Equilibrium. Quarterly Journal of Economics and Economic Policy
Volume 14 Issue 4 December 2019
p-ISSN 1689-765X, e-ISSN 2353-3293
www.economic-policy.pl

ORIGINAL ARTICLE

Citation: Thalassinos, E., Cristea, M., & Noja, G. G. (2019). Measuring active ageing within the European Union: implications on economic development. *Equilibrium. Quarterly Journal of Economics and Economic Policy, 14*(4), 591–609. doi: 10.24136/eq.2019.028

Contact to corresponding author: thalassinos@ersj.eu; University of Piraeus, Karaoli and Dimitriou 80, Piraeus 185 34, Greece

Received: 23.06.2019; Revised: 1.09.2019; Accepted: 27.09.2019; Published online: 28.12.2019

Eleftherios Thalassinos
University of Piraeus, Greece
University of Malta, Malta
orcid.org/0000-0003-3526-4930

Mirela Cristea
University of Craiova, Romania
orcid.org/0000-0002-6670-9798

Gratiela Georgiana Noja
West University of Timisoara, Romania
orcid.org/0000-0002-9201-3057

Measuring active ageing within the European Union: implications on economic development

JEL Classification: *C23; I30; J14; O52*

Keywords: *Active Ageing Index; European Union; economic development; labour market; macro-econometric modelling*

Abstract
Research background: The ageing phenomenon undermines the stability and equilibrium of the labour market and it affects the economic development of countries, as well as the welfare of older people aged over 65 years.
Purpose of the article: Against this background, our research is conducted to assess the specific ways in which active ageing (measured through the active ageing index — AAI), correlated with other economic and labour market credentials, would impact the economic development of EU Member States.
Methods: The research methodology consists of two econometric procedures, namely (i) cluster analysis performed on EU–28 countries to configure congruent groups according to similar features of the active ageing (measured through the Active Ageing Index — AAI) and Gross Domestic Product (GDP) levels, respectively (ii) panel data analysis, applied distinctly on two panels, EU–15 (old) and EU–13 (new), relying on four macro-econometric models (robust regression, panel corrected standard errors, spatial lag and spatial error), in order to test the direct influences of AAI and other economic and social selected variables on economic development. The analysis

is made for the 2010–2018 lapse of time, by capturing all the available data for the AAI as reported by the European Commission.
Findings & Value added: The results highlight important dissimilarities between the EU countries that require a rethinking of policies for the active ageing population support. Thereby, constant policy rethinking, adequate strategies, measures and tools for the active ageing population support become outlier keystones that entail a successful integration of the older people within all life dimensions.

Introduction

One of the demographic challenges that most of the countries around the world are currently facing is represented by the population ageing, on the background of an increased life expectancy concurrently with a downsizing birth rate. Countries based on social security systems supplied by the working force contributions deeply resent these demographic difficulties because of the significant decrease of the number of active persons on the labour market.

Therefore, the ageing phenomenon affects multiple dimensions of the economic and social life, by undermining the labour market equilibrium. Sheer implications are registered upon the welfare of the older people aged over 65 years, ascribed to the negative impact on pension levels that depend on social security contributions (Cristea & Mitrică, 2016; Cristea & Thalassinos, 2016), as well as on health expenditures, whose support is also embedded in the social security system (European Commission, 2016a; Káčerová & Mládek, 2012).

According to the statistics, at a worldwide level, older people's share (65+) in the total population has increased from 6.16% in 1990 to 8.67% in 2017, while population growth has decreased from 1.74% per year in 1990, to 1.15% in 2017, due to a decrease in the birth rate (from 25.88 per 1000 persons in 1990, to 18.75 in 2017), and an increase of life expectancy (from 65.44 years in 1990, to 72.23 years in 2017) (World Bank, 2019).

Within the European Union (EU), even if the ageing population was considered a problem only for the developed countries (namely, the old EU–15 countries), the effects of ageing on the labour market and economic welfare are also strongly felt in developing countries from the Central and Eastern Europe (CEE, mostly, the new EU–13), which will sharpen in the coming years (Cristea *et al.*, 2016). The EU proposed an integrated instrument to measure and monitor the active ageing, called "the Active Ageing Index (AAI)", tested even since 2010 and further applied for 2012, 2014, 2016 and 2018 (UNECE/European Commission, 2019; Zaidi, 2015). Active ageing means "helping people stay in charge of their own lives for as long

as possible as they age and, where possible, to contribute to the economy and society" (European Commission, 2016a).

On this frame of reference and facts, our general research objective is to assess the specific ways in which active ageing (measured through the active ageing index — AAI), correlated with other economic and labour market credentials, would impact the economic development of EU MS. The research methodology is being approached through a double perspective: *(i) cluster analysis* performed on EU–28 MS to form congruent groups according to similar features of the AAI and Gross Domestic Product (GDP); *(ii) macro-econometric models*, namely robust regression — RREG and panel corrected standard errors estimations — PCSE, along with *spatial analysis models* (spatial lag and spatial error), designed to assess the direct influences of AAI and other economic and social selected variables on economic development. The macro-econometric models were applied distinctly on two panels, EU–15 (old EU countries), and EU–13 (new MS). The analysis is made for the 2010–2018 lapse of time, by capturing all the available data for the AAI (UNECE/European Commission, 2019).

