Economic convergence in ageing Europe

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European regions experience accelerating ageing, but the process has substantial regional variation. This paper examines the effect of this variation on regional economic cohesion in Europe. We measure the effect of convergence or divergence in the share of the working age population on convergence or divergence in economies of NUTS-2 regions. The effect of convergence or divergence in ageing on economic convergence or divergence is quite substantial and, in some cases, is bigger than the effect of changes in productivity and labour force participation. Convergence of ageing leads to economic convergence only when the share of the working age population in rich regions exceeds that in poor regions and the former regions experience a substantial decline in the share of the working age population, or the latter regions experience an increase. In 2003-2012, an inverse relationship between convergence in ageing and economic convergence was the rule rather than the exception.

regional cohesion | European Union 27 | NUTS-2 | economic convergence | population ageing | convergence in ageing

1. Introduction

One of the long-lasting policy goals of European Union is to equalize as much as possible quality of life across member countries and their regions. In practice, this aim manifests itself in the attempts to reduce regional disparities in economic development through the Regional Cohesion Program. Since the beginning of the EU Cohesion Policy in the late 1980s, the program has allocated increasingly large funding, and the results of the implemented measures are claimed to be quite successful (Cappelen et al., 2003; Leonardi, 2006; Pellegrini et al., 2013). Particularly, the "success story" could be heard in the context of Eastern-European regions catching up with the advantageous regions of the older EU states (Bosker, 2009). Multiple studies have found evidence of decreasing income disparities over time in Europe, both before and after the EU enlargement (Borsi and Metiu, 2015; Ezcurra et al., 2005; Ezcurra and Rapún, 2007; Fingleton, 1999; Maza et al., 2012; Monfort, 2008; Neven and Gouymte, 1995). However, a notable part of the reduction in regional disparities that is attributed to the Cohesion Policy, may have been explained by different dynamics in regional population structures that most studies on economic cohesion tend to overlook (Crespo Cuaresma et al., 2014a).

The major point of regional policies in the European Union is to reduce disproportions in all aspects that can influence differentiation in the quality of life, including demographic developments (European Commission, 2014; Giannakouris, 2008). The logic behind these policies implies that convergence in population age structures is desirable because it will contribute to the reduction in regional economic and life quality disproportions. Yet, as we show in this paper, this assumption does not necessarily hold in real life. Changes in population structures, that affect economic prospects, are not happening uniformly across countries and regions of Europe (Reher, 2015; Wilson et al., 2013). Reducing, lasting or increasing disparities in potential labour supply may accelerate or hinder economic convergence depending on whether these disparities favor the more economically developed regions or the lesser developed ones. Thus, the interplay between convergence or divergence in population ageing and convergence or divergence in economic development is not straightforward and, to our knowledge, has never been addressed in the literature. The goal of this paper is to shed light on this association.

The paper is organized as follows. Section 2 summarizes theoretical considerations about the relationship between demographic and economic convergence and introduces the conceptual framework, discussing the possible interconnection between convergence in ageing and economic convergence. Section 3 presents the analytical strategy. Section 4 describes the features of the data and provides background information about the setting of the study. Section 5 first overviews the observed dynamics of variance in both population structures and economic output. Then using the chosen counterfactual approach it establishes the contribution of convergence in ageing to convergence in economies. Finally, the third subsection provides an explanation of the observed relationships. The discussion of the results, some limitation and prospects for future research are inculded in section 6.

2. Theoretical considerations and the proposed framework

Various theoretical and empirical studies have shown that population ageing – i.e. changes in the population age structure that result in a shrinking relative size of the working age population – has a negative effect on economic growth (Bloom and Williamson, 1998; Bloom et al., 2010; Crespo Cuaresma et al., 2014b; Prskawetz et al., 2007; Van Der Gaag and De Beer, 2015). A decline in the size of the working age population has a downward effect on GDP per capita, whereas an increase in the number of elderly citizens has an upward effect on costs of pensions and care (Kluge, 2013; Kluge et al., 2018; Van Nimwegen, 2013). Other things equal, a decrease in the share of the working age population slows down the economic growth of a region (Teixeira et al., 2016). Thus, population ageing appears to be one of the main determinants of long-term economic prospects, that can possibly affect economic convergence (Bloom et al., 2010; de la Croix et al., 2009; Kelley and Schmidt, 1995; Lee and Mason, 2010). Unlike many previous studies, we prefer to define population ageing as the process altering the whole age distribution of the population

instead of focusing exclusively on the elderly part of the population (Kashnitsky and Schöley, 2018). With such an approach, and in the context of modern Europe, which is the most advanced region in terms of demographic transition, the share of working age population is the most suitable basic summary indicator of population ageing (Lee, 2003).

Convergence in population ageing, i.e. convergence of the share of the working age population, does not necessarily lead to economic convergence (Goldstein and Kluge, 2016). Convergence in ageing may even contribute to economic divergence. This depends on differences in the levels of the share of the working-age population between economically advantageous and lagging-behind regions. For example, if the share of the working age population is relatively low in poor regions, convergence in ageing helps to reach economic convergence because the advantage of the rich regions due to population age composition declines (Salvati, 2016). In contrast, if the share of the working age population is relatively high in poor regions with low productivity, convergence in ageing may slow down economic convergence, as it eliminates one of the poor regions' resources for faster economic development, i.e. the favourable age composition of the population. Divergence in ageing, in that latter case, contributes to a faster economic convergence (Crespo Cuaresma et al., 2016). Thus, for better understanding the mechanisms of regional cohesion, we need to distinguish four types of regions: rich regions with low and high shares of the working age population and poor regions with low and high shares of the working age population. This paper introduces a new method to visualize the relationship between changes in the share of the working age population and in GDP per capita in the four types of regions. To our knowledge, only a couple of recent studies explicitly focused on the investigation of changes in relative dynamics of population ageing with the use of convergence analysis (Gutiérrez Posada et al., 2018; Kashnitsky et al., 2017; Sabater et al., 2017); and none examined the interplay between convergence in ageing and economic convergence.

