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Economic convergence in ageing Europe

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Abstract

European regions experience accelerating ageing, but there is substantial regional variation in the process. 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 has been smaller than the effect of changes in productivity and labour force participation; yet, this effect was still quite substantial. Convergence of ageing leads only to economic convergence 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. Our empirical analysis shows that in the period 2003-2012 an inverse relationship between convergence in ageing and economic convergence was the rule rather than the exception.

Keywords: regional cohesion, economic convergence, population ageing, convergence in ageing

1. Introduction

Ageing is one main determinant of long-term economic prospects, that can possibly affect economic convergence (Kelley and Schmidt, 1995; de la Croix, Lindh, and Malmberg, 2009; Bloom, Canning, and Fink, 2010; Lee and Mason, 2010). Population ageing – i.e. the change in the population age structure resulting in a shrinking relative size of the working age population – has a negative effect on economic growth (Bloom and Williamson, 1998; Prskawetz et al., 2007). 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. Thus, other things equal, a decrease in the share of the working age population slows down the economic growth of a region.

European regional policies aim for economic cohesion across European regions. Since the beginning of the EU Cohesion Policy in the late 1980s, the program tends to allocate 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. Multiple studies have found evidence of decreasing income disparities over time in Europe, both before and after the EU enlargement (Borsi and Metiu, 2015; Crespo Cuaresma, Doppelhofer, and Feldkircher, 2014; Ezcurra et al., 2005; Ezcurra and Rapún, 2007; Fingleton, 1999; Maza, Hierro, and Villaverde, 2012; Monfort, 2008; Neven and Gouymte, 1995). However, the effect attributed to the Cohesion Policy may have been explained to some extent by differences in population ageing that studies on economic cohesion tend to overlook.

While the positive association between the potential labour force and economic output is quite straightforward, different developments in ageing may influence economic convergence in a more complex manner. Convergence in population ageing, i.e. convergence of the share of the working age population, does not necessarily lead to economic convergence. 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. In contrast, if the share of the working age population is relatively high in poor regions, 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 that latter case, contributes to a faster economic convergence. Thus, for better understanding the mechanisms of regional cohesion, we need to distinguish four types of regions: rich regions

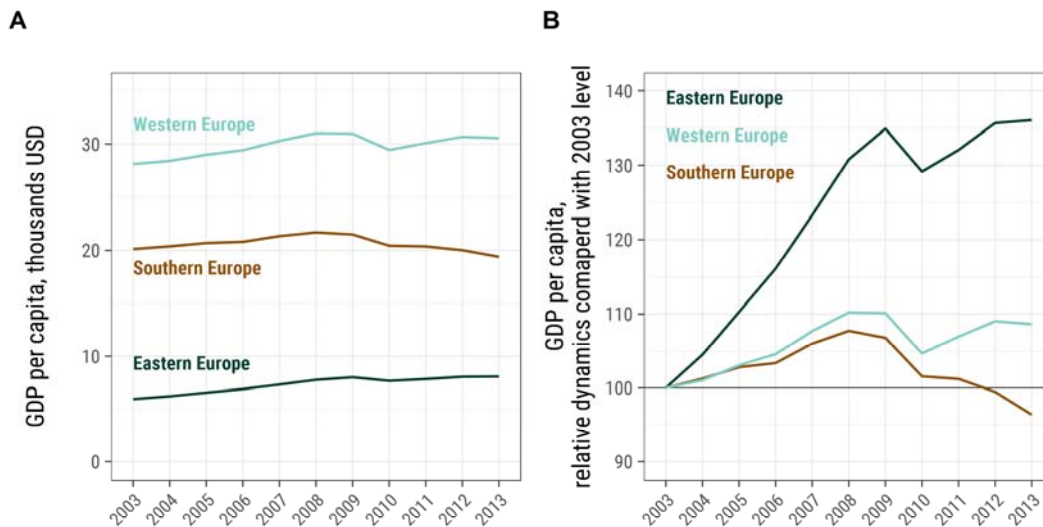
with low and high shares of the working age population and poor regions with low and high shares. This paper introduces a new method to visualize the relationship between changes in the share of the working age population and in GDP per capita in the four types of regions. To our knowledge, no previous studies aimed at investigating changes in relative dynamics of population ageing with the use of convergence analysis, nor examined the interplay between convergence in ageing and economic convergence.

The paper is organized as follows. Section 2 provides background information about the setting of the study. Section 3 reveals the possible interconnection between convergence in ageing and economic convergence. Section 4 describes the features of the data and the methods used for the analyses. Section 5 provides the results of the analyses. The discussion of the results, some limitation and prospects for future research are in the section 6.

2. Background

This paper studies the period 2003 to 2012. There are two reasons why this is an interesting period: the largest ever enlargement of the European Union in 2004 and the economic crisis of 2008-2009. Both events noticeably affected the process of economic convergence (Borsi and Metiu, 2015; Bosker, 2009; Crespo Cuaresma, Ritzberger-Grünwald, and Silgoner, 2008; Dall’Erba, Percoco, and Piras, 2008; Doran and Jordan, 2013; Ertur, Le Gallo, and LeSage, 2007). The uneven impact of the economic crisis across three subregions of Europe¹ 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 (figure 1).