The paper is structured on six major parts: succeeding a display of the importance and relevance of this topical subject in the first section, a detailed critical literature review is presented further. The research methodology is comprised in the third part, along with the data used for the empirical analysis. The main part of the paper consists of an accurate assessment of the results obtained, connected with other similar researches, completed with discussion, concluding remarks and recommendations on strategies and policies required to expand the concept of active ageing at the level of all EU MS, with spillover effects on economic development.

Literature review

The ageing phenomenon entails a consistent number of economic and social issues, such as the connection between life satisfaction of older people and economic conditions, or health status related to health services (Káčerová & Mládek, 2012). Therefore, numerous studies have depicted the importance of active ageing for developed and developing economies, focusing on their sheer implications and specific measurement units.

Diverse strands of thoughts centre on the active ageing index (AAI) as a comprehensive way to assess this process. Regarding AAI, this is determined as a rank, based on four groups of indicators, which comprise 22 sub-indices on the total, namely: *(i) employment field* that follows the employment rate for the age 55–74, divided on 4 cohorts (paid activities); *(ii)*

the way and degree of *participation in the society* by voluntary and political activities or the care of family members and other old people (unpaid activities); (*iii*) "*independent, healthy and secure living*", which includes also the lifelong learning attending; and (*iv*) "*capacity to actively age*", covering life expectancy, Information and Communications Technology (ICT) reliance, social capacity interaction, and educational attainment (European Commission, 2016b, p. 5). The AAI was determined for 2010, 2012, 2014, 2016 and 2018 years (UNECE/European Commission, 2019) and has received *some critics*, based on the fact that it "measures current achievements, not capabilities (i.e. the opportunity set of achievable "doings" and "beings"), resulting in a valuable, but incomplete, tool for policymaking purposes" (De São José *et al.*, 2017, p. 49), and on the subjective methodology (Djurovic *et al.*, 2017).

On this vein, Bacigalupe *et al*. (2018, p. 97), assessing the AAI for the period 2012–2014 and its support for policymakers in the regions from Southern Europe, have revealed that "the AAI can be a good tool for monitoring active ageing and it could be well used as an advisory tool for policymaking at the regional level in the EU". Contrary to these beliefs, Dykstra and Fleischmann (2018, p. 19), based on 2010 AAI and the European Social Survey (ESS) data, have argued that a greater impact of independence is associated with a healthy and active way of life of the older people rather than with the "productive ageing".

The AAI was analysed also by the EU, in correlation with the following components: GDP per capita, which conducted to a direct proportional influence in both directions; life satisfaction, also with a positive relationship registered; and Gini coefficient, with a low reversed relationship (UNECE/European Commission, 2019). Um *et al*. (2019, pp. 87, 95) building up a comparison with China and the EU countries, regarding the application of AAI for Korea, "a country where speed and level of population aging is among the highest in the world", concluded that "it is also important that the AAI continues to improve and explore the possibility to become a global instrument with a consensual set of domains and indicators of active and healthy aging". Xiong and Wiśniowski's analysis (2018) for China and the EU revealed that China is far behind the EU in terms of implementing active ageing strategies. In order to sustain the welfare of older people in China, authors (Xiong & Wiśniowski, 2018, p. 365) recommend a flexible retirement plan for older people, with the possibility of voluntary reintegration on the labour market, but also health and care services adapted to the older people, their involvement in lifelong learning programs, "to enjoy active, independent, secured and healthy life". At the EU level and for each MS, Kafková (2018) substantiated that the AAI com-

ponents do not have effects on the quality of life of older people to the same extent, with their importance assigned in determining the AAI. One such component that has a high weight in AAI for the EU MS is the employment rate, which had not involved the same implications on the quality of life of the older people.

Summarizing, we can say that the AAI, with all the controversies attributed, represents a relevant milestone for each country's emplacement in relation to the socio-economic integration of the older people and their wellbeing.

Data and methodology

In order to achieve the general objective, based on relevant literature underpinnings, we have compiled a complex dataset, both for the EU–28 as a whole, but also separately for the EU–13 and EU–15 countries, grouped as follows:

- *economic development*: GDP per capita (constant 2010 United States Dollar, USD) (*GDP_C*); "Labour productivity per person employed and hour worked as percentage from the EU–28 average" (%) (*LP*);
- *ageing and labour market indicators*: Active Ageing Index (Rank) *(AAI)*; Old dependency ratio (population 65+ to population 15–64 years, %) (*ODR*); Share of population over 65 years within the total number of population (%) (*Pop_65*); Active labour market policies (% of GDP) (*ALMP*); Passive labour market policies (% of GDP) (*PLMP*); Research and Development expenditures (% of GDP) (*RD*).

