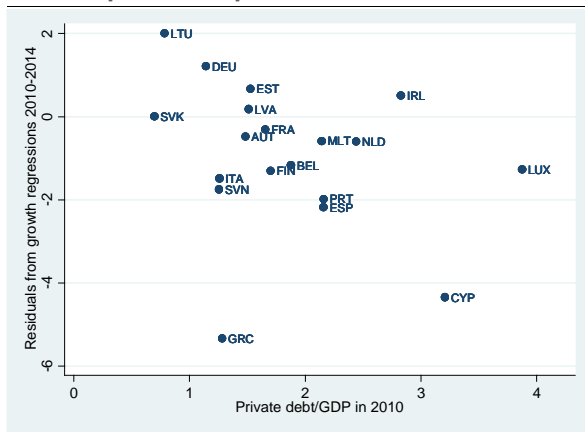
To answer this question, the first step is to estimate a standard convergence path. Namely, a convergence path that would normally be expected based on the relevant characteristics of countries, i.e. the initial level of output per capita and all other conditioning factors. This path is obtained using the prediction from the regression estimated on the largest panel of countries and time periods (column 1, Table III.1 and column 2, Table III.2) to have more robust and less distorted estimates (see Box III.3). The second step is to relate deviations of per

<sup>(122)</sup> For the EU and euro area, which include new member states, it is not possible to go further back than 1999, which is the start of the split sample in column (6) of Table I.2, due to the availability of the Fraser Index.

<sup>(123)</sup> B ower and Turrini (2010), op. cit., find that EU accession has accelerated growth and convergence for new member states.

capita GDP (or TFP) from these predicted convergence paths to variables reflecting the presence of macroeconomic imbalances.

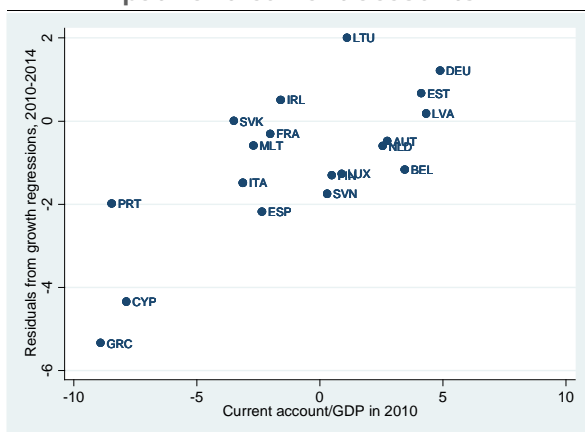
Graph III.10: Deviations from convergence path and private debt stocks



Source: Eurostat and authors' estimations.

Graph III.10 plots the average value of deviations from expected convergence paths in 2010-2014 for euro area countries against private debt-to-GDP ratios in 2010. Excluding Greece, there is a clear downward sloping relationship. This indicates that countries with the highest debt ratios in 2010 are those that have exhibited GDP per capita well below growth regression-based expectations.

Graph III.11: Deviations from convergence path and current accounts



Source: Eurostat and authors' estimations.

Similarly, Graph III.11 plots the average value of residuals between 2010-2014 for euro area countries against current account to GDP ratios in 2010. The plot displays a clear upward sloping relationship. This shows that countries with more negative current account ratios in 2010 are also

those that have shown GDP per capita clearly below what was predicted.

To simultaneously take into account the role of different sources of macroeconomic imbalances, we carry out a multivariate regression analysis. Six variables reflecting sources of macro-economic imbalances are considered: (i) the initial private debt-to-GDP ratio; (ii) the initial government debt-to-GDP ratio; (iii) the initial net international investment position (NIIP) in per cent of GDP; (iv) credit to the private sector as a share of GDP; (v) the current account gap; and (vi) the share of construction in total value added, as a proxy for changes in the weight of the non-tradable sector<sup>(124)</sup>. All variables are in percentages. The credit variable and the construction share are both demeaned by the country long-term average to allow for different economic structures. The current account gap is estimated as the difference between the actual current account balance and what can be explained by the fundamentals of the economy, following the methodology proposed in Coutinho et al. (2018)<sup>(125)</sup>. Box III.3 contains more details on the methodology.

Table I.3 shows the results from the regression analysis. These are displayed separately for the euro area and for a comparator group consisting of all countries except the euro area. It also shows two sample splits in time: after 1999, i.e. EMU completion, and after 2007, i.e. after the financial crisis. The same is repeated for GDP per capita and for TFP growth.