Figure 1. GDP per capita dynamics by subregions of Europe: A – absolute values; B – relative dynamics

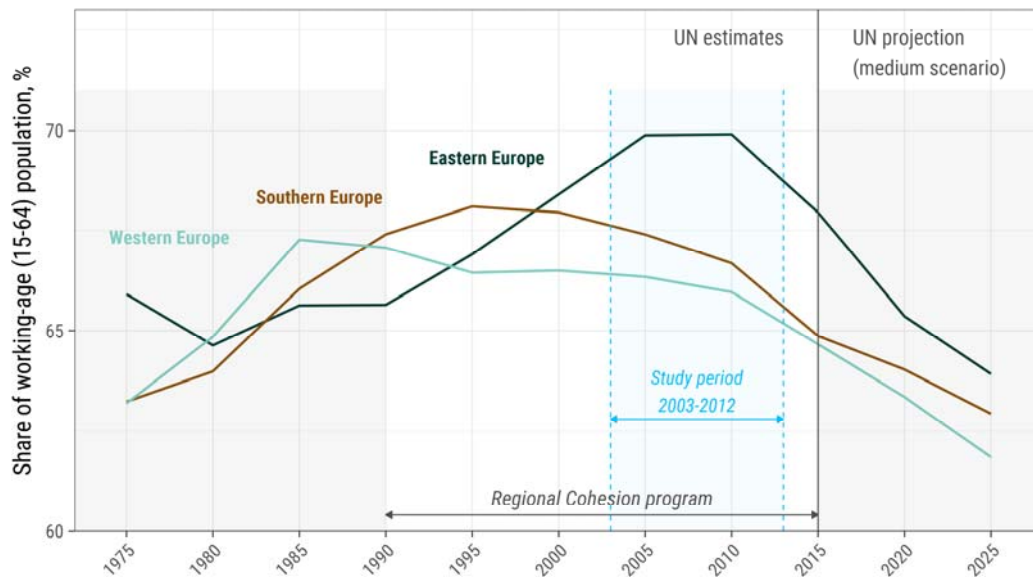


Source: (Cambridge Econometrics, 2015).

¹ We divide Europe into three subregions: Eastern, Southern, and Western. Initially, we tried to use the official subdivision of European countries into Northern, Western, Southern and Eastern parts (EuroVoc, 2015). But the subset of Northern regions turned out to be too small and heterogeneous. So, we merged Scandinavia with Western Europe, and 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 2). In 2003, the sharp contrast was still clearly visible even within the reunited Germany (figure A1-A).

Figure 2. *Asynchronous demographic dividend in Europe: dynamics of the share of working age population in subregions of Europe during the period 1975-2025*



Source: (UN Population Division, 2015). Note: within each subregion, data for countries are weighted by the number of NUTS-2 regions in countries for compatibility with other results in the paper.

Post-communist countries were relatively late with the onset of the Demographic Transition 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, 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. The relative advantage of East-European regions in ageing was prominent within the study period, but it will reduce substantially in the coming years.

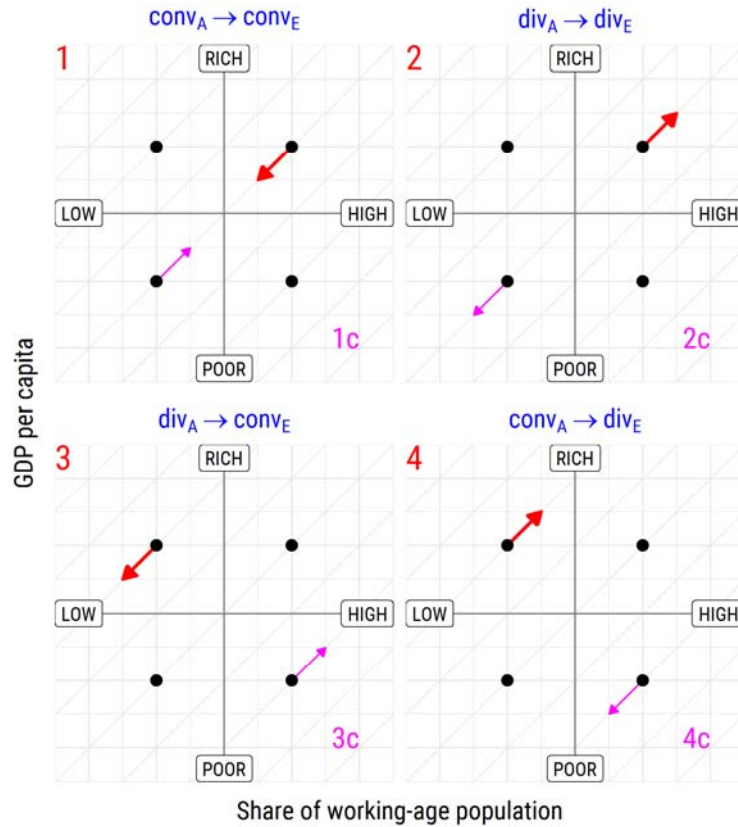
A steep decline in the share of the working age population happened uniformly in Europe after 2010. The main reason for that is cohort turnover. The baby-boom generation, born after 1945, started to cross the age line of 65 accelerating ageing. Naturally, the “aftershock” of such a massive demographic perturbation of the past, as was the baby-boom in the Western world, is very perceptible (Lanzieri, 2011; Van Bavel and Reher, 2013). The baby-boom was stronger in Northern and Western Europe, but the effect of baby-boomers’ retirement on the share of the working-age population was partially leveled by changes in migration trends 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.