To illustrate the possible interrelationship between convergence in ageing and economic convergence, let us consider four hypothetical regions such that they represent the four types of combination of GDP per capita and the share of the working age population levels, above and below the median values: rich-high, rich-low, poor-high, and poor-low (see the black dots in Figure 1). Then consider the joint change in the variance of the two variables when the share of working age population is changed only in one of the regions. Assuming constant labour productivity, changes in the share of the working age population would result in proportionate changes in GDP per capita (i.e. changes in region's position in Figure 1 follow the diagonal lines). In such a setting, there can be four principal cases of interaction between convergence in ageing and economic convergence (Figure 1).

First, if there is a decrease in the rich region with a high share of the working age population, there is an overall decrease in the variance of both the demographic and economic variables; hence, convergence in ageing contributes to economic convergence. Second, if the same region experiences an increase in the share of the working age population and in GDP per capita, that results in divergence both in ageing and economy. These two cases represent the positive correlation between convergence in ageing and economic convergence. Third, when the rich with a low share of the working age population experiences a decrease in that share, that results in divergence in ageing contributing to economic convergence. Alternatively, in the fourth case, when the rich region with the small working age population experiences an increase, convergence in ageing contributes to economic divergence. The latter two cases represent a negative correlation between convergence in ageing and economic convergence. Of course, there are four complementary cases, when the changes occur in the poorer regions (pink arrows in Figure 1), but these four cases only mirror the four discussed cases.

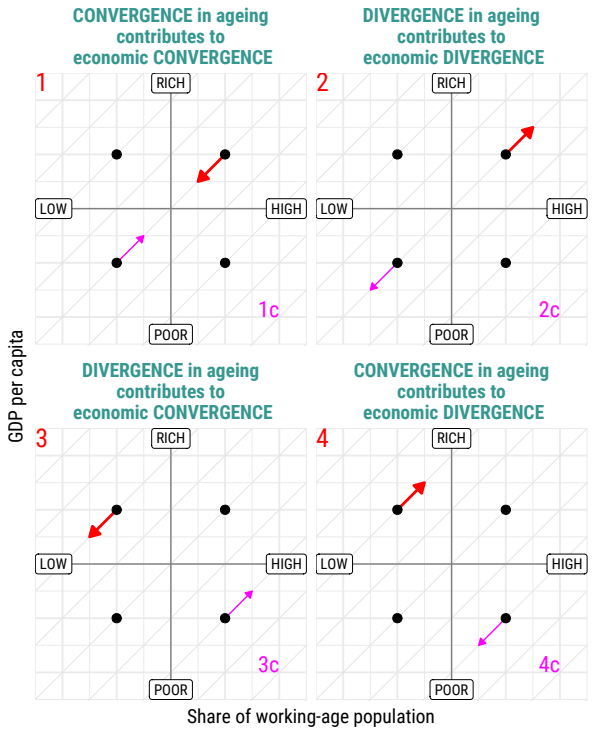

Fig. 1. Possible interplay between convergence in ageing and economic convergence. Note: black dots represent the 4 regions. The arrows show the change that happens in one of the regions: red arrows represent changes in rich regions, pink arrows represent the 4 complementary cases, when changes occur in the poor regions. A change in one point affects variance on both variables.

With this theoretical framework we can see that the standard hypothesis of a positive association between convergence in economies and convergence in ageing only holds when the strongest changes happen to rich regions with a high share of the working age population or poor regions with a low share. Alternatively, when the overall variance is mostly driven by changes in poor regions with a high share or rich regions with a low share, one would expect to find

a negative association between convergence in economies and convergence in ageing.

3. Analytical strategy

Aiming to investigate the association between convergence or divergence in economies and population structures, we use the sigma convergence approach (Monfort, 2008), i.e. we conceptualize regional convergence as a decrease in the variance across regions. To measure convergence, we use Theil's T index of inequality (Theil, 1967, 1979) as the measure of variance. This analysis shows the baseline convergence in economies and population structures separately.

To analyze the impact of convergence in ageing on economic convergence, we decompose economic growth into productivity and demographic components using the following formula:

$$\frac{Y_{t_0+T}/P_{t_0+T}}{Y_{t_0}/P_{t_0}} = \frac{Y_{t_0+T}/W_{t_0+T}}{Y_{t_0}/W_{t_0}} \cdot \frac{W_{t_0+T}/P_{t_0+T}}{W_{t_0}/P_{t_0}}$$

where t_0 is the starting year, T is the length of the period, Y is gross domestic product, P is the population size, W is the size of the working-age population. In the right-hand side of equation 1, the two elements represent productivity and the change in the population structure respectively. Note that in this paper we define productivity by the ratio between GDP and the size of the working age population. This implies that productivity not only depends on labour productivity (the ratio of GDP and the work force) but on labour force participation (the ratio of the work force and the working age population) as well. Thus, the decomposition we use is a slightly simplified version of the one proposed by Bloom and Williamson (1998). We aim primarily to assess the impact of the size of the working age population rather than disentangling the effects of labour productivity and participation. Other researchers used more elaborated versions of the formula (Hsu, 2017), but they studied the effects of components of economic convergence rather than convergence in any of the components.

