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Public Pension Expenditure in the New EU Member States: A Panel Data Approach*

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Abstract

Sustainability and stability of public pension systems based on the pay-as-you-go social security scheme have been challenged by the aging societies of industrial economies. This paper concentrates on pension systems of eleven post-socialist economies referred to as the New Member States of the European Union that share a similar history of adaptations to a market economy and establishment of multi-pillar pension systems. Due to similar demographic and economic challenges, their pension systems are facing, and the corresponding pension reforms aimed at enhancing their pension systems´ sustainability, we empirically test for the convergence of public pension expenditure to GDP among these economies in the period between 1995 and 2017. At the same time, the impact of various macroeconomic, demographic, and institutional variables on public pension expenditure to GDP is empirically estimated. The results provide evidence of convergence in terms of public pension expenditure to GDP among the New Member States of the European Union, while also revealing the fiscal burden that population aging represents for the analyzed pension systems.

1. Introduction

Sustainability of public finances, especially of social security systems, is largely affected by aging societies, in which the proportion of elderly is increasing, due to higher life expectancy and decreasing fertility rates. Some of the economies are facing even greater demographic challenges if the working-age population emigrates, causing a reduction in the proportion of individuals paying social contributions. This paper concentrates on pension systems of eleven post-socialist economies called the New Member States of the European Union (in further text abbreviated as NMS), that share a similar history of adaptations to a market economy and establishment of a multi-pillar pension system. This group comprises Bulgaria, Croatia, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia, and Slovenia. The pension systems of NMS are prevalently based on the pay-as-you-go social security (PAYG) scheme, in which retirement benefits to current pensioners are financed from the contributions of the current workers (Barr and Diamond, 2006). As such, they are subject to changes in demographic and economic conditions, especially those in the labor market. Additionally, they are influenced by the parameters and rules of the pension systems (Verbič and Špruk, 2008).

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Pension systems' sustainability, which is usually measured by public pension expenditure as a share of GDP (World Bank, 2008; European Commission, 2009; Moscarola, 2009; Pallares-Miralles et al., 2012; Marcinkiewicz and Chybalski, 2014), is further compromised in the NMS by poor design characteristics and weak labor market performances in the transition period. This was especially present during the privatization period of formerly state-owned enterprises, which were undergoing a restructuring period and large redundancies in the labor market were resolved by early retirement. Consequently, the system dependency ratio, expressed as the ratio between the number of pensioners and workers has grown. Furthermore, the link between paid contributions and benefits was weak, as contributions were paid by employers, not workers (Wagner, 2005). Polanec et al. (2013) describe the transition period as characterized by "declining real wages relative to pensions as a result of declining demand for labor due to price liberalization and aggregate demand shocks", referring to the literature on the transition in Eastern Europe (Gomulka, 1992; Kornai, 1994; Berg and Blanchard, 1994 and Rosati, 1994). As a result, public pension expenditure to GDP was relatively high and growing.

Consequently, the new members of the European Union have been reforming their pension systems for several decades to make them more sustainable, by changing the parameters and rules of the systems. The main goal of the reforms was to contain future pension expenditure trends. Changes in the rules and parameters of the pension system mostly included changing the retirement age, contribution rates, introducing measures that discourage early retirement, changing the calculation of pensions and indexation of pensions, introducing mechanisms of automatic adjustment of pension parameters to demographic trends, and harmonization of pension ages between the genders (Carone et al., 2016). A radical change of the systems was the introduction of new pillars that took place in the late 1990s and early 2000s. Aside from Slovenia, all the NMS introduced a mandatory private individual scheme. The financial crisis of 2007–08 has prompted numerous reforms aimed at increasing sustainability, while to cope with demographic trends, countries have recently strengthened the link between pensions and life expectancy by replacing Defined Benefit (DB) schemes with the Notional Defined Contribution (NDC) schemes.