3. The hypothetical link between convergence in ageing and economic convergence

The positive correlation between the share of the working age population and economic output was justified theoretically (Bloom and Williamson, 1998) and found in many empirical studies (Crespo Cuaresma, Lábaj, and Pružinský, 2014; Prskawetz et al., 2007). Generally, there is enough evidence of a negative association between population ageing and economic output.

To illustrate the possible interrelationship between convergence in ageing and economic convergence, let us consider 4 hypothetical regions such that they represent 4 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 3). Then consider the joint change in variance of the two variables when the share of working age population is changed only in one of the regions. Assuming the theoretical positive relation between the share of working age population and GDP per capita, 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 3 follow the diagonal lines). Then, in principle there can be 4 cases of interaction between convergence in ageing and economic convergence (figure 3). First, if there is decrease in the *rich-high* region, there is an overall decrease in the variance of both variables; hence, convergence in ageing contributes to economic convergence. Second, if the same *rich-high* region experiences an increase in the share of the working age population and 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-low* region experiences a decrease in the share of the working age population, that results in divergence in ageing contributing to economic convergence. Alternatively, in the fourth case, when the *rich-low* region experiences 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 4 complementary cases, when the changes occur in the poorer regions (poor-low and poor-high, pink arrows in figure 3), but these 4 cases only mirror the 4 principle cases.

Figure 3. 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 the 4 principle cases, pink arrows represent the 4 complementary cases, when changes occur in the poor regions. Change in one point affects variance on both variables.

The outlined 4 cases are based on the assumption of constant productivity, i.e. we assume a linear positive relationship between changes in the share of working age population and changes in GDP per capita. Here we define productivity by the ratio of GDP and the size of the working age population. This implies that productivity includes both labour productivity (the ration of GDP and the work force) and labour force participation (the ratio of the work force and the working age population). In reality, as we see in section 5, productivity has changed and regional differences in the change of productivity affect the relationship between convergence in ageing and economic convergence.

4. Data & methods

4.1. Data

This paper uses Eurostat data on population age structure (Eurostat, 2015a) and mortality records (Eurostat, 2015b) by one-year age groups for the period 2003-2012. The data are aggregated at NUTS-2 level, version of 2010 (Eurostat, 2015c). 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.

The population data required some preparation. First, for some regions, data were partially missing. Due to the changes in administrative division at the NUTS-2 level, there were no data for all five regions of Denmark before 2008 and two regions in the eastern part of German, Chemnitz (DED4) and Leipzig (DED5) before 2006. Furthermore, mortality data were missing for Ireland in 2012, and population structure data was missing for Slovenia in 2003-2004. We reconstructed the missing using the data from national statistical offices. Second, exploratory data analysis showed inconsistency of population estimates for the regions of Romania. There was a Census in Romania in 2011 that registered a large, and previously underestimated, decrease in population size. Evidently, the outmigration from Romania was underreported. Yet, no rollback corrections were made, and Eurostat provides non-harmonized data for Romanian regions. Thus, we harmonized the population figures for Romanian regions. Finally, we excluded the non-European remote territories of France, Portugal, and Spain², which are outliers both in geographical and statistical terms.

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 the CRD. 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 year³. Second, the CRD 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 CRD does not include Croatia in the 2015 version of the data base, we also removed it from the analysis.

² The excluded NUTS-2 regions are: ES63, ES64, ES70, FR91, FR92, FR93, FR94, PT20, and PT30.

³ Prior to accept this assumption, we did a sensitivity analysis, which showed that the assumption does not affect the results strongly.

The data set used for the analyses contains data for 261 NUTS-2 regions of EU27 for the period 2003-2012.

4.2. Methods

To measure convergence, we use Theil's T index of inequality (Theil, 1967) as the measure of variance, and use the decomposition of the index into between and within groups effects (Shorrocks, 1980; Theil, 1979a; Theil, 1979b). We look at sigma convergence (Monfort, 2008), i.e. we define regional convergence by a decrease in the variance across regions.

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

$$\frac{GDP_{t_0+T}/P_{t_0+T}}{GDP_{t_0}/P_{t_0}} = \frac{GDP_{t_0+T}/W_{t_0+T}}{GDP_{t_0}/W_{t_0}} * \frac{W_{t_0+T}/P_{t_0+T}}{W_{t_0}/P_{t_0}} \quad (1)$$

where t_0 is the starting year, T is the length of the period, GDP 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 demographic (change in the population structure) components, correspondingly. 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 but on labour force participation as well. Thus, the decomposition we use is a slightly simplified version of the one proposed by Bloom and Williamson (Bloom and Williamson, 1998), as we aim only at distinguishing the demographic component and do not differentiate between productivity and labour force participation.