Data were extracted from: OECD (2019) (for *GDP_C*), Eurostat (European Commission, 2019a) (for *LP, ODR, Pop_65* and *RD*), United Nations Economic Commission for Europe (UNECE)/European Commission (2019) (for AAI), and the Employment, Social Affairs & Inclusion (European Commission, 2019b) (for *ALMP* and *PLMP*). The analysis is made for a period of five years (2010, 2012, 2014, 2016 and 2018), according to the availability of data for AAI.

To grasp the current framework of active ageing, economic development and labour market performance within the EU we have graphically represented and assessed the main indicators considered (Annex, Figures 1 and 2), while detailed summary statistics of all the variables comprised in the empirical analysis (separately for EU–28, EU–13 and EU–15) are described in the Annex, Table 1. As regards the latest available data on AAI, in 2018, at the level of EU–28 (Annex, Figure 1(a)), the highest overall scores were registered by Sweden (47.2), Denmark (43), the Neth-

erlands (42.7), but also in the United Kingdom (UK), Finland, Germany, Ireland and France. Opposite, the lowest ranks were in Bulgaria, Slovenia, Poland, Hungary, Romania, Croatia and Greece (under the 32 threshold). Still, some of these latter countries have the lowest old dependency rates (Annex, Figure 1(b)).

Moreover, the GDP per capita has modest levels in CEE countries, along with low thresholds of labour productivity (Annex, Figure 2 (a) and (b)).

The methodology implies processing the models configured in Stata, based on several econometric procedures: *(1) cluster analysis* for all EU–28 MS, by reporting to the latest available data for the AAI, namely 2018, jointly with other indicators that are not included within the AAI determination, but relevant for the labour market, in relation with economic welfare; *(2) panel data analysis*, set on four macro-econometric models, namely: robust regression (RREG), panel corrected standard errors estimations (PCSE), spatial lag and spatial error. The dependent variable used in processing the macroeconometric models was the GDP per capita.

Cluster analysis was applied for all the EU–28 MS based on the Ward method inset on hierarchical clusters and the Euclidean distances (Cornish, 2007). The indicators used to configure the clusters were previously standardized in terms of mean and standard deviation in order to provide accurate results and to discard cross-country variations.

The *panel data analysis* was applied distinctly on two panels, EU–15 and EU–13, grounded on four macro-econometric models (RREG, PCSE, spatial lag and spatial error), in order to test the direct influences of AAI and other economic and social selected variables on economic development. In this case, we have used the logarithm of the variables so as to make them stationary. The analysis is made on five years (2010, 2012, 2014, 2016 and 2018) with available data for the AAI (UNECE/European Commission, 2019). The general configuration of the model deployed is presented in equation (1), taking the form of a multiple regression panel model processed through RREG and PCSE, but further reconfigured through the spatial procedures (spatial lag — equation (2) and spatial error — equation (3)) to better capture the spillover effects of the neighbouring locations.

$$log\_GDP\_C_{it} = \alpha_0 + \alpha_1 AAI_{it} + \alpha_2 log\_Pop\_65_{it} + \alpha_3 log\_RD_{it} + \alpha_4 log\_ODR_{it} + \\ + \alpha_5 log\_ALMP_{it} + \alpha_6 log\_PLMP_{it} + \varepsilon_{it} \quad (1)$$

$$log\_GDP\_C = \lambda W log\_GDP\_C + \alpha_0 + \alpha_1 AAI + \alpha_2 log\_Pop\_65 + \alpha_3 log\_RD + \\ + \alpha_4 log\_ODR + \alpha_5 log\_ALMP + \alpha_6 log\_PLMP + \varepsilon \quad (2)$$

$$log\_GDP\_C = \alpha_0 + \alpha_1 AAI + \alpha_2 log\_Pop\_65 + \alpha_3 log\_RD + \alpha_4 log\_ODR + \\ + \alpha_5 log\_ALMP + \alpha_6 log\_PLMP + \rho W\varepsilon + \upsilon \quad (3)$$

To accomplish our general objective and in accordance with the methodological procedures configured, we have advanced the following two hypotheses (*H*) to be tested:

H_1: *There are significant differences between the EU–28 MS regarding the active ageing policies and strategies in relation to economic development, the EU–13 MS having downsized results compared to the EU–15;*

H_2: *There are significant direct effects of the active ageing policies and strategies on economic development, more emphasized for the EU–15 group than the EU–13*.

Research results

Results of cluster analysis

In order to verify the 1st hypothesis, H_1, by cluster modelling, we have pursued to group the EU–28 MS according to the level of economic development (*GDP_C*), based on the *AAI*, labour productivity (*LP*), old dependency ratio (*ODR*), active and passive labour market policies (*ALMP, PLMP*), and R&D expenses (*RD*) at the level of 2018 (the latest year with available data on the determined ranks for the AAI). The correlation matrix of the considered variables is presented in Annex, Figure 3 (a). The results of cluster modelling are presented through the dendrogram of cluster forming for the EU–28 MS, at the level of 2018 in Annex, Figure 3 (b), respectively by Table 2 and Table 3.