In order to check how convergence in ageing affects economic convergence, we conduct a counterfactual analysis. Using the decomposition of economic growth, we estimate counterfactual economic growth rates based on the assumption of no change in population structures and the actual development in the productivity component using a slightly modified version of equation 1:

$$Y_{t_0+T}/P_{t_0+T} = Y_{t_0}/P_{t_0} \cdot \frac{Y_{t_0+T}/W_{t_0+T}}{Y_{t_0}/W_{t_0}} \cdot \frac{W_{t_0+T}/P_{t_0+T}}{W_{t_0}/P_{t_0}}$$

in which the GDP per capita in year t_0 is multiplied by the growth in productivity $\frac{Y_{t_0+T}/W_{t_0+T}}{Y_{t_0}/W_{t_0}}$ and the change in the share of the working age population $\frac{W_{t_0+T}/P_{t_0+T}}{W_{t_0}/P_{t_0}}$. Then, we compare convergence for the observed and counterfactual economic growth rates. The difference is interpreted as the effect of convergence in ageing on economic convergence.

This approach is based on the assumption of constant productivity, i.e. we assume a linear positive relationship between changes in the share of the working age population and changes in GDP per capita. Note that we define productivity by the ratio of GDP and the size of the working age population. Regional differences in the change of productivity can affect the relationship between convergence in ageing and economic convergence.

The analysis and the necessary data preparation were conducted using R, a language and environment for statistical computing, version 3.4.0 (R Core Team, 2017). The following additional packages were essential for the analysis and data visualization: tidyverse (Wickham, 2017), rgdal (Bivand et al., 2015), cowplot (Wilke, 2016), RColorBrewer (Neuwirth, 2014).

4. Data and background dynamics

This paper uses Eurostat data on population age structure (Eurostat, 2015) and mortality records (Eurostat, 2015) by one-year age groups for the period 2003-2012. The data are aggregated at the NUTS-2 level, version of 2010 (Eurostat, 2015). At the moment of data acquisition (March 2015), mortality records covered the period up to 2012. For the majority of countries, data on population structure are available since 2003. Hence, data were available for the period 2003-2012. Necessary data harmonization steps were performed (Kashnitsky et al., 2017).

GDP estimates at regional level were taken from the Cambridge Regional Database (Cambridge Econometrics, 2015). Several notes have to be made concerning the use of these data. First, GDP is a measure that relates to the year for which it is calculated; population estimates, in contrast, are given at the beginning of each year. Since we have quite a limited study period, and do not want to shorten it further by calculating mid-year population, we assumed that GDP estimates refer to the end of the year. We did a sensitivity analysis, which showed that the assumption does not affect the results strongly. Second, the Cambridge Regional Database uses the 2006 version of NUTS, and the population data from Eurostat uses the 2010 version of NUTS. The required transformations were performed to match the data from both data sets. Finally, as the economic database does not include Croatia in the 2015 version of the database, we also removed it from the analysis. The data set used for the analyses contains data for 261 NUTS-2 regions of EU27 for the period 2003-2012.

The study period analyzed in this paper, from 2003 to 2012, is a rather unique one. Two major events, that directly affect the relationship between demographic structures and economic performance of the regions, happened within this period. First, in 2004 the European Union experienced the biggest ever enlargement in its history. This major reshaping European political landscape notably affected intra-European migration flows (Bosker, 2009; Crespo Cuaresma

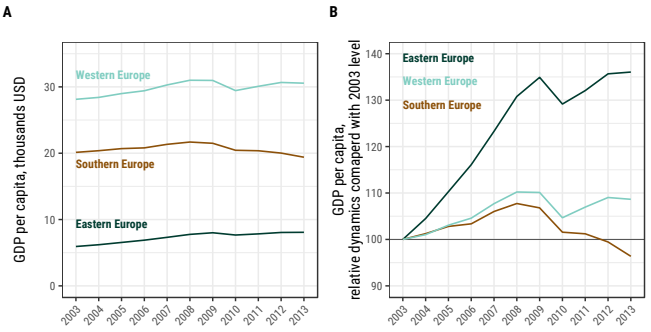

Fig. 2. GDP per capita dynamics by parts of Europe: A – absolute values; B – relative dynamics.

et al., 2008, 2015). Second, Europe was heavily stricken by the economic crisis of 2008-2009 (Crespo Cuaresma et al., 2014a; Percoco, 2016). Both events affected the process of economic convergence making the period very interesting to study (Borsi and Metiu, 2015; Dall'Erba et al., 2008; Doran and Jordan, 2013; Ertur et al., 2007; Fingleton et al., 2012). The uneven impact of the economic crisis across Europe is of particular importance for convergence: the catching up East-European regions seems to recover rapidly while the falling behind South-European regions are the most stricken with the economic crisis (Salvati, 2016; Salvati and Carlucci, 2016) (Figure 2). We divide Europe into three parts: Eastern, Southern, and Western. Initially, we tried to use the official subdivision of European countries into Northern, Western, Southern and Eastern parts (EuroVoc, 2017). But the subset of Northern regions turned out to be too small and heterogeneous. So, we merged Scandinavia with Western Europe, and the Baltic regions with Eastern Europe.

Not only the features of regional economic development make the study period interesting for analysis, the demographic settings are also unusual. During the study period, the main difference in the share of the working-age population in Europe lied between post-communist countries and the rest of Europe (Figure 3). In 2003, the sharp contrast was still clearly visible even within the reunited Germany (Figure 4-A).