We use the decomposition to assess the effect of con/divergence in ageing on con/divergence in economies. In order to check how con/divergence in ageing affects economic con/divergence, 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:

$$GDP_{t_0+T}/P_{t_0+T} = GDP_{t_0}/P_{t_0} * \frac{GDP_{t_0+T}/W_{t_0+T}}{GDP_{t_0}/W_{t_0}} * \frac{W_{t_0+T}/P_{t_0+T}}{W_{t_0}/P_{t_0}} \quad (2)$$

in which the GDP per capita in year t_0 is multiplied by the growth in productivity $(\frac{GDP_{t_0+T}/W_{t_0+T}}{GDP_{t_0}/W_{t_0}})$ 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 parameters for the real (observed) and counterfactual economic growth rates. The difference between the parameters is interpreted as the effect of con/divergence in ageing on economic con/divergence.

4.3. Software

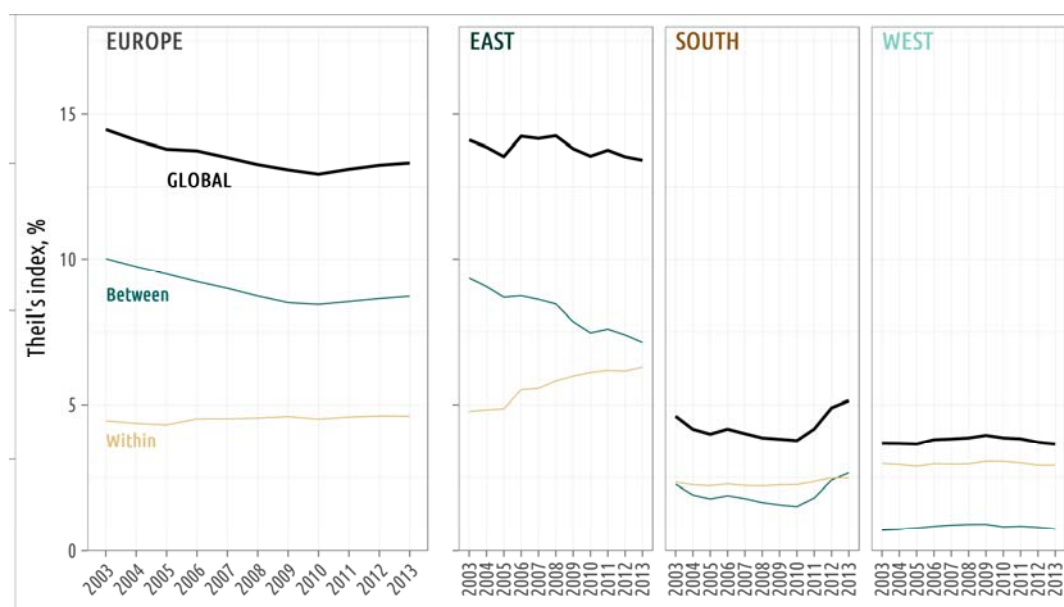
The analysis and the necessary data preparation were conducted using *R*, a language and environment for statistical computing, version 3.2.4 (R Core Team, 2016). Additional packages were used: (i) for data manipulations, *dplyr* (Wickham and Francois, 2015), *tidyr* (Wickham, 2016a), *readxl* (Wickham, 2015); (ii) for visualization, *ggplot2* (Wickham, 2016b), *cowplot* (Wilke, 2016); (iii) for mapping, *rgdal* (Bivand, Keitt, and Rowlingson, 2015), *rgeos* (Bivand and Rundel, 2016).

5. Results

5.1. Economic convergence

During the period 2003-2012, economic convergence had occurred in Europe; sigma-convergence analysis indicates that income inequality (figure 4) reduced during the study period.

Figure 4. Sigma-convergence analysis of regional variation in GDP per capita; the dynamics of Theil's index of inequality (in %) and its decomposition into between- and within-group effects



Note: For Europe 'between' refers to differences between East, South and West Europe and 'within' refers to differences within East, South and West Europe. For East, South and West 'between' refers to differences between the countries in these regions and 'within' refers to differences between regions within the countries.

The decomposition of Theil's index showed, that the decrease in the global European income inequality happened due to the reduction of variance between the subregions in the first part of the study period, before the financial crisis. The within subregions inequality component has remained stable throughout the study period. This finding corresponds with the widely found evidence of the decreasing income disparities between subregions of Europe, especially the