The results entail highest performances achieved by eight EU MS comprised in cluster C1 for France, Austria, Germany, Belgium, the Netherlands, Denmark, Sweden, Finland, followed by the group enclosing Luxembourg and Ireland (cluster C2). The lowest performances were encompassed by the following group of EU–28 MS: Greece, Romania, Slovenia, Lithuania, Latvia, Bulgaria, Croatia, Portugal (cluster C3).

The general conclusion of the cluster analysis is that, overall, the lowest performance in terms of ageing, welfare and labour market policies was registered by the EU–13 countries (including also Greece and Portugal), and the highest, by countries from the old EU–15, especially by the Nordic States (Sweden, Denmark, Finland).

Based on these results, our 1st hypothesis, H_1, is partially validated, namely "*There are significant differences between the EU-28 MS regarding the active ageing policies and strategies in relation to economic development, the EU–13 MS having downsized results compared to the EU–15*".

Results of the panel data analysis

In order to test and verify the second hypothesis, we have further applied the panel data analysis through four macro-econometric procedures, processed distinctly for the EU–13 and EU–15 countries (Annex, Table 4). Spatial analysis models turn on two additional indicators and reported values for *rho* (spatial lag/autoregressive) and *lambda* (spatial error). Model 3 in both samples entail a positive and highly significant *rho* (0.983 for EU-13, and 0.981 for EU–15), reflecting the spatial dependence inherent in the sample and the fact that the general model fit is improved. Model 4 in both samples underline the coefficient on the spatially correlated errors, namely the *lambda* values. These are also positive and extremely significant (0.978 for EU–13, and 0.975 in the case of EU–15), thus reflecting that spatial effects in the data are still present.

The estimations highlight that, for the *EU-13 MS*, there is evidence to attest that between 54–59% of the variation in the GDP per capita can be explained by the variation of selected explanatory variables included in the models (the determination coefficients are 0.540 for RREG and 0.590 for PCSE). As for the spatial analysis, the results are extremely significant from the statistical point of view only for the AAI estimates. They reveal that at an improvement in the AAI rank, the EU–13 countries experience a positive impact on economic development. *RD* expenditures have a positive influence on *GDP_C* (the estimated coefficient is positive and robust across various econometric procedures, even though in the case of spatial error analysis the result has no statistical significance). Moreover, active labour market policies (*ALMP*) can have a positive impact on economic development in EU–13 countries, and thus it is being recommended to extend their application after the model of the Nordic states (Danish model), along with a reconsideration of the passive labour market policies (*PLMP*), less visible in EU–13 countries (Noja & Cristea, 2018).

As regards the *EU–15 countries*, RREG and PCSE estimations show that the selected variables largely influence (of about 86.9%, respectively 63.4%) the variation of the GDP per capita. One can notice that the AAI has a positive impact on GDP per capita, but only in the case of RREG model, and to a lower extent than in the EU–13 countries. Favourable influences on GDP per capita are accounted also through greater allocations on research and development and active labour market policies. Negative effects on economic development within the EU–15 MS are induced by an increase in the old dependency rates for the population aged over 65 years, relying on a significant reduction of the share of active persons aged 20–64 years.

Based on these results, our 2nd hypothesis, H_2 is partially validated, namely *"There are significant direct effects of the active ageing policies and strategies on the economic development, more emphasized for the EU–15 group than the EU-13"*.

Discussion

We have performed the analysis considering the comprehensive index proposed by the EU for monitoring active ageing (*AAI*), yet criticized by some specialists (e.g., De São José *et al.*, 2017; Djurovic *et al.*, 2017) alongside with other specific indicators, jointly with the GDP per capita, in order to test the extent to which this indicator is relevant for countries grouping at the level of EU–28, compared with the analysis made by UNECE/European Commission (2019) for 2018.

Thereby, we have noticed that, when more specific variables, as labour productivity, active and passive labour market policies, old dependency ratio and R&D support were included, the results of the countries grouping at the level of the EU–28 are slightly different from the previous ones obtained by UNECE/European Commission (2019), when only the GDP per capita and AAI were considered. For instance, Latvia, Lithuania and Portugal were placed into up-medium cluster (instead of low performance in our case), the UK was positioned into higher cluster (medium to low in our analysis), and Luxembourg in medium to low group (being medium to high in our case).

Further, distinctive panel data analysis on two panels, EU–15 (old EU MS) and EU–13 (new MS), revealed that constant policy rethinking, adequate strategies, measures and tools for the active ageing population support become outlier keystones that entail a successful integration of the older people within all life dimensions, in order to counteract the multiple

effects on social and economic conditions (Neţoiu & Cârstina, 2014; Pânzaru, 2015), following the good practice model of the Nordic States (Hall & Gylfi, 2014). A special attention must be given to redesign the labour market policies within the EU–13, since these countries are facing numerous shortcomings as high total unemployment rates of various ethnic groups and youths neither in employment nor in education (Marcu *et al.*, 2015; Marcu & Dobrota, 2016; Dincă & Lucheș, 2018).