Post-communist countries were relatively late with the onset of the Demographic Transition (Lee, 2003) and, especially, the Second Demographic Transition (Lesthaeghe, 2010). Only after the collapse of communism did they experience the sharp fertility decline that contributed largely to the boost of their economies. The other countries of Europe that did not have a communist past started to experience accelerating ageing and recuperating fertility even before the study period (Reher, 2011; Wilson et al., 2013). It is clear, that the regions of Eastern Europe fully appreciated the benefits of demographic dividend only after the fall of the Eastern Bloc in 1990, when fertility dropped dramatically. In the rest of Europe, the demographic dividend started to wear off much earlier, in many countries, even before the start of the Cohesion Program (Van Der Gaag and De Beer, 2015). The relative advantage of East-European regions in ageing was prominent within the study period, but it will reduce substantially in the coming years (Kashnitsky et al., 2017).

A steep decline in the share of the working age population happened uniformly in Europe after 2010. The main reason for that is cohort turnover. The baby-boom generation, born after 1945, started to cross the age line of 65 accelerating ageing (Lanzieri, 2011). Naturally, the "aftershock" of such a massive demographic perturbation of the past, as was the baby-boom in the Western world, is very perceptible (Van Bavel and Reher, 2013; Wilson et al., 2013).

The effect of baby-boomers' retirement on the share of the working-age population was especially strong in Northern and Western Europe (Groenewold and De Beer, 2014; Reher, 2015; Van Bavel, 2010). Interestingly, it was partially leveled by reversals of migration flows after the economic crisis of 2008 (Crespo Cuaresma et al., 2015; Wilson et al., 2013). Northern and Western Europe experienced a rise of in-migration at working ages, while less economically competitive regions of Eastern and Southern Europe experienced a drop of in-migration or even net out-migration at working ages. To some extent, migration compensated the effect of cohort turnover on the regional disparities in population age structures (Kashnitsky et al., 2017).

5. Results

5.1. The components: economic convergence and divergence in population ageing. During the period 2003–2012, economic convergence occurred in Europe; sigma-convergence analysis indicates that income inequality reduced during the study period, though, only before the onset of the economic crisis. Simultaneously, inequality in the share of the working age population has risen throughout the study period indicating divergence (Figure 5). Though, the pooled trends for Europe mask substantial differences between the three parts of Europe: within each of them the development of the variance in both GDP per capita and the share of working age population has varied substantially.

Eastern Europe has seen a slight overall decrease in income inequality. In Southern Europe, there was economic convergence in the first part of the period, but after the outbreak of the economic crisis, it has changed to a rapid divergence. Western Europe has experienced the smallest changes in variance. The direction of changes in Western Europe has been opposite to those of Sothern Europe: divergence in the first part of the period and convergence in the second part of the study period. The relative changes in Theil's index of inequality suggests that in the three parts of Europe different groups of regions were most struck by the 2009-2008 economic crisis.

As with the difference in income variance dynamics, changes in the variance of the share of working age population has been notably different in the three parts of Europe.

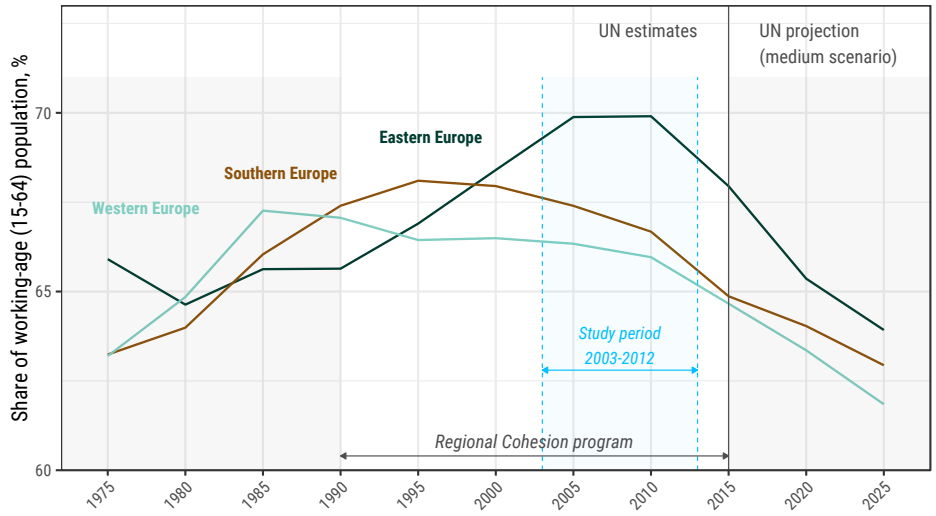

Fig. 3. Asynchronous demographic dividend in Europe: dynamics of the share of working age population in parts of Europe during the period 1975-2025. Note: within each part, data for countries are weighted by the number of NUTS-2 regions in countries for compatibility with other results in the paper.

Eastern Europe has experienced divergence throughout the study period. Southern Europe saw divergence before the economic crisis and convergence after. Western Europe, on the other hand, has experienced fast convergence in the first part of the period, and divergence in the second.

Notably, with the exception of a constant divergence in ageing in Eastern Europe, the changes in variance reverse during the study period, resulting in almost no change by the end of the period. This again highlight the uniqueness of the study period that contained economic crisis, graying of baby boomers, and ending of demographic dividend in Eastern Europe.

5.2. Interplay: the relationship between convergence in ageing and economic convergence. As described in the methodological section, we conduct a counterfactual analysis to assess the effect of convergence or divergence in ageing on convergence or divergence in economies. Assuming no change in population age structures, we first estimate to what extent economies would converge if there were no demographic effect on economic growth, i.e. the only source of economic growth was the growth in productivity (including labour force participation). Then, we compare the no-population-change results with the actual observed evidence for convergence or divergence, and thus assess the effect that convergence in ageing has on convergence in regional economies. Because of the huge differences in the dynamics of the variance between the parts of Europe, we conduct the analysis separately for the parts and the two sub-periods (Table 1).

