I. Convergence in GDP per capita in the euro area and the EU at the time of COVID-19

By Mirko Licchetta and Giovanni Mattozzi

***Abstract**: This paper investigates determinants of convergence in GDP per capita in the euro area and the EU between 1995 and 2021 including the impact of the COVID-19 crisis. It finds that the COVID-19 crisis temporarily slowed convergence but the estimated negative impact is significantly smaller than during the global financial crisis. Diverging effects emerged linked to the timing of the pandemic, the tightness of lockdown measures, and the importance of contact intensive sectors in the economy, like tourism. However, the easing of lockdown measures coupled with policy support (including the successful vaccination strategy) mitigated the risks of a pandemic-driven persistent divergence in growth. Regression results provide further evidence of convergence in the euro area and the EU over the period 1995-2021 and highlight the slowdown in the speed of convergence following the global financial crisis. It finds that this slowdown can, in most part, be attributed both to a contraction in investment rates in converging countries and to the limited catch-up in total factor productivity growth especially in euro area countries. Finally, the estimated model highlights the importance of traditional macroeconomic variables for income convergence and it confirms, in particular, the beneficial influence of investment in physical and human capital and trade in goods and services.*

I.1. Introduction

Convergence in standards of living is a concept that holds high economic, social and political relevance for citizens' wellbeing ([1]) and is essential for European integration. In line with the European treaties, EU policies have been put in place to favour economic, social and territorial cohesion. In political terms, there are reasons to speculate that persistent divergences in economic outcomes or even a mere stagnation of convergence might generate political tensions. This is particularly the case when countries and regions are perceived as being left behind, i.e. neither contributing to, nor benefiting from, innovation and economic progress.

Large differences in GDP per capita of EU Member States have persisted over time (Graph I.1). In 1999, while northern countries enjoyed incomes higher than the EU average, incomes in southern and eastern countries, were well below the average. Contrasting developments in income per capita have occurred in the EU in the last decades. On the one hand, most of the eastern countries have moved up vis-à-vis the EU average over that period. On the other hand, many northern and southern countries have only maintained their income positions or experienced a relative deterioration especially since the global financial crisis.

The asymmetric economic and social impact of the COVID-19 pandemic initially raised concerns of increased divergence in GDP per capita across Member States, jeopardising the proper functioning and stability of the EU and ultimately reducing long-term growth prospects ([2]). However, there is broad consensus that the bold and timely economic policy actions, along with the successful vaccination campaign, were effective in mitigating the economic impact of the crisis. They contributed to a faster recovery than initially expected in both the EU-27 and in the EA-19, with quarterly GDP exceeding pre-pandemic levels already by the end of 2021 ([3]).

In this context, and with a view to drawing possible policy lessons going forward, this paper investigates determinants of convergence in GDP per capita including the impact of the COVID-19 pandemic in the euro area and the EU ([4]).

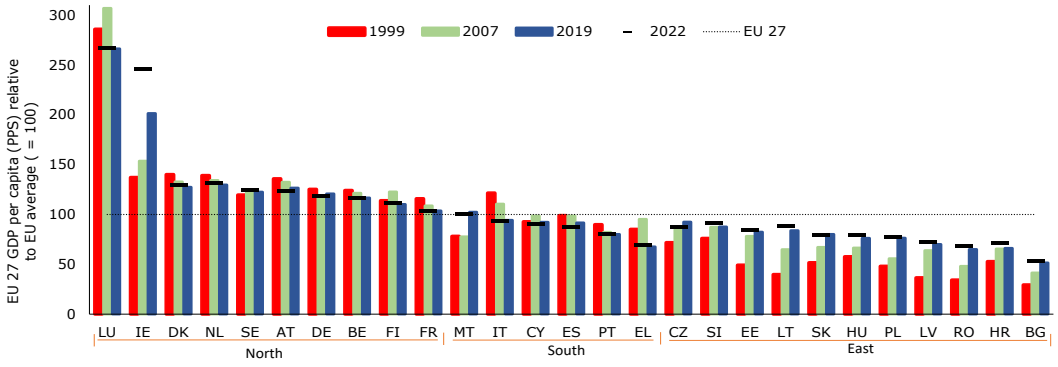
([1]) See Buti, M. and A. Turrini (2015), Three waves of convergence. Can Eurozone countries start growing together again?, 17 April VoxEU.

([2]) In the Commission's autumn 2020 EU European Economic Forecast, GDP per capita for 2022 in all Member States (excluding Greece) was expected to remain well below the 2019 level and Italy, Spain and Portugal were forecast to fall by more than the euro area average.

([3]) See European Commission (2021), *European Economic Forecast – Autumn 2021*. Following the global financial crisis, the sovereign debt crisis in the euro area slowed down the recovery so that the level of GDP took about 7 years to exceed the 2008 level.

([4]) Income convergence is defined in terms of GDP per capita. This study focuses on all European Union Member States (EU-27) and euro area countries (EA-19) Member States respectively. EA12 includes the former euro area Member States (Austria, Belgium, France, Finland, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Greece). New Member States (NMS-13) includes Cyprus, Czechia, Estonia, Hungary, Latvia,

Graph I.1: **Income differences across Member States since 1999**



(1) Data on GDP per capita are expressed in constant prices and purchasing power standard (PPS), as a percentage of GDP per capita in the EU-27 in each year.

(2) GDP per capita for Ireland and Luxembourg should be carefully interpreted. The notably higher-than-average GDP per capita in Luxembourg is due to of the many foreign residents employed in the country and thus contributing to its GDP, while they are not part of Luxembourg's resident population. As for Ireland, the high level of GDP per capita is partly due to the high GDP level related to the presence of large multinational companies holding intellectual properties.

Source: AMECO (Spring 2022 Vintage).