Thus, to encourage the active ageing, countries must centre on creating jobs dedicated to the age segment 55–64 years, involving them in various lifelong learning and educational programmes, and in society through diverse voluntary and political activities or the care of family members and social capacity interaction.

Conclusions

The current research represents an extension of previous ones performed by the authors to investigate the specific ways in which the ageing dimension affects the economic development and labour market outcomes, at the level of the EU–28 MS. The research grasps several important impact results, outlined in accordance with the recommendations for an "active ageing" that are constantly promoted by the European Commission, along with a keen need to build up and monitor an index which includes all the facets of this concept.

The main results show that: there still are significant differences between the EU–28 MS regarding the active ageing policies and strategies deployed for economic development, the lowest performance was registered by the EU–13 countries (including Greece and Portugal), and the highest, by the Nordic States (Sweden, Denmark, Finland), and other five countries from the EU–15 (namely, France, Austria, Germany, Belgium and Netherlands) — 1st hypothesis, H_1,; active ageing measured through the AAI index, built at the EU level, has a positive influence on GDP per capita, in both groups of EU MS, EU–13 and EU–15, much more visible in the EU–13 new MS — 2nd hypothesis, H_2. However, the labour market policies and strategies designed to boost economic development did not lead to remarcable effects for the two groups of EU countries, hence, it is being recommended their substantial reconsideration.

Research limitations consist of the low availability of data for the AAI index, without the possibility to compile longer time series, with an increased conclusiveness for our analysis. Furthermore, in certain conditions, we accounted a lower degree of statistical significance of the estimated

coefficients. Hence, we aim to expand the research in order to better capture the impact of active ageing on labour productivity, health and pension systems, with a detailed assessment on each EU Member State.

References

Bacigalupe, A., González-Rábago, Y., Martín, U., Murillo, S., & Unceta, A. (2018). The Active Ageing Index in a Southern European region (Biscay): main results and potentials for policymaking. In A. Zaidi, S. Harper, K. Howse, G. Lamura & J. Perek-Białas (Eds.). *Building evidence for active ageing policies*. Singapore: Palgrave Macmillan.

Cristea, M., Marcu, N., & Cercelaru, O. V. (2016). Longer life with worsening pension system? Aging population impact on the pension system in two countries: Romania and Croatia. In *Economic and social development: book of proceedings. 15th international scientific conference on economic and social development – human resources development.* Varazdin.

Cristea, M., & Mitrică, A. (2016). Global ageing: do privately managed pension funds represent a long term alternative for the Romanian pension system? Empirical research. *Romanian Journal of Political Science, 16*(1).

Cristea, M., & Thalassinos, I. E. (2016). Private pension plans: an important component of the financial market. *International Journal of Economics and Business Administration*, *4*(1). doi: 10.35808/ijeba/95.

Cornish, R. (2007). *Statistics: cluster analysis*. Mathematics Learning Support Centre.

De São José, J. M., Timonen, V., Amado, C. A. F., & Santos, S. P. (2017). A critique of the Active Ageing Index. *Journal of Aging Studies*, *40*. doi: 10.1016/j.jaging.2017.01.001.

Dincă, M., & Lucheș, D. (2018). Work integration of the roma: between family and labor market. *Sustainability*, *10*(5). doi: 10.3390/su10051495.

Dykstra, P. A., & Fleischmann, M. (2018). Are societies with a high value on the Active Ageing Index more age integrated? In A. Zaidi, S. Harper, K. Howse, G. Lamura & J. Perek-Białas (Eds.). *Building evidence for active ageing policies*. Singapore: Palgrave Macmillan. doi: 10.1007/978-981-10-6017-5_2.

Djurovic, I., Jeremic, V., Bulajic, M., & Dobrota, M. (2017). A two-step multivariate composite I-distance indicator approach for the evaluation of Active Ageing Index. *Journal of Population Ageing*, *10*(1). doi: 10.1007/s12062-016-9169-8.

European Commission (2016a). Ready for the demographic revolution? Measuring active ageing. Retrieved from https://ec.europa.eu/social/main.jsp?langId=en&catId=752&furtherNews=yes&newsId=2430#navItem-1 (20.05.2019).

European Commission (2016b). Active Ageing Index at the local level. Peer review in social protection and social inclusion 2015-2016. Directorate-General for Employment, Social Affairs and Inclusion, Population Unit of the UNECE and the European Centre for Social Welfare Policy and Research in Vienna, Berlin, Germany, 14-15 April 2016.

European Commission (2019a). *Eurostat database*. Retrieved from https://ec.europa.eu/eurostat/data/database.

European Commission (2019b). Employment, social affairs & inclusion. Statistical data. Retrieved from https://ec.europa.eu/social/main.jsp?catId=1249&langId=en (20.05.2019).

Hall, A., & Gylfi, Z. (2014). Values and labor force participation in the Nordic countries. *Economics: the Open-Access, Open-Assessment E-Journal, 8*. doi: 10.5018/economics-ejournal.ja.2014-41.