Consider Southern Europe (middle columns in both panels of the table). In the first part of the period (2003-2007), regions of Southern Europe experienced divergence in population ageing, Theil's index of inequality in the share of the working age population increased by 24%. At the same time economic convergence happened, i.e. Theil's index of inequality in GDP per capita decreased. Even without change in population structures, the decrease would have been about 10%. When we account for changes in the share of the working age population, the convergence turns out to be even stronger; the decrease in Theil's index becomes about 14%. Thus, divergence in ageing resulted in faster economic convergence, revealing a negative correlation between them. In the second sub-period (2008-2012), convergence in ageing contributed to a slowdown of the baseline economic divergence in Southern Europe, hence, revealing a positive correlation between convergence in ageing and economic convergence.

The results of the counterfactual analysis reveal quite a diverse picture. Convergence in population ageing can contribute to economic convergence (Southern Europe in 2008-2012) and divergence in ageing can have a diverging effect on the economy (Western Europe in 2008-2012). But convergence in ageing can also result in economic divergence (Western Europe in 2003-2007), while demographic divergence can have a converging effect on the economy (Eastern Europe in both periods and Southern Europe in 2003-2007).

To understand the relationship between demographic and economic convergence or divergence, we examine differences between ageing in rich and poor regions. Figure 1 showed that the direction of the effect of population ageing on the economy differs depending on whether the main change in ageing occurs in rich or poor regions If the major changes in population structures occur in those regions that are relatively rich and have a high share of the working age population or in regions that are relatively poor and have a low share of the working age population, the relationship is expected to be positive, irrespective of whether there is convergence or divergence in ageing (cases 1 and 2 in Figure

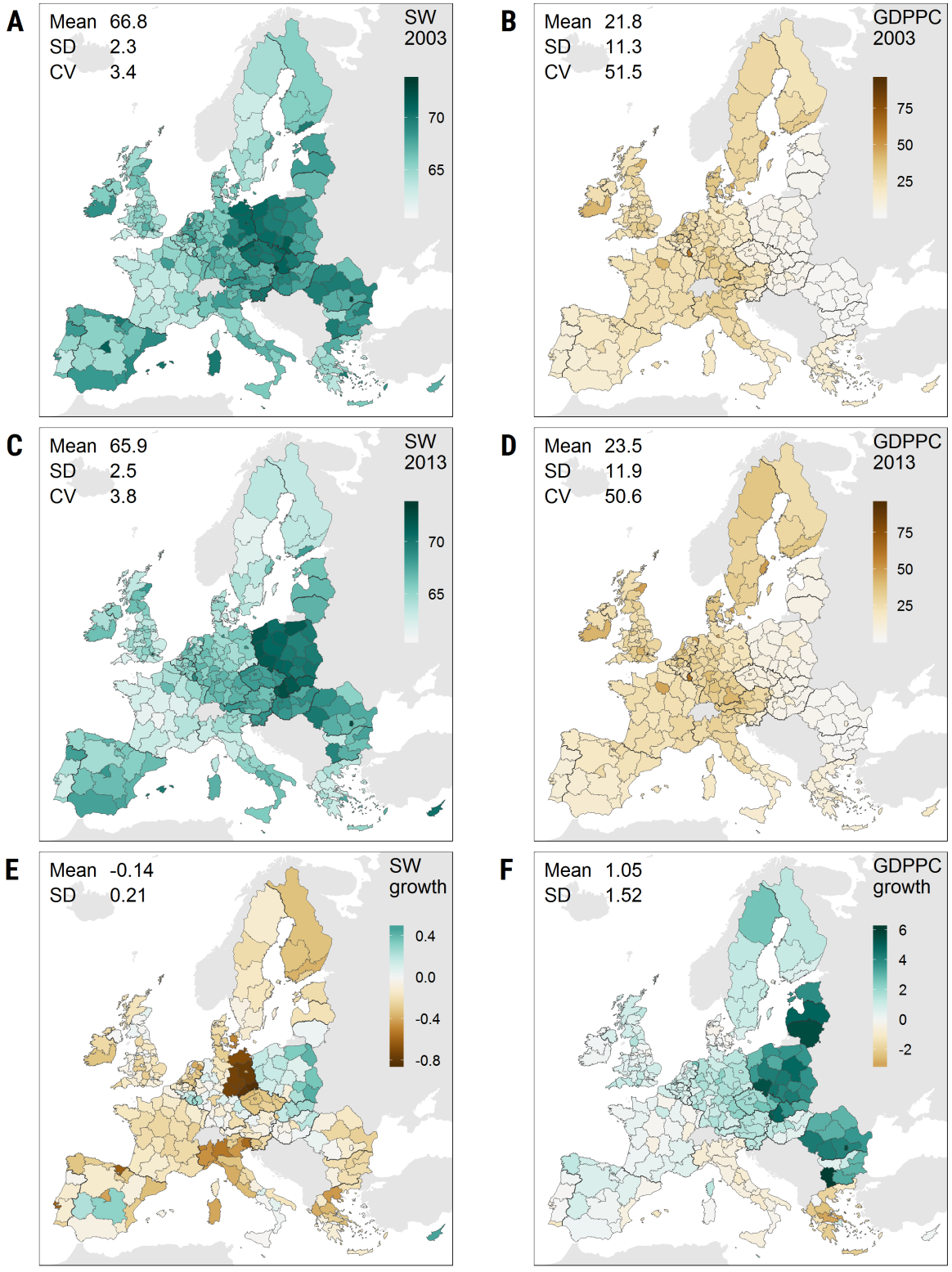

Fig. 4. Descriptive maps: A – share of working age population in 2003, percent; B – GDP per capita in 2003, thousands USD; C – share of working age population in 2013, percent; D – GDP per capita in 2013, thousands USD; E – share of working age population annualized growth rate in 2003-2012, percent; F – GDP per capita annualized growth rate in 2003-2012, percent.