This paper provides several contributions to existing literature. First, using absolute and conditional beta-convergence and sigma-convergence indicators from 1995 to 2021 (see below for explanations of the two forms of convergence), this paper finds that the COVID-19 crisis temporarily slowed the process of convergence across the euro area and the EU. Nevertheless, the estimated impact is smaller than following the global financial crisis. Second, this paper takes stock of developments in convergence in GDP per capita. It takes a long historical perspective and include the period 2020-2021 thereby encompassing the COVID-19 crisis ([5]). In this longer sample, there is evidence for absolute and conditional beta-convergence for both EU-27 and EA-19 over the 1995-2021 period whereas there is a lack of convergence for the EA-12 (the eleven founding members of the euro area plus Greece). Third, this paper provides further evidence of the slowdown in income convergence following the global financial crisis. This is likely to be partly associated with a contraction in investment rates in converging countries. Limited catch-up in total factor productivity growth between euro area countries might have also contributed. Finally, it provides evidence of the impact of a standard set of macroeconomic variables on income convergence.

The structure of this paper is as follows. To assess developments in income per capita and conduct comparative analysis between EU-27, EA-19 and EA-12, the second subsection focuses on sigma convergence and the third section focuses on absolute or unconditional beta-convergence. The fourth subsection provides an econometric assessment of the pandemic's impact based on conditional beta-convergence. The fifth and sixth sections highlight the difference in the impact of the global financial crisis and COVID-19 crisis on income convergence and discuss the drivers of the slowdown in convergence since the global financial crisis. Finally, some policy implications are drawn from the analysis.

I.2. Sigma-convergence

The coefficient of variation of GDP per capita is a widely used measure of sigma convergence ([6]). In the period 1995 to2019, the coefficient of variation decreased by around half in both EA-19 and EU-27 but the global financial crisis significantly slowed down the pace of sigma-convergence for both aggregates (Graph I.2). Within the EU-27, the decline in income disparities was particularly strong

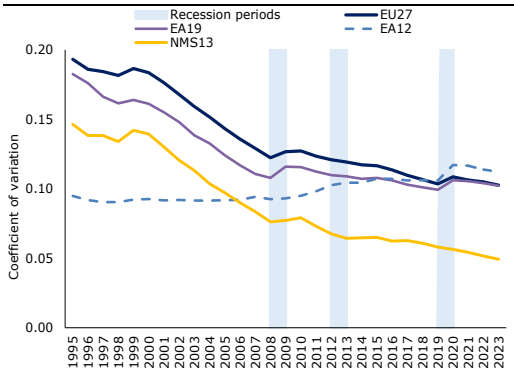
Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania, Croatia.

([5]) It complements analyses presented in the Quarterly Report on the Euro Area, Vol. 20, numbers 1 and 2 and other research such as Pfeiffer, P., Roeger W. and J. In 't Veld (2020). *The COVID-19 pandemic in the EU: Macroeconomic transmission and economic policy response*, ECFIN Discussion Paper 127.

([6]) Sigma-convergence relates to the cross-sectional dispersion of income and it measures if countries are becoming more similar in terms of the level and evolution of GDP per capita. A reduction indicates an increase in the economies' similarities. It is defined as the ratio of the standard deviation to the mean.

in the NMS-13, which experienced the largest fall since 1999. As for the EA-12, income disparities were stagnant before the global financial crisis and widened somewhat after it. By contrast, the COVID-19 crisis led to an increase in the coefficient of variation in the EU although the Commission Spring 2022 European Economic Forecast expected the increase to be temporary and for the downward trend to resume by 2022. (7)

Graph I.2: **Coefficient of variation of real GDP per capita (PPS)**



Source: AMECO (Spring 2022 Vintage).

I.3. Absolute beta-convergence

Beta-convergence is inspired by the neoclassical growth model. It assumes diminishing returns to capital. It implies that lower-income countries or regions tend to grow faster than richer ones. From this perspective, initially poorer economies with lower capital stock experience higher growth rates than developed economies due to the higher return on capital. As opposed to sigma-convergence, which refers to a reduction of disparities among regions over time, beta-convergence focuses on detecting possible catch-up processes. "'Absolute" beta convergence implies that all states or regions in a group will move to one steady state (8). This is the case for homogenous country groups or group of regions. However, economies differ on a variety of structural and institutional features. As a result, countries and regions may converge to different steady states, consistent with the "conditional" beta convergence hypothesis.

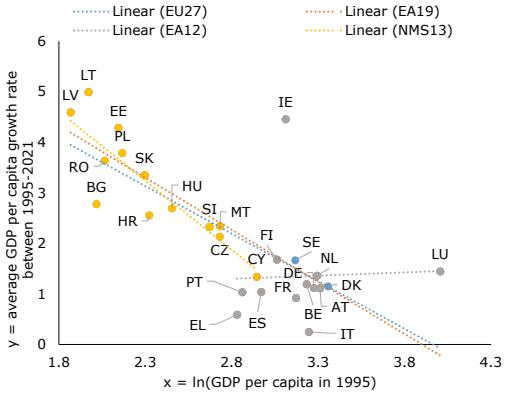
Table I.1: **Absolute beta convergence**

	1995-2008	1995-2012	1995-2019	1995-2021
EA19	-2.915*** (0.66)	-2.325*** (0.61)	-2.153*** (0.59)	-2.061*** (0.53)
EU27	-2.406*** (0.60)	-2.006*** (0.60)	-1.955*** (0.62)	-1.883*** (0.56)
EA12	-0.032 (0.00)	0.623 (0.08)	0.053 (0.00)	0.127 (0.00)
NMS13	-3.626*** (0.61)	-3.238*** (0.70)	-2.642*** (0.73)	-2.735*** (0.76)

(1) Absolute convergence is estimated through a cross-sectional country regression that relates the average annual growth rate of real GDP per capita in PPS over the indicated period and the initial level of GDP per capita. (2) A negative absolute beta coefficient means convergence. Convergence increases with the absolute value of the coefficient. A positive value means lack of convergence. R squared is reported in brackets.

* p<0.10; **p<0.05; *** p<0.01.
Source: Author's calculations and AMECO (Spring 2022 Vintage).