For the sample starting in 1999, private debt, government debt, NIIP and the share of construction are significant in explaining euro area GDP per capita convergence gaps. The corresponding coefficients have the expected signs. Looking at non-euro area countries, the loss in significance is observed for all variables except private debt, while current accounts have significant explanatory power. For the euro area, the estimated coefficients suggest that a reduction

<sup>(124)</sup> In this analysis, an excess weight of non-tradables, which are proxied by the weight of the construction sector in total GVA, is demanded by the country-specific average. This is used instead of unit labour costs (as used in Lukmanova and Tondl, 2017, op. cit.). One variable tends to correlate with the other and the weight of the construction sector in total GVA is available for a broader set of countries.

<sup>(125)</sup> Coutinho, L., Turrini, A., Zeugner, S. (2018), 'Methodologies for the Assessment of Current Account Benchmarks', European Economy Discussion Paper 086/September 2018.



Table III.3: Deviations from convergence paths and macroeconomic imbalances

	GDP growth residuals				TFP growth residuals			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EA>1999	Non-EA>1999	EA>2007	Non-EA>2007	EA>1999	Non-EA>1999	EA>2007	Non-EA>2007
Private debt/GDP, 5 lags	-0.008** [-3.80]	-0.014** [-3.89]	-0.013** [-3.64]	-0.001 [-0.20]	-0.008** [-3.96]	-0.011** [-3.55]	-0.010* [-2.45]	-0.003 [-0.78]
Gov. debt/GDP, 5 lags	-0.026** [-5.30]	-0.005 [-1.18]	-0.029* [-2.22]	-0.001 [-0.14]	-0.028** [-4.82]	-0.004 [-1.54]	-0.021 [-1.71]	-0.003 [-0.90]
NIP/GDP, 5 lags	0.008* [2.33]	-0.002 [-0.62]	0.011+ [1.76]	-0.001 [-0.21]	0.004 [1.16]	0.001 [0.43]	0.000 [0.07]	0.002 [0.65]
Credit flow/GDP, 5 lags (relative to country long-term average)	0.013 [1.38]	0.020 [1.45]	-0.023 [-1.36]	-0.030 [-0.86]	0.021* [2.30]	-0.005 [-0.44]	-0.008 [-0.52]	-0.024 [-1.07]
Current account gap, 5 lags	0.028 [0.91]	0.092+ [1.89]	0.078 [0.93]	-0.031 [-0.36]	-0.013 [-0.49]	0.068+ [1.86]	0.073 [0.87]	-0.021 [-0.49]
Construction VA share, 5 lags (relative to country long-term average)	-0.412* [-2.48]	-0.195 [-1.40]	-0.707** [-3.62]	-0.342 [-1.42]	-0.510** [-3.79]	-0.103 [-0.69]	-0.492* [-2.57]	-0.143 [-0.67]
Observations	53	93	19	32	53	93	19	32
Countries	19	32	19	32	19	32	19	32
R-squared	0.51	0.35	0.75	0.40	0.53	0.28	0.64	0.42

(1) Robust t-statistics in brackets. \*\* p<0.01, \* p<0.05, + p<0.1

Source: Authors' estimations.

of 10 percentage points (pps) in private debt would reduce the convergence gap by around 1 pps. While reducing government debt by 10 pps would reduce the convergence gap by around 2.5 pps.

Results remain statistically unchanged for the euro area when restricting the analysis to the post-crisis period. Wald tests fail to reject the null hypothesis that the estimated coefficients for the two sub-periods are equal at the 95% confidence level. Conversely, for non-euro area countries, the significance is lost for all variables. This is likely due to the reduced number of observations. Across time and country samples, the most robust factor deterring convergence is the presence of high private debt. However, for the euro area high public debt and a high weight of non-tradables also seem important. Turning to the analysis of deviations from TFP growth paths, the role of private and government debt as well as construction is confirmed for euro area countries. For non-euro area countries, a significant role is found only for private debt and current accounts.