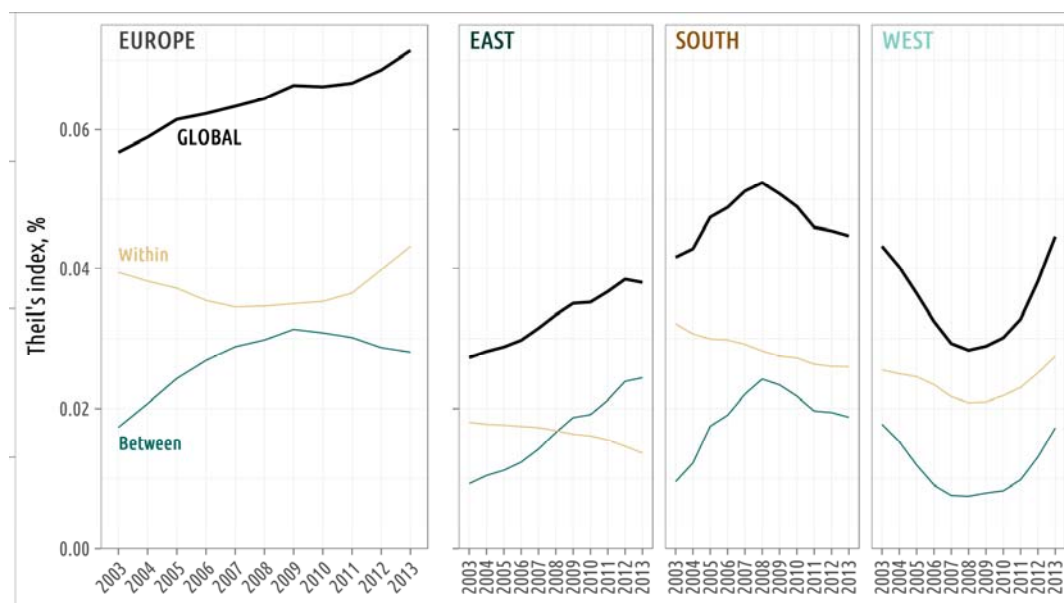
catching up development of Eastern Europe (Borsi and Metiu, 2015; Crespo Cuaresma, Loichinger, and Vincelette, 2016; Dall’Erba, Percoco, and Piras, 2008). Note also that the between-groups component of the variance is extremely high; usually the main variance in data lies in the difference between the units at the lowest level, within groups.

Within each of the 3 subregions the developments of the variance in GDP per capita has varied substantially. Eastern Europe has seen a slight overall decrease in income inequality; though the differences between countries have decreased, while the within-countries component of variance has increased throughout the study period. In Southern Europe, there was economic convergence in the first part of the period; after the outbreak of the economic crisis, it has changed to divergence. Here again the main source of changes in variance came through the between-countries component. Western Europe has experienced the smallest changes in variance. The direction of changes has been opposite to those of Eastern Europe: divergence in the first part of the period and convergence in the second part of the study period.

5.2. Divergence in population ageing

Inequality in the share of the working age population (figure 5) has risen throughout the study period. The growth in Theil’s index in the first part of the period is caused by the rising between-subregions differences. As was mentioned in section 2, that is likely the result of different timing in the demographic transition. But in the 2010s the differences between subregions have started to reduce, while the within subregions inequality has begun to grow.

Figure 5. Sigma-convergence analysis of regional variation in the share of working age population; the dynamics of Theil's index of inequality (in %) and its decomposition into between- and within-group effects



Note: For Europe ‘between’ refers to differences between East, South and West Europe and ‘within’ refers to differences within East, South and West Europe. For East, South and West ‘between’ refers to differences between the countries in these regions and ‘within’ refers to differences between regions within the countries.

The diverging population dynamics in East-European regions, that still have experienced the window of demographic opportunities during the study period, explain the growth of the variance, mainly in the first part of the period and trough the between-subregions component.

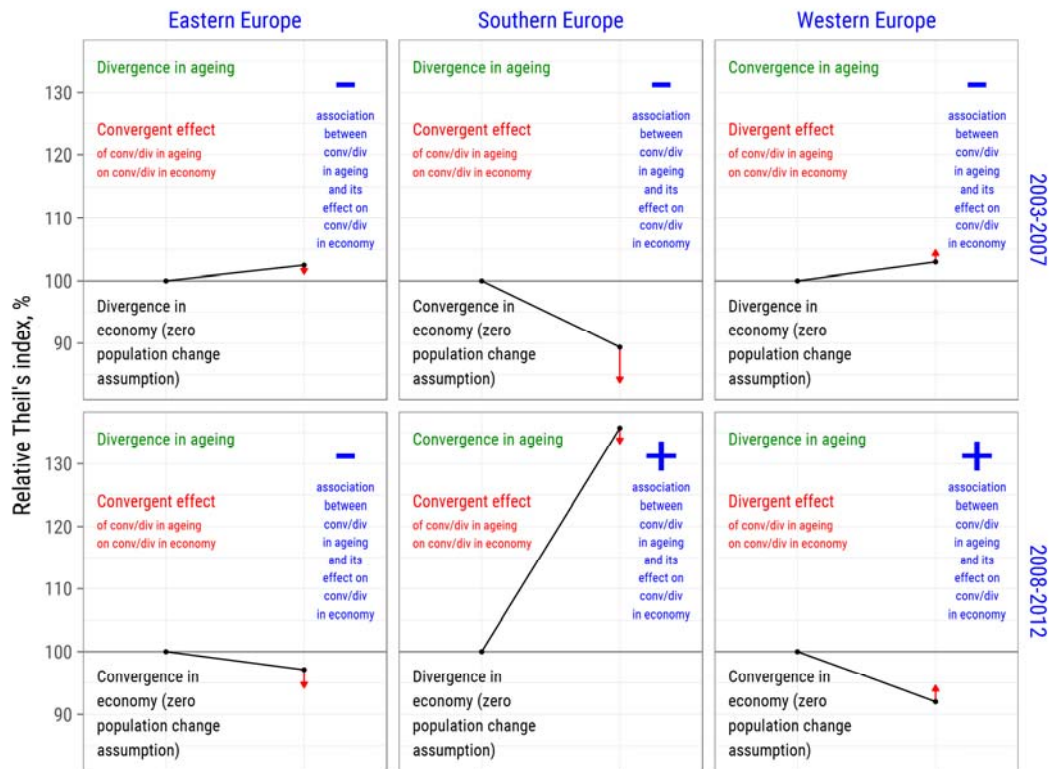
As with the difference in income variance dynamics, the changes in the share of the working age population variance has been notably different in the 3 subregions of Europe. Eastern Europe has experienced divergence throughout the study period, which can be attributed the between-countries component. Southern Europe saw divergence before the economic crisis and convergence after; Western Europe has experienced the opposite.