Graph I.3: **Absolute beta convergence (1995-2021) in real GDP per capita (PPS)**



Source: AMECO (Spring 2022 Vintage).

The global financial crisis and subsequent sovereign debt crisis proved detrimental for income convergence. Compared with 1995-2008, the absolute beta coefficient in the period 2008-2019 was about one fifth lower in the EU-27 and one quarter smaller in the EA-19 (Table I.1) (9) (10). Results for EA-12 point to an almost zero absolute convergence coefficient prior to the global financial crisis and to a lack of convergence in the

(7) The increase was larger in EA-19 and EA12 (6.5% and 10% respectively) than in EU-27 (3.4%) although it was slightly lower than in the aftermath of the global financial crisis, especially in EU-27 and EA-19.

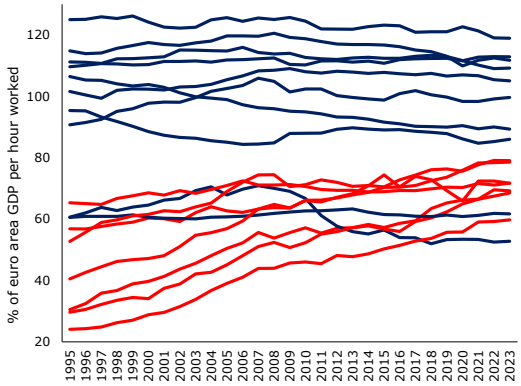
(8) See Temple (1999), *The New Growth Evidence*, Journal of Economic Literature, Vol 37, No1 March 1999 (pp. 112-156) and Durlauf, SN, P.A. Johnson and J.R.W. Temple (2005), *Growth Econometrics*, Chapter 08 in Handbook of Economic Growth, 2005, vol. 1, Part A, pp 555-677.

(9) NMS13 experienced a decrease in the degree of the convergence coefficient in line with the decrease experienced by EU-27 although the New Member States still faced a much higher level of convergence both before and after the global financial crisis.

(10) The 1995-2008 period is highly heterogeneous in terms of economic regime for the EU-27 and EA-19 aggregates as some countries only joined the EU in 2004. For many of these countries the early part of the sample has been characterised by a difficult transition from a planned economy regime.

following period although results are not statistically significant ([11]).

Graph I.4: **Productivity in euro area Member States**



(1) GDP in per hour worked in PPS and in percentage of EA-19. The blue refers to EA-12 Member States. The red lines refer to Member States joining the euro area after 2001. Luxembourg and Ireland are not included

Source: AMECO (2022 Spring Vintage).

Absolute beta convergence estimate suggests that COVID-19 had little impact on the process of convergence (see also below). Indeed, the negative relationship between the log of GDP per capita in 1995 and the average GDP per capita growth between 1995 and 2021 supports the hypothesis of absolute convergence for EU-27 and EA-19. The slope of the curve in Graph I.3 measures the speed at which the gap with the steady state closes the so called 'speed of convergence'. The absolute beta convergence coefficient among the EU-27 and euro area has been around 2% over the 1995-21 period. This is broadly consistent with the 2% 'iron law"of convergence , which suggests that economies will converge at a common rate of 2% per year. In addition, as anticipated by the beta-convergence process, a large majority of the countries that joined the EU after 2004 achieved a catch-up consistent with their lower initial levels of income per capita. This result emphasises that, since 1995, poorer EU and euro area countries have exhibited faster growth than richer ones ([12]);it is consistent with the dynamics of productivity across euro area countries (Graph I.4). On the other hand, there is lack of convergence for EA-12, albeit the results are not statistically significant ([13]).

I.4. Conditional beta-convergence

Conditional beta-convergence assumes that countries move to different steady-state growth rates that reflect various structural and institutional factors. The drivers of income convergence were originally analysed under the lenses of the neoclassical Solow growth model. An augmented version of the Solow model including physical capital accumulation, human capital accumulation and population growth found that these drivers explained about 80% of international differences in standards of living ([14]). However, technical change remained exogenous in such models. With the endogenous growth literature, technical change has become endogenous and policy-relevant factors, such as human capital ([15]), R&D&I, trade openness ([16]) and institutional quality have been put forward.

I.4.1. Explanatory variables

We estimate a set of beta conditional regressions to assess the determinants of GDP per capita convergence in the euro area and the EU including the impact of COVID-19 (Box I.1 provides details on the modelling approach). Several studies have investigated the impact of the COVID-19 pandemic on economic activity ([17]) but the impact

([11]) Regional data based on ARDECO point to a similar decline in the pace of beta convergence in the EU-27 after the global financial crisis. However, the impact appears smaller than when using country level data.

([12]) See ECB (2015), Real convergence in the euro area: evidence, theory and policy implications, Economic Bulletin, Issue 5/2015.

([13]) The central results are broadly unchanged under alternative starting points including from 1999 and 2000 (closer to the introduction of the euro) and with regional ARDECO data.

([14]) Mankiw G., Romer P. and Weil D. (1992), *A Contribution to the Empirics of Economic Growth,* The Quarterly Journal of Economics.

([15]) Hall R. and Jones C. (1999),*Why do Some Countries Produce So Much More Output Per Worker than Others?,* The Quarterly Journal of Economics, Oxford University Press.

([16]) Sachs J. and Warner A. (1995), *Economic Convergence and Economic Policies*, NBER WP No. 5039 and Ben-David, D. (1996), *Trade and Convergence among Countries*, Journal of International Economies.