Overall, results indicate that to a certain extent convergence gaps across the euro area are a consequence of the presence of macroeconomic imbalances. Also, that the relevant factors underpinning imbalances are not the same as those that explain convergence gaps across the comparator country group. The relatively stronger role of government debt in explaining convergence gaps of euro area countries can be linked to the

probability of bond market tensions increasing more than proportionally with the size of debt, i.e. threshold effects. As government debt is on average higher in euro area countries, the result appears consistent with this hypothesis. Furthermore, de Grauwe et al. (2013) demonstrate that euro area countries are more vulnerable to self-fulfilling government debt crisis<sup>(126)</sup>. On the other hand, current accounts seem less important for euro area countries in explaining deviations from convergence paths. A possible interpretation is that the liquidity provision by the European System of Central Banks helps mitigate the real effects of current account sudden stops. Finally, convergence paths among euro area countries appear to be comparatively more related to a past of strong growth in the tradable sector. This is not significant for non-euro area countries and appears consistent with the stylised facts reviewed in Section I.2. The narrowing of interest rates in the euro area periphery, as a result of monetary union, was matched by capital inflows largely channelled into the construction sector and other non-tradable activities. After the crisis, the contraction in domestic demand led to the contraction of non-tradables, in some cases amid the bursting of housing bubbles. The fact that resources were largely absorbed in non-tradable activities meant the euro area periphery had less room to keep

<sup>(126)</sup> De Grauwe, P. and Ji, Y., 2013. Self-fulfilling crises in the Eurozone: An empirical test. *Journal of International Money and Finance*, 34, pp. 15-36.

growing out of exports, in a context where domestic demand remained persistently subdued in the presence of deleveraging needs. Moreover, as TFP growth is generally faster in the tradable sector, the growth of construction and non-tradable activities is associated with subsequent disappointing growth rates in TFP.

### III.5. Conclusions

This article uses a large dataset of advanced and emerging economies to: analyse convergence in the euro area from a comparative perspective; disentangle which components of per-capita GDP have been converging or diverging; estimate expected convergence paths; and lastly, assess the role played by macroeconomic imbalances in explaining deviations from these paths.

The analysis of sigma convergence, i.e. a falling dispersion in real variables, indicates that convergence across the EU and the euro area does not differ much compared to comparator country groups. However, when focusing solely on EA-11 founders, excluding Luxembourg, evidence of convergence gets weaker and divergence is rather prevalent in post-crisis years. Lack of convergence for the EA-11 could partly be related to the fact that this is a much more homogenous group in terms of per capita income, especially when compared to the EU, euro area or other comparator groups. It is therefore expected to exhibit a slower rate of convergence.

Moreover, the divergence process observed for this group of countries after the crisis is largely related to divergent employment rates. This is evident when comparing the dispersion in GDP per capita with the dispersion in GDP per employee and is likely to be a transitory phenomenon. Nonetheless, a more worrying and structural aspect underpinning weak convergence among the EA-11 is the virtual absence of convergence in TFP in recent decades.

The estimation of growth regressions confirms that the EU and euro area exhibit conditional beta convergence, i.e. per capita GDP grows faster when initial levels are lower, taking into account the effect of other growth drivers. However, this is not the case for the EA-11. The result is similar for TFP convergence.

Predictions from growth regressions allow us to estimate expected convergence paths. Deviations from these paths are associated with a number of initial conditions, which summarise the presence of macroeconomic imbalances, private debt in particular. Most interestingly, the euro area seems to be affected by a number of peculiar factors, notably government debt and the share of the construction sector on value added, which have no significant role among a comparator group. The fact that government debt is on average higher in euro area countries and the increased vulnerability of single currency members to a self-fulfilling government debt crisis could explain this result. As for construction, this could be explained by the fact that the EMU start-up shock led to a decline in real interest rates in the euro area periphery, followed by a relative expansion of non-tradable activities, characterised by relatively low TFP growth.

Overall, the analysis underscores the importance of conditions ensuring macro stability and resilience for economic convergence. Preventing the accumulation of excessive private debt is particularly important both inside and outside the euro area. In addition, there is a specific role for maintaining prudent levels of public debt and running prudent fiscal policies within the euro area. An important policy implication is that sustainable convergence requires continuing to address legacy imbalances. In this respect, it will be important not only to maintain effective economic surveillance to monitor the completion of the structural adjustment, but also to ensure a more symmetric adjustment within the euro area as this would support nominal growth in the periphery and a faster adjustment of stock imbalances. Moreover, completing and deepening EMU would help prevent the accumulation of new harmful imbalances and their negative repercussions on convergence dynamics. Completing the banking union in order to delink bank and sovereign risk should help reduce the euro area's vulnerability to self-fulfilling debt crisis. Completing the capital markets union would also help reallocate surpluses in the euro area through equity rather than debt. It might also help prevent the misallocation of capital that led to the excessive expansion of non-tradable sectors in the EU (Buti and Turrini, 2015).