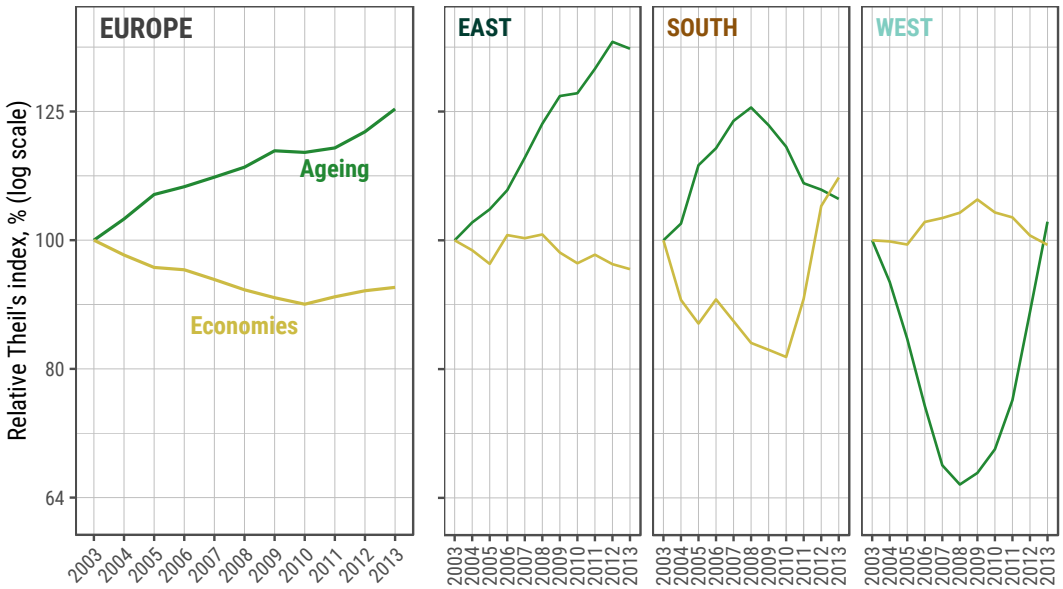

Fig. 5. Sigma-convergence analysis of regional variation in GDP per capita and the share of the working age population – the relative dynamics of Theil's index of inequality, 2003 is taken for 100 percent; log scale.

	2003-2007			2008-2012		
	EAST	**SOUTH**	**WEST**	**EAST**	**SOUTH**	**WEST**
Relative change in Theil's index of inequality in AGEING	122.2	123.8	65.1	115.2	86.5	160.7
Convergence or divergence in AGEING	divergence	divergence	convergence	divergence	convergence	divergence
Relative change in Theil's index of inequality in ECONOMIES -- CONDITIONAL	102.4	89.4	103.0	97.1	135.7	92.0
Relative change in Theil's index of inequality in ECONOMIES -- REAL	101.0	83.7	104.9	94.2	133.2	94.6
Effect of population structure on con/divergence in ECONOMIES	convergent	convergent	divergent	convergent	convergent	divergent
Association between convergence in AGEING and convergence in ECONOMIES	**–**	**–**	**–**	**–**	**+**	**+**

Table 1. Relationship between con/divergence in ageing and economic con/divergence

1). In contrast, when the major changes in population structures occur in the group of regions that are poor but have a higher share of the working age population or regions that are rich with a low share of the working age population the relationship is likely to be negative (cases 3 and 4 in Figure 1).

5.3. The clue: who's driving the relationship. In order to identify the regions showing the major demographic changes Figure 6 shows the changes in the distributions of regions according to the share of the working age population for rich and poor regions. For each of the three parts of Europe and for each period, we distinguish poor and rich regions by dividing the regions in two groups according to the initial GDP per capita (below and above the median values). Then we plotted the initial and final distributions of the share of the working age population. Note that we did the grouping separately for both sub-periods, so that some regions may have appeared, for example, in the poorer group in the first sub-period and in the richer group in the second sub-period, and vice versa. Figure 7 shows how regions were classified in four groups: how regions were classified in four groups: poor and rich regions with low and high shares of the working age population. For example, in the first sub-period, Cyprus was in the rich group of regions of Southern Europe with a low share of the working age population; in the second sub-period, it stayed relatively rich but moved to the upper half of the share of working age population distribution (see Figure 7).

A change in the slope of the cumulative density for a group of regions between the beginning and the end of the period (lines of the same colors) in Figure 6 shows whether there was convergence or divergence in ageing: a steeper slope at the end of the period implies convergence, a flatter slope means divergence. Figure 6 shows which part of the distribution contributed most to the observed change. Most importantly, the change in the distance between the cumulative density lines for the poor and rich regions (different colors) indicates the effect of convergence or divergence in ageing on economic convergence or divergence: decreasing distance means a convergent effect; increasing distance means a divergent effect. And we can identify which group of regions and which part of its distribution contributed most to the narrowing or the widening of the distance between poor and rich regions. This explains the direction of the relationship between demographic and economic convergence or divergence.