([17]) On the drivers of the COVID-19 impact on real GDP, Sapir (2020) finds that lockdown measures, the share of tourism and the quality of institutions prior to the crisis helped explaining the differential impact across the EU. Chatelais (2021) estimates that differences in the degree of containment measures along with the structure of the economy (such as the size of tourism and the technological development) can account for most of the 2020 GDP contraction in Europe. Sapir, A. (2020), 'Why has COVID-19 hit different European Union economies so differently', Bruegel Policy Contribution Issue n°18 and Chatelais, N. (2021), *Covid-19 and divergence in GDP declines between Europe and the United States*. See also Licchetta M. and Meyermans E. (2022), *Gross fixed capital formation in the euro area during the COVID-19 pandemic*, Quarterly Report on the Euro Area (QREA), vol. 20(4), and Meyermans, E, Rutkauskas, V. and Simons, W (2021), *The uneven impact of the COVID-19 pandemic across the euro area,* QREA, vol. 20(2).

on convergence in GDP per capita has received less attention so far ([18]). The most parsimonious baseline model reflects the following widely used indicators ([19]):

- Initial level of GDP per capita: taking into account differences in macroeconomic and institutional factors across countries and time: Low values of income per capita would be associated with higher growth rates in subsequent years.

- Share of total investment in GDP: an increase in the share of gross fixed capital formation (GFCF) in GDP is expected to increase the capital share and the growth rate of GDP per capita. In the process of catching up, countries with lower levels of income per capita tend to accumulate capital at a faster rate. ([20])

- Openness to trade: An increase in the sum of import plus export as a share of GDP suggests that open economies can borrow abroad and import technology and know-how supporting total factor productivity growth and more generically gains from specialisation. ([21])

- Proportion of early school leavers (as a share of the 18-24 population): to proxy for human capital ([22]) to account for investment in skills.

- General government gross debt (as a share of GDP): an increase in public debt could be associated to lower growth in GDP per capita over the longer-term as public debt might detract resources from more productive private investment opportunities. We would therefore expect a negative relationship between GDP per capita and the share of public debt as a share of GDP over the long-term.

The baseline model is augmented with the following variables related to COVID-19:

- The Oxford Stringency Index: to assess the impact of lockdown measures ([23]). Lockdown measures (along with voluntary social distancing) had a negative impact on GDP across Member States, although it lessened over time so that the economic impact of the second lockdown was more contained than that of the first. The stringency indicator is interacted with the COVID-19 crisis dummy that equals 1 in 2020-2021.

- The tourism sector as a share of GDP: proxy for the relative size and economic importance of contact intensive sectors ([24]). Member States with the largest shares of travel and tourism in their economies witnessed the steepest fall in GDP ([25]). In the regression framework, this indicator is interacted with the COVID-19 crisis dummy.

- Share of people vaccinated of the total population in 2020 and 2021: to provide an indication of the prospect of a return to more normal conditions. By the end of 2021, around 72% of the total population in the European Union had received at least one vaccine dose although there were large differences within the EU. In the regression model the share of people with at least one vaccine dose is interacted with the COVID-19 crisis dummy.

I.4.2. Empirical results

A set of parsimonious conditional beta equations to assess the determinants of the real convergence

([18]) Focusing on a global dataset, Brussevich et al. (2022) found divergence in per-capita income during the COVID-19 recovery, with countries at the bottom of the income distribution falling significantly behind. The authors highlighted that higher vaccination rates and targeted containment measures were associated with a faster recovery. Brussevich, M., Liu, S. and Papageorgiou, C. (2022), *Income convergence or divergence in the aftermath of the COVID-19 shock*, IMF WP 2022/121.

([19]) Some widely used indicators were tested but resulted not statistically or economically significant. They included proxies for institutional quality (e.g. the Economic Freedom Index from the Heritage Foundation), population growth, domestic credit, net capital stock (per unit of GDP), Foreign Direct Investment (as a share of GDP) and inflation rate.

([20]) However, this has not been always the case for example in Spain prior to the global financial crisis when there was an accumulation of investment in non-tradables that proved to be unsustainable.

([21]) See Edwards, (1998), Openness, Productivity and Growth: What Do We Really Know?, The Economic Journal, 108 (March. and Frankel and Romer, (1999), Does Trade Cause Growth?, The American Economic Review Vol. 89, No. 3, Jun.

([22]) Human capital has long been identified as a source of income convergence. See Lucas, R. (1988), *On the Mechanics of Economic Development* ,Journal of Monetary Economics.

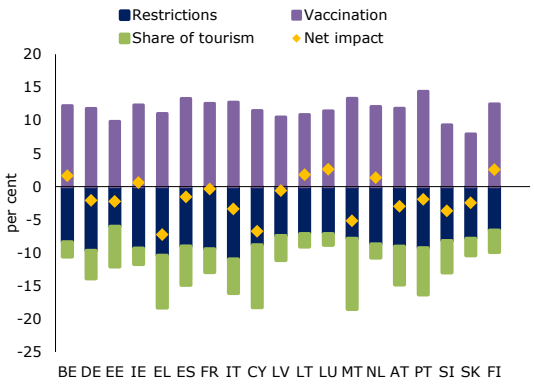
([23]) See Hale, T. et Al. (2020), *Variation in government responses to COVID-19*, BSG Working Paper Series.

([24]) In 2019, contribution to GDP from the travel and tourism sector in France was 8.9%, Germany was 10.7%, Italy was 13.1%, Spain was 14.9% and Greece amounted to 20.1%. See World Bank (2021) Database.

([25]) Milesi-Ferretti (2021) using a large sample, shows how the deviation of 2020 growth from its pre-COVID forecast is strongly correlated with the share of tourism in GDP and to a lesser extent with other indicators of the supply composition of economic activity. Milesi-Ferretti G.M., (2021) The Travel Shock, CEPR Discussion Papers 16738, C.E.P.R. Discussion Papers.

indicator represented by the annual growth of GDP per capita (in PPS) for the EA-19 is reported in Table I.2 (Column 1-3). Column 1 shows the baseline model for the EA-19 over the 1995-2019 pre-COVID-19 period. This model puts in relation growth rates of per-capita real GDP growth with other explanatory variables aiming at capturing drivers of growth in GDP per capita. In addition to the (lagged) initial income per capita, the estimated model confirms the beneficial influence of investment and trade in goods and services on income convergence. The investment variable may be a source of endogeneity in growth regressions as investment is also influenced by expected growth rates. However, there was no evidence of endogeneity for the investment indicator in our sample (See Box I.1). At the same time, an increase in public debt is associated with lower growth in GDP per capita over the long-term ([26]). However, the sign and value of the estimate of the impact of public debt on growth in GDP per capita should be interpreted with care as causality could go in both directions. ([27]) Finally, in Column 2, the base model is extended to cover the COVID-19 crisis period (2020-21) and it remains broadly unchanged suggesting stability of the estimated convergence path ([28]).