Káčerová, M., & Mládek, J. (2012). Population ageing as generation substitutions: economic and social aspects. *Ekonomický časopis. 3*(60).

Kafková, M. P. (2018). The Active Ageing Index (AAI) and its relation to the quality of life of older adults. In A. Zaidi, S. Harper, K. Howse, G. Lamura & J. Perek-Białas (Eds.). *Building evidence for active ageing policies*. Singapore: Palgrave Macmillan. doi: 10.1007/978-981-10-6017-5_4.

Marcu, N., & Dobrotă, C.E. (2016). The economic impact of the cohesion policy. *Revista Economica*, *68*(3).

Marcu, N., Meghișan, G. M., & Ciobanu, M. C. (2015). Research on Romanian labour market dynamics. *Revista de Chimie*, *66*(9).

Neţoiu, L., & Cârstina, S. (2014). Analysis of the correlation between minimum wage levels in the country, indicators of social protection and poverty threshold. *Procedia Economics and Finance*, *8*. doi: 10.1016/S2212-5671(14) 00120-8.

Noja, G. G., & Cristea, M. (2018). Working conditions and flexicurity measures as key drivers of economic growth: empirical evidence for Europe. *Ekonomický časopis*, *66*(7).

OECD (2019). OECD databases. Retrieved from https://data.oecd.org/ (12.05.2019).

Pânzaru, C. (2015). Some considerations of population dynamics and the sustainability of social security system. *Procedia - Social and Behavioral Sciences*, *183*. doi: 10.1016/j.sbspro.2015.04.847.

The World Bank (2019). Data bank. Retrieved from https://databank.worldbank.org/data/home.aspx (16.05.2019).

UNECE/European Commission (2019). 2018 Active Ageing Index: analytical report. Report prepared by Giovanni Lamura and Andrea Principi, Geneva, June. Retrieved from https://www.unece.org/fileadmin/DAM/pau/age/Active_Ageing_Index/Stakeholder_Meeting/ACTIVE_AGEING_INDEX_TRENDS_2008-2016_web_cover_reduced.pdf (19.05.2019).

Um, J., Zaidi, A., & Choi, S. J. (2019). Active Ageing Index in Korea–comparison with China and EU countries. *Asian Social Work and Policy Review*, *13*(1).

Xiong Q., & Wiśniowski A. (2018). Comparative study of active ageing in China and the EU countries. In A. Zaidi, S. Harper, K. Howse, G. Lamura & J. Perek-Białas (Eds.). *Building evidence for active ageing policies*. Singapore: Palgrave Macmillan. doi: 10.1007/978-981-10-6017-5_17.

Zaidi, A. (2015). Active Ageing Index: a legacy of the European year 2012 for active ageing and solidarity between generations. *Policy Brief, 4*.

Annex

Table 1. Summary statistics

			EU–28		
	N	mean	sd	min	max
AAI	140	34.01357	4.461316	26.2	47.2
GDP_C	140	32865.45	20907.05	6843.263	108600.9
LP	140	95.23429	28.17827	41.2	190.8
ODR	140	26.74786	4.11978	16.5	35.3
POP_65	140	17.73286	2.35404	11.2	22.6
ALMP	140	.4239571	.3191144	.023	1.491
PLMP	140	.8834286	.6927842	-.064	3.126
RD	140	1.563593	.8752389	.261	3.726
			EU–13		
	N	mean	sd	min	max
AAI	65	31.28923	2.716853	26.2	37.9
GDP_C	65	17142.37	6106.295	6843.263	30818.46
LP	65	73.01385	12.56671	41.2	95.9
ODR	65	25.54769	3.736396	17.3	32.5
POP_65	65	17.23692	2.105318	12.4	21
ALMP	65	.24	.1982774	.023	.965
PLMP	65	.3806769	.2148851	-.064	1.043
RD	65	.9974769	.5420827	.261	2.579
			EU–15		
	N	mean	sd	min	max
AAI	75	36.37467	4.339669	27.4	47.2
GDP_C	75	46492.12	19582.04	21354.5	108600.9
LP	75	114.492	23.35188	73.3	190.8
ODR	75	27.788	4.176736	16.5	35.3
POP_65	75	18.16267	2.484426	11.2	22.6
ALMP	75	.5833867	.3190545	.074	1.491
PLMP	75	1.319147	.6686987	.0559999	3.126
RD	75	2.054227	.8119677	.598	3.726

Table 2. Clusters results associated with the impact of the AAI, labour productivity, labour market policies and R&D activities upon the GDP per capita, EU–28, 2018