5.3. Relationship between convergence in ageing and economic convergence

As described in section 4, 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, see section 3). 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 subregions of Europe, we conduct the analysis separately for the subregions and the two sub-periods (figure 6).

Figure 6. Counterfactual analysis, the effect of convergence or divergence in ageing on economic convergence or divergence



Note: the black dots and line show the baseline economic convergence/divergence on condition of no-population-change; the relative changes in Theil's index are shown. Convergence/divergence in ageing is written in green. Red arrows indicate the addition effect that changes in population structures cast on economic convergence.

To illustrate figure 6, consider Southern Europe (the middle panels). In the first part of the period (2003-2007), regions of Southern Europe experienced economic convergence, i.e. Theil's index of inequality in GDP per capita decreased. Even with no change in population structures (black line), the decrease was about 10%. When we account for changes in the share of working age population, the convergence turns out to be even stronger, the decrease in Theil's index is about 14% (red line). The green text states that there was divergence in the share of working age population during that period (see also figure 5). 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, hence, revealing a positive correlation between convergence in ageing and economic convergence. Note that in most cases the effect of differences in ageing on economic convergence or divergence has been relatively small compared with the effect of changes in productivity (including changes in labour force participation).

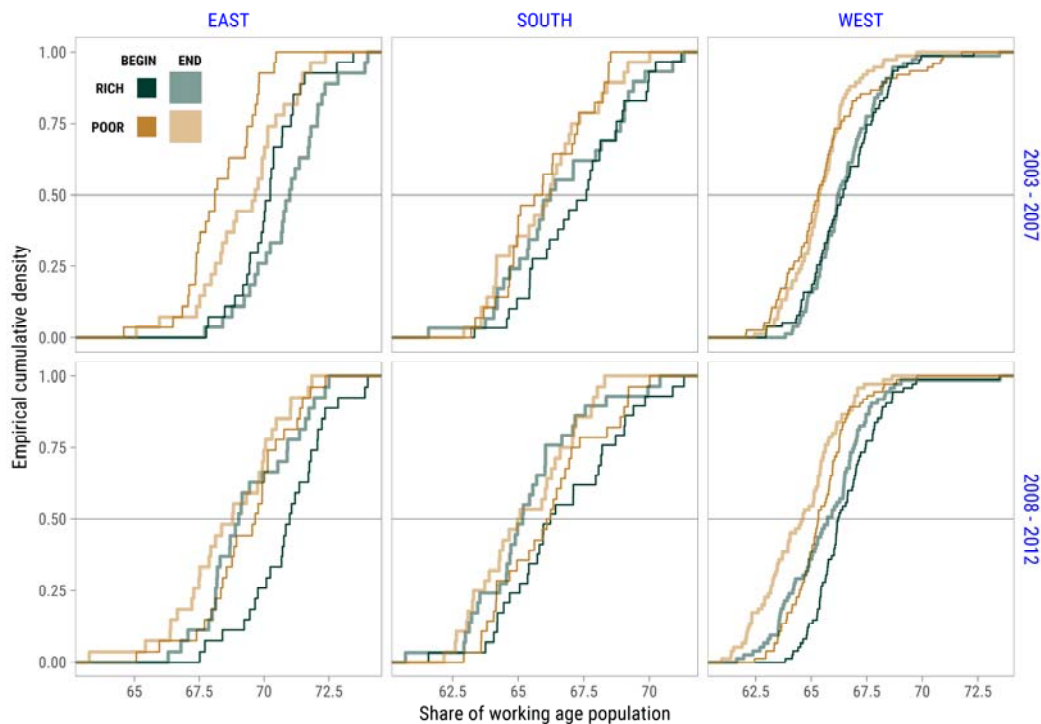
The results of the counterfactual analysis reveal quite a diverse picture.: Convergence in population ageing can contribute to economic convergence (Southern Europe in 2008-2012) and divergence in ageing can have a diverging effect on the economy (Western Europe in 2008-2012). But convergence in ageing can also result in economic divergence (Western Europe in 2002-2007), while demographic divergence can have a converging effect on the economy (Eastern Europe in both periods and Southern Europe in 2002-2007).