Graph I.5: **Cumulative marginal impacts (2020 and 2021) on annual growth in GDP per capita in EA-19, COVID-19 regressors**



(1) Marginal impacts calculated with equation 3 in Table I.2.
Source: Author's calculations.

The baseline model is augmented with COVID-19 variables for the EA-19 and results are shown in Table I.2 (Column 3). As expected, the introduction of lockdown measures to curb the spread of the virus lowered the growth in GDP per capita ([29]). The negative impact of the lockdown measures increases with the size of the tourism sector, a labour-intensive sector characterised by face-to-face interactions and severely hit by border closures. On the other hand, growth in GDP per capita increases with the roll out of the successful vaccination strategy providing evidence that it supported the recovery by facilitating the re-opening of the economy. ([30]) Graph I.5 highlights the estimated cumulative marginal impacts and illustrates how the estimated positive impact of vaccination strategy offset in most countries (at least partially) the negative economic impacts of the government restrictions on the economy that are of relevance for those Member States that rely more on tourism (as measured by the share of tourism in GDP). Findings in this area are broadly consistent with recent evidence on the short-term

([26]) Coutinho and Turrini (2020) also find that reducing government debt would reduce the convergence gap. See Coutinho L. and Turrini, A. (2020) *Real Convergence Across the Euro Area. What Role Do Macroeconomic Imbalances Play?,* Intereconomics volume 55. See also Chudik, A, Mohaddes, K, Pesaran, MH and Raissi, M 2010, Debt, Inflation and Growth: Robust Estimation of Long-Run Effects in Dynamic Panel Data Models, CESifo Working Paper Series.

([27]) See for example P. Heimberger (2021) *Do Higher Public Debt Levels Reduce Economic Growth,* The Vienna Institute for International Economic Studies WP 211 and Pescatori, A., Sandri, D and Simon, J *Debt and Growth: Is There a Magic Threshold?,* IMF WP/14/34.

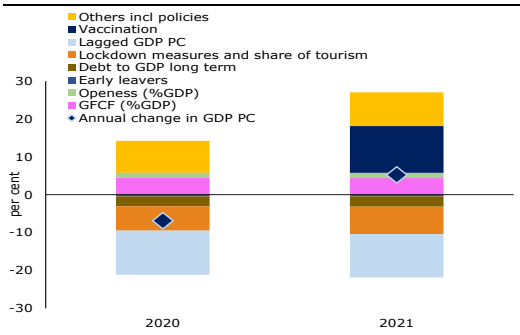
([28]) One issue with our chosen model is that the population growth indicator does not result statistically significant albeit it has the correct negative sign. Population growth accounts for the dilution of capital stock per capita so it was expected to have a negative impact on the rate of growth of GDP per capita. Another issue is that the chosen measure of institutional quality (Economic Freedom Index from the Heritage Foundation) has the correct sign but it is not statistically significant in most regressions. So it was not included in the most parsimonious specification although good quality institutions have long been recognised as an important growth driver for example, via stronger incentives to innovate and take risks that translates into faster total factor productivity growth.

([29]) The stringency index is statistically significant in 2020 but not in 2021 when included for the two single years separately. This is consistent with the more contained economic impact in 2021.

([30]) An IMF study on a large sample found that vaccines are statistically associated with variables related to the reopening of the economy, such as NO_2 emissions and mobility. Nevertheless, the impact of vaccines is more muted in those countries experiencing high stringency of lockdowns and large waves of COVID-19 cases. See Deb, P, Furceri, D, Jimenez, D Kothari, S Ostry JD and Tawk, N 2021, The Effects of COVID-19 Vaccines on Economic Activity. IMF WP No. 2021/248. See also IMF October 2021 WEO, which found that higher COVID-19 vaccination rates are associated with improved output expectations across horizons in a sample of advanced and emerging market economies.

impact of COVID-19 ([31]). Finally, Graph I.6 provides an overview of the contribution of the various estimated drivers of the annual changes in GDP per capita during the COVID-19 crisis.

Graph I.6: **Breakdown of the annual changes in GDP per capita in EA-19 during COVID-19**



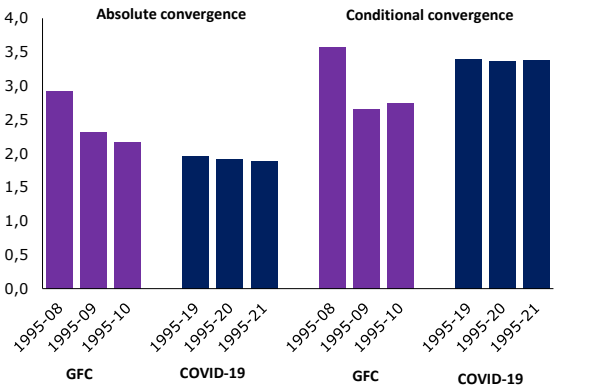
(1) Marginal impacts calculated with equation 3 in Table I.2.
Source: Author's calculations.

I.5. Impact of COVID-19 crisis on income convergence

The COVID-19 crisis had a negative impact on convergence in the EA-19 although such an impact is expected to be more temporary and less sizable than following the global financial crisis . This might be due to the very different nature of the COVID-19 and the global financial crises and the different policy responses. The global financial crisis originated from macro-financial imbalances that had built up for years requiring a long-lasting adjustment by households and governments. By contrast, COVID-19 was a major exogenous shock emerging from a health emergency the effects of which were mitigated by governments. Given the bold policy response, once government restrictions were lifted, there was limited adjustment pending.