To illustrate the interpretation of Figure 6, consider Southern Europe (the middle panels). The share of the working age population in rich regions is higher than in poor regions. Since the distance between the cumulative density lines for poor and rich regions decreased in the first sub-period (2003-2007), demographic change had a convergent effect on the economy (see also the corresponding column in Table 1). The main cause of the narrowing of the lines for poor and rich regions was the change in the lower part of the rich regions' distribution – these are mainly non-metropolitan regions of Northern Italy and Northern Spain (Figure 7). Such a case corresponds with the third case from the conceptual framework (bottom-left panel in Figure 1, pink arrow); this case explains the situation when divergence in ageing contributes to economic convergence – and that is precisely what happened in Southern Europe in the first sub-period. In the second sub-period (2008-20012), the distance between the cumulative density lines for poor and rich regions again narrowed. But this time the change was mainly driven by the developments in the upper part of the rich regions' distribution – now the group consisted mostly of the metropolitan regions of Southern Europe (Figure 7). That corresponds to the first case from the conceptual framework (top-left panel in Figure 1), when convergence in ageing contributes to economic convergence, thus revealing a positive association between them.

In Eastern Europe, the main changes occurred in the upper part of the poor regions' distribution during the first sub-period and in the lower part of the rich regions' distribution during the second sub-period – third case from the hypothetical framework and its inverse. In Western Europe, the main changes first happened in the upper part of the poor regions' distribution – fourth case (bottom-right panel in Figure 1); then, in the second sub-period, changes in the lower part of the poor regions' distribution were driving the increase in the distance between density lines – the inverse of second case (top-right panel in Figure 1).

Thus, population convergence does not have to lead to economic convergence and demographic divergence does not necessarily imply economic divergence. On the contrary: in many cases the relationship is inverse.

6. Conclusion and discussion

The evidence of economic convergence in Europe corresponds with earlier findings (Borsi and Metiu, 2015; Eckey and Türck, 2007; Fingleton, 1999). Separate analysis for the parts of Europe showed that large differences between parts of Europe are the main driver of convergence in GDP per capita, which correspond with the results of Crespo Cuaresma et al. (2014a). In contrast, differences in the dynamics of the share of the working age population contribute to divergence in ageing in Europe, but we see some convergent regional dynamics within parts of Europe.

We employed counterfactual analysis to estimate to what extent relative changes in population structures affect economic convergence. We used the decomposition of GDP per capita growth rates into the productivity (which includes also labour force participation) and demographic components. Then we analyzed the changes in the GDP per capita variance assuming no change in the demographic component. The difference between the zero population change scenario and the real development of regional economies shows the effect of convergence in ageing on economic convergence. We found that the direction of the relationship varies over time and in different subgroups of regions. It

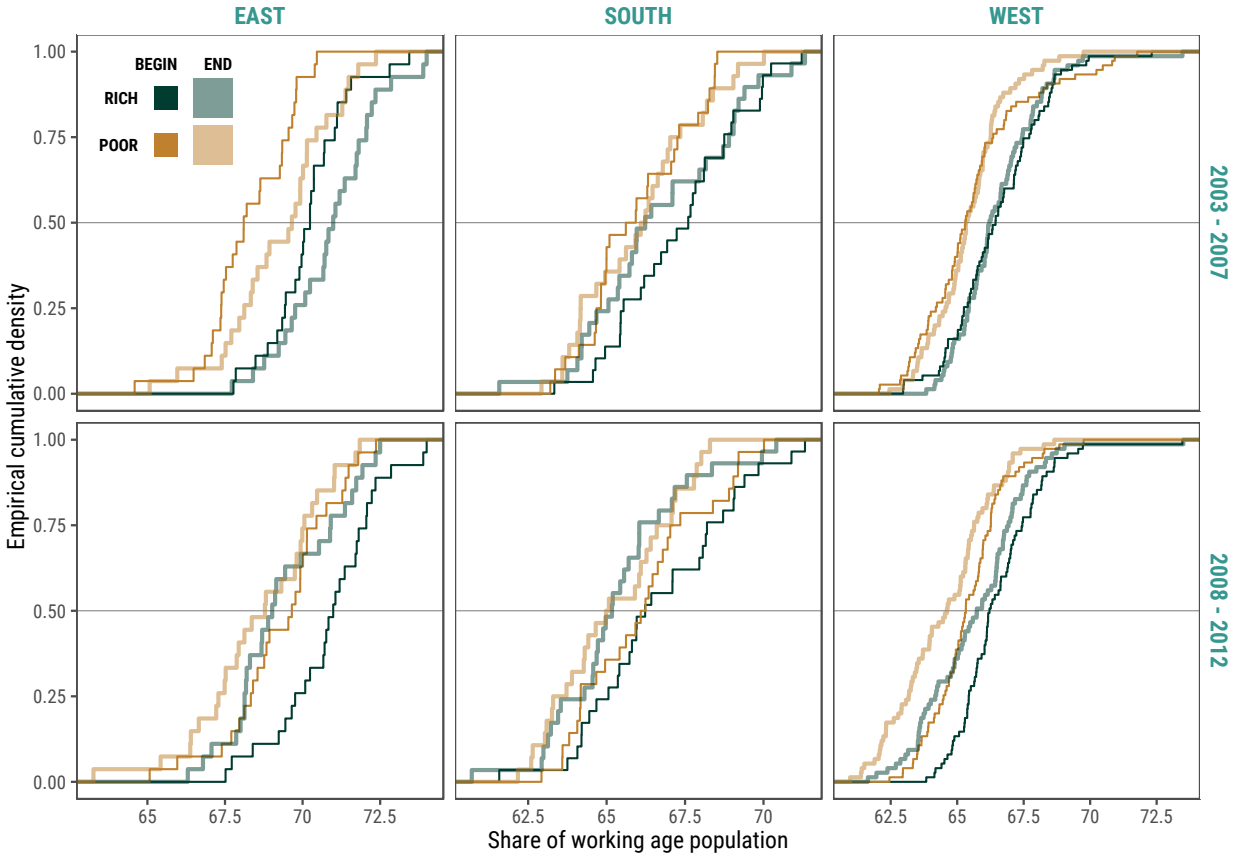

Fig. 6. Empirical cumulative densities of the share of working age population distributions, divided in halves by GDP per capita. Note: solid lines represent distributions at the beginning of the period, half-transparent lines – the end the period.