To understand the relationship between demographic and economic convergence or divergence, we examine differences between ageing in rich and poor regions. Figure 3 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 3). 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 3).

In order to identify the regions showing the major demographic changes figure 7 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 subregions and for each of the sub-periods, we distinguished poor and rich regions by dividing the regions in 2 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 for the regions – separate line for each group (figure 7). 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. For example, in the first sub-period, Cyprus was in the rich-low group of regions of Southern Europe; 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 8). Figure 8 shows which regions were classified in which of the four groups: poor-low, poor-high, rich-low, and rich-high.

Figure 7. Empirical cumulative densities of the share of working age population distributions, divided in halves by GDP per capita

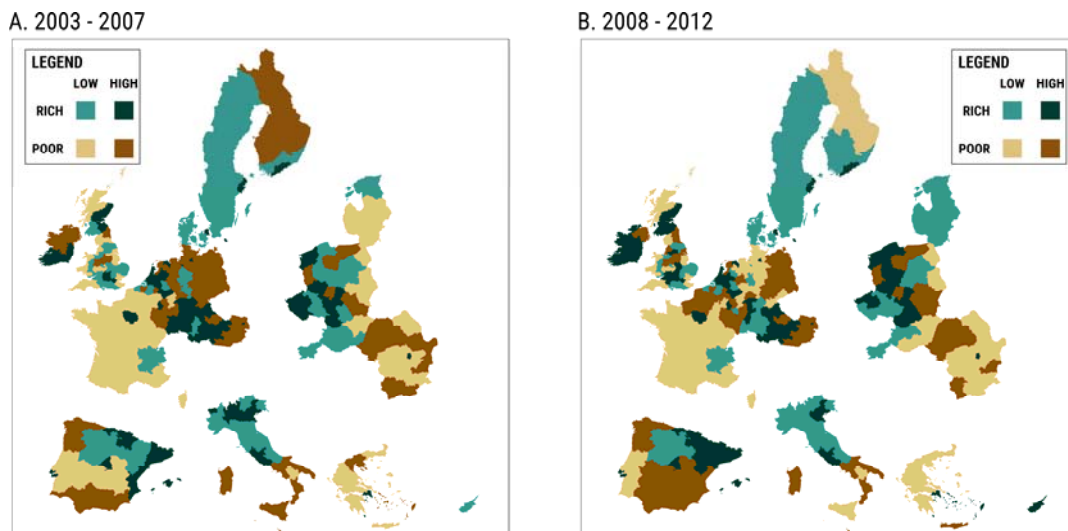


Note: solid lines represent distributions at the beginning of the period, half-transparent lines - the end the period.

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) 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 7 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 (figure 7, different colors) indicates the effect of convergence or divergence in ageing on economic convergence or divergence (see also the red arrows in figure 6): 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.

Figure 8. 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 subregion (x3).

To illustrate the interpretation of figure 7, 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 panel in figure 6, the red arrow). 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 8). Such a case corresponds with the 3rd case from the hypothetical framework (bottom-left panel in figure 3, complementary case, 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 the Southern European states (figure 8). That corresponds to the 1st case from the hypothetical framework (top-left panel in figure 3), 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 - 3rd 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 – 4th case (bottom-right panel in figure 3); 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 – inverse of 2nd case (top-right panel in figure 3).

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 subregions showed that large differences between subregions of Europe are the main driver of convergence in GDP per capita, which correspond with the results of (Crespo Cuaresma, Doppelhofer, and Feldkircher, 2014). In contrast, subregional differences in the dynamics of the share of working age population contribute to divergence in ageing, while some convergent regional dynamics mainly occur within subregions; though there has been quite a lot of heterogeneity in the dynamics of regions within the subregions during the study period.

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 highlights the effect of con/divergence in ageing on economic con/divergence. We found that the direction of the relationship between con/divergence in ageing and economic con/divergence is rather complex and depends on the characteristics of the regions where the main changes in population structures occur - whether those regions are relatively poor or rich, and have relatively low or high share of 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 con/divergence in ageing and economic con/divergence is negative.

The empirical evidence for the 3 subregions of Europe in 2 sub-periods showed that all 4 possible cases occurred. This explains why there was no universal effect of ageing on the economy. The effect of con/divergence in ageing on economic con/divergence was usually much smaller than the effect of changes in productivity and labour force participation; yet, this effect was still quite substantial.