Despite the deeper drop in GDP, regression results in this paper provide support for a less sizable impact on income convergence of the COVID-19 crisis relatively to the global financial crisis. The estimated absolute and conditional beta-convergence coefficients for the EA-19 remained broadly unchanged following the COVID-19 shock (Graph I.7). This suggests that the bold policy response to COVID-19 at EU and national level mitigated the negative economic impact. By contrast, the estimated beta coefficient decreased significantly following the global financial crisis suggesting a longer-lasting impact. One important caveat is that the full impact of the COVID-19 crisis might have not fully played out yet although the evidence available points to substantially lower long-term damages than following the global financial crisis.

Graph I.7: **Beta coefficients estimates (absolute value)**



(1) Results are for the EA-19 sub-sample but they are qualitatively unchanged for the EU-27. Absolute beta-convergence estimates from Table I.1. Conditional beta-convergence results are based on the equation in Column 3 in Table I.2.

Source: Author's calculations.

Regression results in Table I.2 (Column 5-7) provide evidence of the global financial crisis having a more long-lasting negative impact on conditional beta-convergence than the COVID-19 crisis. First, there is a positive and statistically significant interaction (Column 5 Table I.2) between the level of GDP per capita (lagged) and a global financial crisis dummy (equal to 1 over the 2009-12 period). A structural break following the global financial crisis (with a dummy equal to 1 from 2008 onward) is also supported in the data suggesting that the global financial crisis slowed down annual growth of GDP per capita over a lasting period (Column 7 Table I.2). By contrast, results for the COVID-19 period are not statistically significant (Column 6 Table I.2) suggesting that the process of convergence might have been little affected by the pandemic.

I.6. Drivers of the slowdown in convergence after the global financial crisis

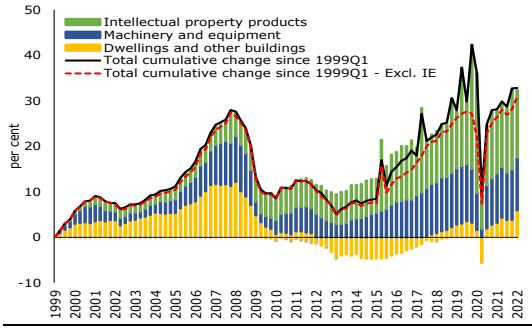
The process of convergence in the euro area slowed down significantly following the global

([31]) See also Canton, E, J. Durán, W Simons, A. Vandeplas, F Colasanti, M Garrone and A Hobza, 2021, The Sectoral Impact of the COVID-19 Crisis. An Unprecedented and Atypical Crisis. European Commission Economic Brief 69.

financial crisis. The estimated conditional beta coefficient is significantly smaller in the post-2007 period (see Column 8-10 in Table I.2 for the EA-19 subsample excluding Ireland and Luxembourg ([32])). The significant fall in investment rates of many converging countries in the period following the global financial crisis contributed to the observed slowdown in convergence. In particular, capital accumulation was sluggish in the euro area in the decade following the global financial crisis (Graph I.8) and gross fixed capital formation (GFCF) took about 10-years to return to its pre-crisis level ([33]). Indeed, there is preliminary regression evidence that the contribution of GFCF declined after the global financial crisis. In this shorter subsample, the GFCF indicator is still positive, but it is smaller, and it loses its statistical significance (see Column 9-10 Table I.2). ([34]) This result might suggest that after 2008 the neo-classical convergence channel has not been fully in play because growth in GFCF after the 2008 was relatively weak to support growth in countries. By contrast, in the period before 2008, growth in GFCF was higher in many converging countries. ([35]) The interaction between the investment indicator and the lagged GDP per capita was also tested but it was not statistically significant in most regressions (including when residential constructions were excluded).

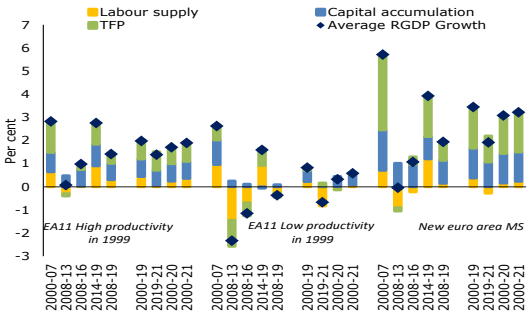
The weakness in the degree of convergence following the global financial crisis might also be related to the more pronounced slowdown in growth of total factor productivity (TFP) (Graph I.9), a key driver of income convergence. Limited productivity catch up and in particular a progressive reduction in TFP growth is a key driver for the lack of convergence of some of the early members of the euro area (Greece, Portugal, Spain and Italy) ([36]). Euro area countries with both high and low labour productivity levels (defined according to real GDP per hour worked in 1999) have experienced a slowdown in TFP growth over recent decades (Graph I.9). However, the countries with low initial productivity experienced consistently lower TFP growth throughout the sample period and a more pronounced slowdown during the global financial crisis. TFP growth in the euro area, which was already low before the global financial crisis, has worsened since then. At the same time, TFP growth was the key driver of post accession growth in the countries that joined the euro area after 2007 ([37]). Differences across countries, and regions, are also stark in some cases.

Graph I.8: **Cumulative change in GFCF in the euro area since 1999Q1**



Source: Eurostat.

Graph I.9: **Decomposition of average annual GDP growth in EA-19**



(1) Note: Luxembourg is excluded.
Source: AMECO and author's calculations.

([32]) GDP data for Ireland and Luxemburg are distorted by the presence of large multinationals or large financial sectors. In Table I.2 (column 5-10) the beta convergence equation has been re-estimated excluding Ireland and Luxemburg. Regressions results are qualitatively unchanged in this smaller sample.

([33]) When Irish data are excluded, GFCF recovered its pre COVID-19 level within 2 years. See also Licchetta and Meyermans (2022).

([34]) However, the number of observations is considerably smaller in this subsample starting in 2008, leaving less degrees of freedom for the estimation. So results are only indicative and inference from this subsample should be viewed with caution.