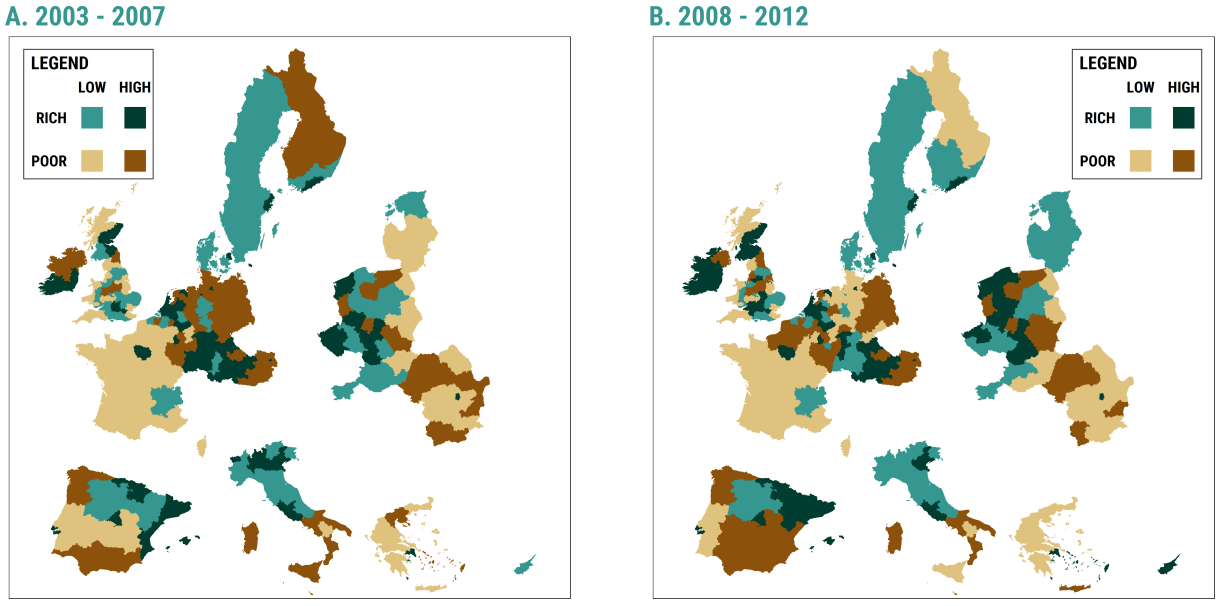

Fig. 7. Classification of European regions in 4 groups according to the level of GDP per capita and the share of working age population at the beginning of sub-periods: poor-low, poor-high, rich-low, and rich-high. Note: regions were classified separately for each sub-period (x2) and each part of Europe (x3).

depends on the characteristics of the regions that experience the biggest changes in population structures, whether those regions are relatively poor or rich, and have relatively low or high shares of the working age population. If the main changes occur in the rich regions with a high share of the working age population or in poor regions with a low share of the working age population, the relationship is positive. Otherwise, when rich regions with a low share or poor regions with a high share experience the biggest changes in population structures, the relationship between convergence in ageing and economic convergence is negative.

The empirical evidence for the three parts of Europe in two periods showed that all four possible cases occurred. This result has a strong policy implication. With the main goal of the European Union's Regional Program to reduce regional disparities in the quality of life, it is important to understand that not every indicator should converge in order to facilitate economic cohesion. As shown in this paper, lasting or even increasing regional differences in population age structures often contribute to faster economic convergence. Policy measures that affect regional population age structures in order to promote economic convergence should address the right group of regions depending on the type of relationship between convergence in ageing and convergence in economies.

Our study is the first to focus on the interrelation between convergence in population structures and convergence in economic development. Further research may focus on disentangling the effects of labour force participation and labour productivity. While labour force participation usually decreases with age (Bloom et al., 2015; Lee and Mason, 2011), and thus ageing of the working age population has a negative impact on total labour force participation, the effect on productivity is more complex. Some researchers find evidence in support of the human capital theory, showing a positive effect of labor force ageing on GDP through the growth in productivity (de la Croix and Monfort, 2000; Futagami and Nakajima, 2001; Gómez and De Cos, 2008; Lindh and Malmberg, 1999, 2009; Rauhut, 2012). Other researchers show a negative effect (Bloom and Williamson, 1998; Bloom et al., 2010; Crespo Cuaresma et al., 2016; Teixeira et al., 2016).

The framework for analyzing the effect of convergence in ageing on economic convergence, proposed in this paper, addresses a new question in the field of demographic economics. This question is gaining importance in the light of the rapidly declining share of the working age population, while future convergence in ageing among European regions is likely to occur. With the rapidly declining share of the working age population, the only source of economic growth is increased productivity including an increase in labour force participation. The demographic burden that follows the prosperous years of demographic dividend will have an increasing downwards effect on GDP per capita in the coming decades (Van Der Gaag and De Beer, 2015). In such a setting, the relative regional differences in the dynamics of population structures may have a bigger effect on regional cohesion. Even though the direct effect of the population age structure on economic development is rather small, the role of convergence in ageing on economic convergence appears to be quite significant and in many cases is as important as the effect of relative changes in productivity and labour force participation.

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