Clusters (C)	**EU-28 Member States**	**Cluster Modelling – Ward Method**
		Performance
C1	France, Austria, Germany, Belgium, the Netherlands, Denmark, Sweden, Finland	*Very High* (particularly through the highest *AAI*, increased *GDP_C*, *RD*, *LP*)
C2	Luxembourg, Ireland	*Medium to high* (through *AAI*, *ALMP*, and highest levels of *GDP_C* and *LP*, and also for the reduced *ODR*)
C3	Greece, Romania, Slovenia, Lithuania, Latvia, Bulgaria, Croatia, Portugal	*Very low* (particularly through the smallest *AAI*, highest *ODR*, lowest *GDP_C*, *LMP* and *RD*)
C4	Slovak Republic, the United Kingdom, Poland, Malta, Cyprus, Estonia, the Czech Republic	*Medium to low* (through all variables, particularly low *ALMP*, *PLMP* and *RD*, *medium AAI*)
C5	Hungary, Italy, Spain	*Low* (particularly through the small *AAI*, *GDP_C*, but also *LP* and *RD*, yet increased *ALMP* and *PLMP*)

Table 3. Cluster analysis results (AAI, labour productivity, labour market policies and R&D activities interlinked with the GDP per capita), 2018

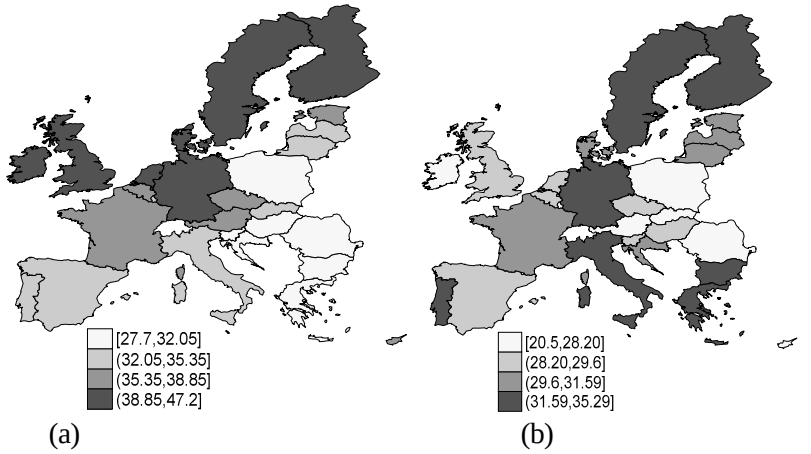
Indicators	*Cluster 1 (C1)*			*Cluster 2 (C2)*			*Cluster 3 (C3)*			*Cluster 4 (C4)*			*Cluster 5 (C5)*			*F*	*R-sq*
	N	*mean*	*sd*	*N*	*mean*	*sd*	*N*	*mean*	*sd*	*N*	*Mean*	*sd*	*N*	*mean*	*sd*		
GDP_C	8	0.7324	0.4872	2	2.8988	0.9569	8	-0.7057	0.2998	7	-0.3234	0.4276	3	-0.2114	0.5041	30.5905***	0.8418
AAI	8	1.4931	0.8045	2	0.7030	0.6181	8	-0.5550	0.5572	7	0.3844	0.7687	3	-0.3019	0.4207	9.6882**	0.6275
LP	8	0.7112	0.2356	2	2.8005	0.8684	8	-0.8103	0.4063	7	-0.3344	0.3240	3	-0.0899	0.7346	36.7546***	0.8647
ODR	8	1.0920	0.5127	2	-1.2987	0.1196	8	1.1827	0.5180	7	0.1814	0.7784	3	1.1555	0.9024	8.6707**	0.6013
ALMP	8	0.9238	1.2042	2	0.6153	1.6054	8	-0.7562	0.2981	7	-0.5726	0.3228	3	0.9980	0.8764	6.4340**	0.5281
PLMP	8	0.5550	0.7492	2	-0.4206	0.1590	8	-0.6903	0.4176	7	-1.0228	0.2806	3	0.0984	0.9385	8.7100**	0.6024
RD	8	1.2897	0.4781	2	-0.4185	0.0474	8	-0.7741	0.5663	7	-0.7102	0.5757	3	-0.4695	0.1049	21.8905***	0.7920

Table 4. Panel data analysis results, EU-13 and EU-15, data for the period (lapse of time): 2010, 2012, 2014, 2016, 2018