([35]) Over the 1996-2007 period, many Member States who joined the euro area after 2004 experienced higher growth in GFCF than the older Member States. For example, the Baltic countries saw their GFCF increasing up to seven times faster than the entire euro area aggregate. Following the global financial crisis, GFCF decreased or stagnated in most Member States. Even in the countries where it increased, growth in GFCF have been consistently lower than in the period 1996-2007.

([36]) Some of these early members experienced substantial capital inflows in the first decade of the euro that fuelled unsustainable credit booms in consumption and real estate rather than boosting productivity. See Diaz del Hoyo J., E. Dorrucci, F. Heinz and S. Muzikarova (2017). *Real convergence in the euro area: a long-term perspective* European Central Bank. Occasional Paper Series, No. 203 / December and IMF (2017), *Euro Area Policies Selected Issues*, Country Report No. 2017/236.

([37]) Čihák M., Fonteyne W. (2009), Five Years After: European Union Membership and Macro-Financial Stability in the New Member States, IMF WP No. WP/09/68.

I.7. Conclusion and implications for policy

The COVID-19 crisis was like no other and had more severe consequences on countries particularly exposed to contact intensive sectors. Some of the most affected economies already experienced below EU average per capita income levels in 2019. At the same time, there were great concerns that the COVID-19 shock could further reduce the degree of convergence across the EU and lead to further divergences. The preliminary evidence provided in this paper, however, suggests that the COVID-19 shock is likely to have been significantly less damaging to the convergence process than the global financial crisis. Some of the channels that played out after the global financial crisis were probably not in play during the COVID-19 crisis.

Regression results provide further evidence for the growth-enhancing role of trade, and physical and human capital. The latter driver of growth is particularly relevant in the context of the unprecedented skill shortages that emerged during the recovery from the COVID-19 crisis. The importance of human capital as a driver of growth also highlights a key role for skill policies in addressing the root causes of labour shortages. Finally, this paper further stresses the need to tackle structural economic weaknesses and improve productivity growth, a main driver for income convergence.

Completing the EU integration process by deepening the single market, completing the banking union and the capital market union, remain therefore of primary importance to support the process of convergence through productivity advances. This paper also provides intellectual support to two critical rationales for NextGenerationEU (NGEU), boosting growth potential in the EU through productivity enhancement and supporting countries that are weaker (in terms of lower GDP per capita and higher public debt). At the same time NextGenerationEU signals a firm political commitment to protect the region's cohesion 'at all times', further strengthening the euro area's financial architecture during the pandemic.

Table I.2: **Conditional beta convergence estimates**

Y = Change in Real GDP PC PPP	(1) EA19 Base pre COVID-19	(2) EA19 Base All	(3) EA19 Augm All	(4) EU27 Augm All	(5) EA19 ex GFC dummy interacted	(6) EA19 ex COVID 19 dummy interacted	(7) EA19 ex Post 2008 dummy	(8) EA19 ex Augm All	(9) EA19 ex Pre GFC	(10) EA19 ex Post GFC
Time	**1995-2019**	**1995-2021**	**1995-2021**	**1995-2021**	**1995-2021**	**1995-2021**	**1995-2021**	**1995-2021**	**1995-2007**	**2008-2021**
Real GDP PC (lagged)	-3.399***	-3.390***	-3.379***	-3.061***	-5.085***	-4.629***	-6.922***	-4.637***	-6.196***	-2.187**
GFCF (% of GDP)	0.194***	0.202***	0.206***	0.187***	0.204***	0.271***	0.149***	0.247***	0.319***	0.090
Openness (% GDP)	0.014***	0.015***	0.015***	0.013***	0.010***	0.009***	0.010***	0.008***	0.005	0.015***
Early leavers	-0.043*	-0.044*	-0.044**	-0.033*	-0.051***	-0.039**	-0.076***	-0.042**	-0.061***	-0.084**
Debt-to-GDP	-0.023***	-0.024***	-0.022***	-0.016**	-0.008	-0.009	0.034**	-0.012	0.015	0.039***
Share of tourism			-0.197**	-0.139	-0.152**	-0.140**	-0.190**	-0.135**		-0.211**
Stringency			-0.080***	-0.094***	-0.120***	-0.013	-0.113***	-0.108***		-0.113***
First dose (% pop)			0.158***	0.158***	0.162***	0.152***	0.157***	0.161***		0.156***
Global Financial Crises (GFC) dummy (2009-12 =1)					-15.725***					
RGDP PC (lagged)* GFC dummy					3.839***					
COVID-19 dummy (2020-21 =1)						2.583				
RGDP PC (lagged)* COVID-19_dummy						-2.257				
Post 2008 dummy (2008-21=1)							-17.673***			
Real GDP PC(lag) * Post 2008 dummy							4.361***			
Constant	9.541***	9.261***	9.155***	8.043***	14.708***	11.281***	20.208***	12.021***	15.496***	1.739
Observations	428	466	466	645	417	417	417	417	179	238
R2	0.23	0.20	0.38	0.35	0.55	0.44	0.51	0.43	0.63	0.45
Root mean squared error	3.15	3.54	3.13	3.08	2.60	3.13	2.69	2.90	1.61	3.1

Note: * p<0.10; **p<0.05; *** p<0.01.
Source: Author's calculations.

Box I.1: **Modelling income convergence**

This paper estimates conditional beta convergence for the euro area and the EU with panel regression using annual data from 1995 to2021 (1). Following previous studies (2) we estimate the following conditional beta convergence equation:

$$\Delta lnY_{it} = \alpha + \beta lnY_{it-1} + \gamma X_{it} + \varepsilon_{it} \qquad (1)$$

where: Yit = real GDP per capita; Xit= a set of quantitative (e.g. macroeconomic and institutional factors) and qualitative (e.g. dummy variables) control variables that condition convergence; i = countries; t = time period over which growth rate is computed and β = measure of convergence. Macroeconomic data are from AMECO or Eurostat. To take account of the COVID-19 crisis, this paper relies on data on lockdown measures from Oxford University, tourism from the World Travel & Tourism Council and vaccination data from the European Centre for Disease Prevention and Control.