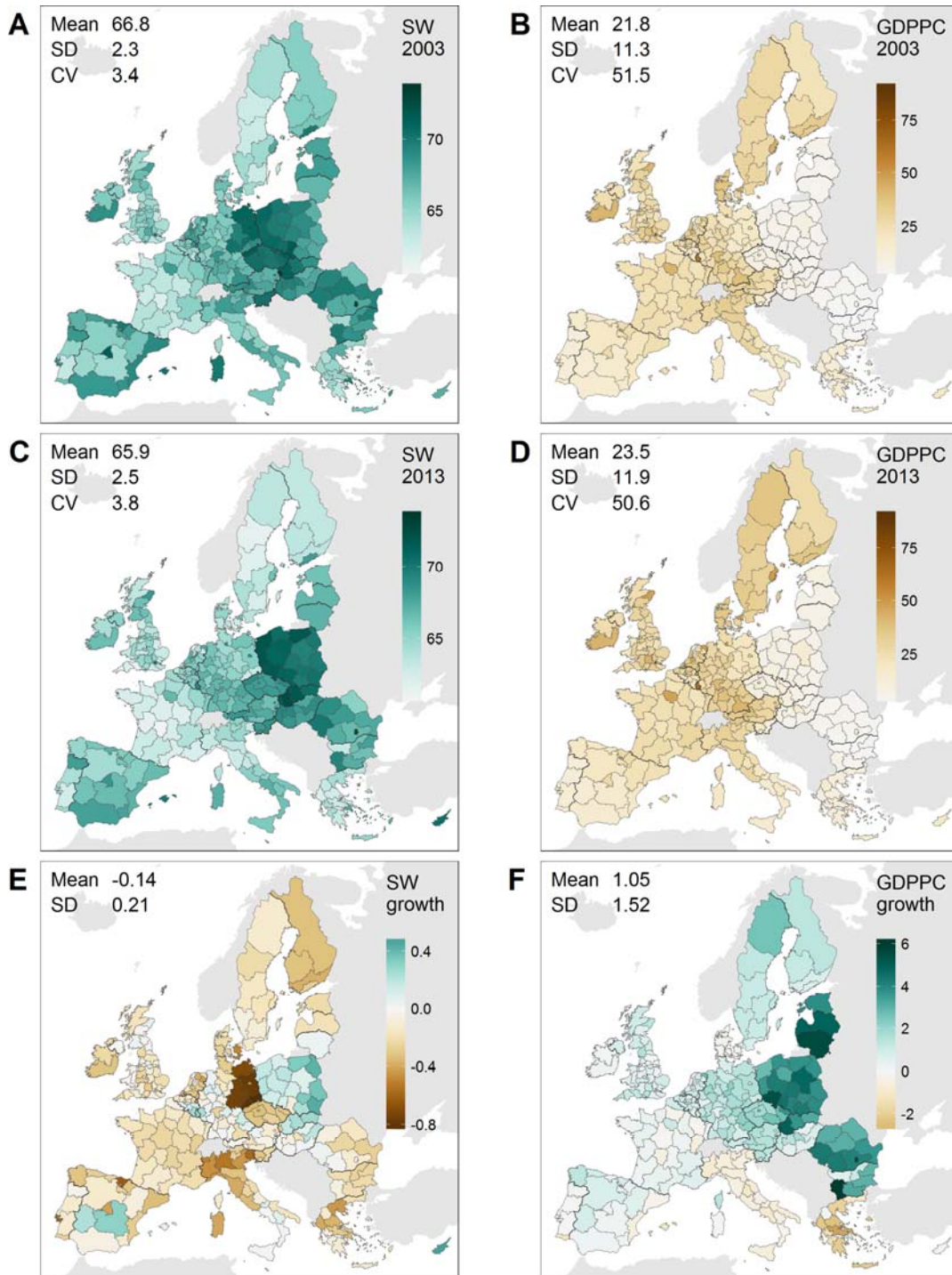
Further research may focus on distinguishing the role of labour force participation from the total productivity effect, as analyzed in this paper. While labour force participation usually decreases with age (Bloom et al., 2015; Lee and Mason, 2011), and thus ageing affects it negatively on the population level, the effect of 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 (Gómez and De Cos, 2008; Lindh and Malmberg, 1999; de la Croix and Monfort, 2000; Lindh and Malmberg, 2009; Rauhut, 2012). Thus, the distinction between productivity and labour force participation effects may result a deeper understanding of the relationship between con/divergence in ageing and economic con/divergence.

The framework for analyzing the effect of con/divergence in ageing on economic con/divergence, proposed in this paper, addresses a fresh question in the field of demographic economics. This question is gaining importance in the light of the rapidly declining share of working age population, while future convergence in ageing among European regions is likely to occur. With the rapidly declining share of 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.

APPENDIX

Figure A1. Descriptive maps: A – labor supply in 2003, %; B – GDP per capita in 2003, thousands USD; C – labor supply in 2013, %; D – GDP per capita in 2013, thousands USD; E – labor supply annualized growth rate in 2003-2012, %; F – GDP per capita annualized growth rate in 2003-2012, %



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European regions experience accelerating ageing, but there is substantial regional variation in the process. 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 has been smaller than the effect of changes in productivity and labour force participation; yet, this effect was still quite substantial. Convergence of ageing leads only to economic convergence 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. Our empirical analysis shows that in the period 2003-2012 an inverse relationship between convergence in ageing and economic convergence was the rule rather than the exception.

The Netherlands Interdisciplinary Demographic Institute (NIDI) is an institute for the scientific study of population. NIDI research aims to contribute to the description, analysis and explanation of demographic trends in the past, present and future, both on a national and an international scale. The determinants and social consequences of these trends are also studied.

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