EU-13				
	(1)	**(2)**	**(3)**	**(4)**
	log_GDP_C RREG	**log_GDP_C PCSE**	**log_GDP_C Spatial lag**	**log_GDP_C Spatial error**
log_AAI	2.616***	2.541***	1.230***	1.145**
	(0.529)	(0.303)	(0.270)	(0.416)
log_POP_65	-4.848	-5.438	-4.033	-4.923
	(4.832)	(3.461)	(2.663)	(3.557)
log_RD	0.229**	0.252***	0.108**	0.0831
	(0.0783)	(0.0361)	(0.0389)	(0.0493)
log_ODR	2.705	3.195	2.718	3.582
	(4.055)	(2.906)	(2.220)	(2.933)
log_ALMP	0.0950	0.0812***	0.0496*	0.0424
	(0.0497)	(0.0209)	(0.0219)	(0.0289)
log_PLMP	-0.0513	-0.0549	-0.0199	-0.0340
	(0.0687)	(0.0530)	(0.0320)	(0.0472)
_cons	5.834*	6.171***	-1.323	7.731***
	(2.205)	(1.334)	(1.158)	(1.841)
rho			0.983***	
_cons			(0.0181)	
sigma			0.127***	0.163***
_cons			(0.00985)	(0.0140)
lambda				0.978***
_cons				(0.0235)
N	63	63	65	65
R^2	0.540	0.590	-	-
EU-15				
	(1)	**(2)**	**(3)**	**(4)**
	log_GDP_C RREG	**log_GDP_C PCSE**	**log_GDP_C Spatial lag**	**log_GDP_C Spatial error**
log_AAI	0.899***	0.223	-0.0155	0.102
	(0.153)	(0.411)	(0.255)	(0.444)
log_POP_65	1.493*	1.876	0.697	0.546
	(0.700)	(1.871)	(1.102)	(1.628)
log_RD	0.251***	0.242***	0.0939*	0.151
	(0.0371)	(0.0663)	(0.0465)	(0.0864)
log_ODR	-1.724**	-3.028	-1.329	-1.234
	(0.626)	(1.686)	(0.961)	(1.479)
log_ALMP	0.0767**	0.232***	0.138***	0.120*
	(0.0255)	(0.0600)	(0.0357)	(0.0544)
log_PLMP	-0.00177	-0.207***	-0.116**	-0.111*
	(0.0200)	(0.0409)	(0.0379)	(0.0529)
_cons	8.718***	14.51***	2.699*	13.05***
	(0.600)	(1.774)	(1.098)	(1.847)
rho			0.981***	
_cons			(0.0193)	
sigma			0.128***	0.165***
_cons			(0.0121)	(0.0157)
lambda				0.975***
_cons				(0.0265)
N	75	75	75	75
R^2	0.869	0.634	-	-

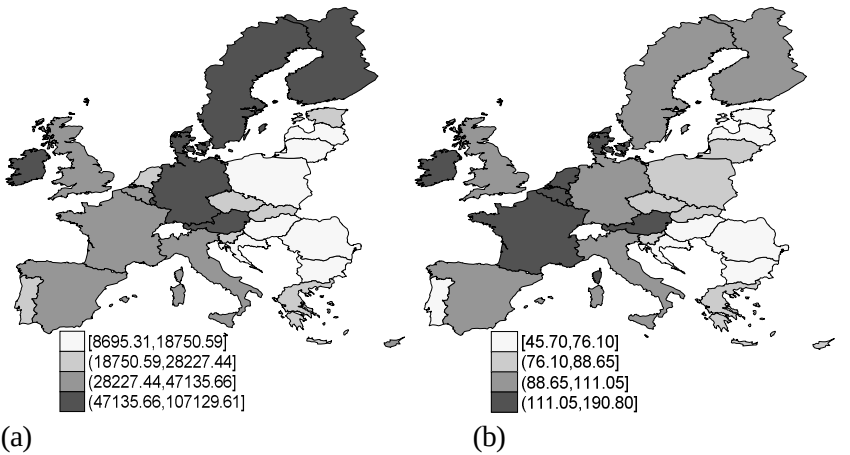
Standard errors in parentheses, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Figure 1. The ageing indicators, across the EU–28, 2018: a) AAI; b) ODR



Source: authors' processing in Stata based on data provided by UNECE/European Commission (2019) and Eurostat.

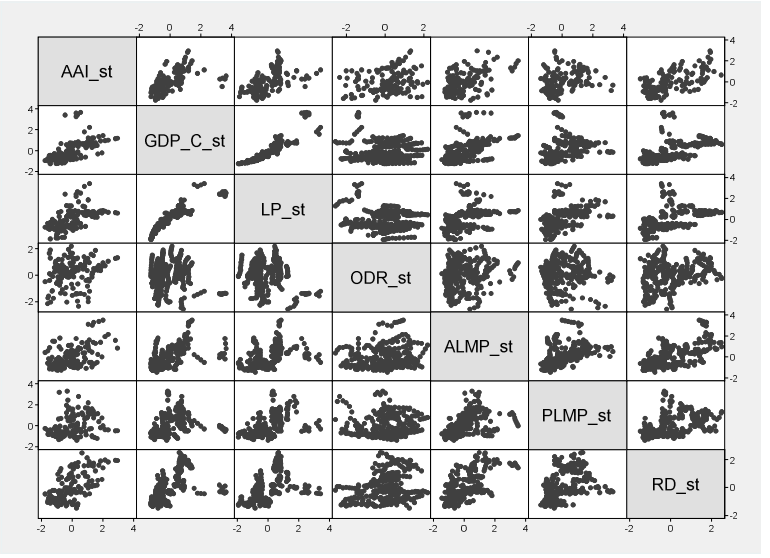
Figure 2. The economic development indicators, across EU–28, 2018: a) GDP_C; b) LP



Source: authors' own processing in Stata 16 based on data provided by OECD and Eurostat.

Figure 3. Correlation matrix (a) and dendrogram of cluster modelling (b), EU–28, 2018

a)



b)