Several variables widely used in the growth literature were simultaneously estimated in the baseline model with pooled OLS with robust (clustered) standard errors to account for the heteroscedasticity and serial correlation between errors. Indicators that are not statistically and economically significant are manually deleted stepwise. Several tests have been performed to assess the robustness of the central results of this paper (Table A). The most notable findings are:

- The baseline model (Column 1) is estimated using annual data. Focusing in such a short period, there is a risk of capturing some cyclical aspects. However, results are broadly unchanged when: 1) following standard practice in the estimation of growth regressions with panel data, annual observations are converted into averages over non overlapping, 5 year sub-periods, to reduce the effects of cyclical disturbances on the results (Column 2) (3); 2) initial conditions are lagged by 2 years (Column 3), rather than 1 year as in the base model (Column 1); and 3) the dependent variable is real GDP per capita not in PPS (Column 4) (4).

- The augmented model (Column 5) is estimated with pooled OLS with robust (clustered) standard errors and it is qualitatively unchanged when the investment variables reflects GFCF excluding dwellings (Column 6). Moreover, we could not find proof of endogeneity for the investment indicator (5).

- Finally, the inclusion of lagged variables within a panel framework raises additional risks of endogeneity and autocorrelation but we found that our results are broadly stable when spatial correlation consistent

(1) A difference from cross sectional approaches, a panel data approach allows the variation both across countries and across time.

(2) See for example Coutinho L. and Turrini A. (2020) and Berti, K and. Meyermans, E. 2018, *Sustainable convergence in the euro area: A multidimensional process*, Quarterly Report on the Euro Area (QREA), European Commission, vol. 16(3), pages 3-24.

(3) Focusing on 5 year averages allows us to investigate the drivers of trend growth whereas focusing on annual data aims at considering the cyclical variation in the growth of GDP per capita. However, 5 year averages are not suitable to study the impact of COVID-19 on convergence because the time period affected is too short to identify 'structural' trends in average growth. In addition, because of the Russian invasion of Ukraine and its notable negative economic impacts, an assessment of the impact of COVID-19 on income convergence should concentrate exclusively on 2020 and 2021. While using annual data we make the comparison with the global financial crisis as meaningful as possible by focusing on the 2 years immediately after the beginning of the two events.

(4) In addition, results are qualitatively unchanged (not shown in the table) when 1) the regression model is estimated with annual data transformed in 2,3 and 4 year moving averages and 2) when the augmented model is re-estimated with years and regional dummies.

(5) We use the endogeneity test for explanatory variables (endog) implemented by the Stata command xtivreg2. Under the null hypothesis of exogeneity, the chi-squared p-value for investment was 0.4250 in the model with fixed effects. It cannot therefore be rejected 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. The investment indicator remains positive and statistical significant when the model is re-estimated with IV and GMM using the inflation deflator as an instrument (not shown in the table). Finally, results are broadly unchanged when the investment deflator is used as instrument for the investment indicator delivering the expected negative sign, significant coefficients while the other regressors are qualitatively unchanged. On the latter approach see also Bower U. and Turrini, A. (2009), *EU Accession: A road to fast-track convergence?* Economic Papers 393, December 2009.

(Continued on the next page)

Box (continued)

standard errors are computed (Column 7) or GLS coefficient estimates with panel corrected standard errors are adopted (Column 8-9) or under the random effect estimator (Column 10) ([6]).

Table A: Conditional beta convergence in EA19 (1995-2021): robustness

Y = Change in Real GDP PC (PPS)	(1) Base	(2) Base 5y not overlap average	(3) Y= Change in Real RGDP PC T=2	(4) Y= Change in Real RGDP PC (No PPS)	(5) Augmented Model	(6) GFCF Ex-Dwellings	(7) Pooled OLS Disc Kray	(8) PCSE GLS	(9) XT GLS	(10) Random Effects XT REG
Real GDP PC PPS (lag)	-3.390***	-2.807***			-3.379***	-2.949***	-3.379***	-3.791***	-3.842***	-3.664***
GFCF (% of GDP)	0.202***	0.206**	0.257***	0.201***	0.206***		0.206***	0.190***	0.170***	0.214***
Openness (% GDP)	0.015***	0.013***	0.014***	0.012***	0.015***	0.012***	0.015***	0.016***	0.015***	0.015***
Early leavers	-0.044*	-0.042*	-0.038*	-0.043**	-0.044**	-0.030	-0.044*	-0.045**	-0.043**	-0.044**
Debt-to-GDP (%)	-0.024***	-0.022***	-0.029***	-0.026***	-0.022***	-0.024***	-0.022**	-0.024***	-0.022***	-0.022***
Share of tourism					-0.197**	-0.184**	-0.197***	-0.228**	-0.176**	-0.188**
Stringency					-0.080***	-0.083***	-0.080***	-0.076***	-0.110***	-0.082***
First dose (% pop)					0.158***	0.159***	0.158***	0.161***	0.169***	0.158***
GFCF (Ex D) (% of GDP)						0.217***				
Constant	9.261***	7.115**	7.787***	5.083***	9.155***	8.792***	9.155***	10.737***	11.382***	9.764***
Observations	466	95	466	466	466	466	466	466	466	466
R2	0.20	0.47	0.39	0.18	0.38	0.38	0.38	0.40		
Root mean squared error	3.53	1.99	2.47	3.57	3.12	3.12	3.12	2.92		3.10

([6]) The inclusion of country fixed effects was also tested while favouring random effects. This is consistent with Bell and Jones (2015), which shows that in the context of macroeconometric panels (as opposed to microeconometric panels), the more parsimonious random effect model is often superior to the fixed effects model. See Bell and Jones (2015), Explaining Fixed Effects: Random Effects Modeling of Time-Series Cross-Sectional and Panel Data, Political Science and Research Methods. See also Pamies, S, Carnot, N. and Pătărău, A , (2021), *Do Fundamentals Explain Differences between Euro Area Sovereign Interest Rates?*, ECFIN DP 141, June 2021.