As these economies face the same challenges that determine expenditure and the level of sustainability of pension systems, it is of special interest to examine the determinants of public pension expenditure. All analyzed economies have recently joined the European Union, although at different stages, and as EU members, they are regulated by the same directives. In the light of ensuring "quality of public finances", European Commission emphasizes the need for "sound and sustainable" public finances and the need for "fiscal consolidation because of an aging population" (Gemmell and Kneller, 2003). Furthermore, in the area of pension policy, an intergovernmental means of governance in the European Union called Open Method of Coordination on Social Protection and Social Inclusion (Social OMC) was established in 2006. The Pensions strand of the Social OMC has three main aims - adequate pensions, sustainable pensions, and modernized pensions - and its indicator portfolio is structured along with these objectives (Eurostat, 2019). Therefore, a more harmonized pension system framework may be expected, which was the motivation for examining convergence in public pension expenditure.

Statistical analyses were performed by using dynamic panel data models that enabled a simultaneous examination of convergence and identification of the main determinants of public pension expenditure in the analyzed period. Next to conditional beta-convergence, which our model empirically tests, two other widely recognized concepts in economics in the convergence analysis: sigma-convergence (σ-convergence) and absolute beta-convergence (β-convergence) are applied.

This paper contributes to the existing literature in two ways. To our knowledge, it is the first that examines convergence in public pension expenditure among the NMS. As opposed to numerous studies on welfare state convergence that concentrate on OECD economies and the Old Member States due to the limited availability of data, we provide evidence of convergence in this important segment of public finances. Second, our results highlight demographic and economic factors that are essential in the understanding of pension spending, which is an important guideline for policies aimed at increasing the sustainability of public pension schemes.

The remainder of this paper is structured as follows. Section 2 briefly presents previous research. Section 3 describes the dataset and econometric model. Section 4 presents our findings and comments on the limitations of this research. Section 5 concludes.

2. Literature Review

This section focuses on the review of the literature on public pension spending, its determinants, and the concept of convergence. Convergence is in social sciences defined as "the tendency of societies to grow more alike, to develop similarities in structures, processes, and performance" (Kerr et al., 1973). It can also be interpreted as the "transitional period between the present situation and the future model", which relates to "similar economic, political and social structures of countries as they get richer" (Kerr et al., 1973; Wilensky, 2002; Bouget, 2006). The process of convergence in social welfare is usually seen as a result of "broader economic convergence" (Kerr et al., 1973).

Although economic convergence is not new, and it stems primarily from the macroeconomic research on the determinants of economic growth (Barro and Sala-i-Martin, 1992), it also found common ground in the area of the welfare system convergence analysis. A short review of possible directions of convergence analysis in welfare state research can be found in Schmitt and Starke (2011). Bouget (2006) analyzes economic literature of convergence, in which "globalization at an international level, a process of catching up between countries and the reduction in the domestic budgetary deficit" are seen as important factors of convergence. Holzinger and Knill (2005) focus on the assessment of cross-national policy convergence, which is defined as the growing similarity of policies over time, measured by indicators such as degree, scope, and direction of convergence. In assessing whether countries' policies are similar, two categories are distinguished: the similarity of policy outputs, which are the policies adopted by the government, and policy outcomes, or the actual effects of a policy in terms of goal achievement.

Caminada et al. (2010) state that convergence of social protection objectives and policies among the EU member states may occur as a result of the

implementation of EU social policies and as a consequence of economic integration. In their literature review, they conclude that convergence in the social expenditure, as a measure of the level of social protection in different countries, can be found among European countries in the last 25 years. Festić and Mencinger (2009) analyzed the perspective of reforms of the pension systems of the NMS and concluded that the "international factors" have had a major impact on the policies introduced by national governments and emphasize the World Bank's (1994) influence in the shaping of multi-pillar systems.

Papers that empirically test for the welfare state convergence often use the sigma-convergence concept, which indicates the reduction in differences among the analyzed units over time (Schmitt and Starke, 2011). The concept of sigma-convergence was introduced in the seminal paper by Sala-i-Martin (1990), while the concept of absolute beta-convergence is used in the context of poor economies that tend to grow faster than rich ones (Sala-i-Martin, 1995). Starke et al. (2008) name a few studies that find evidence of absolute beta-convergence in terms of total public social expenditure and public spending on health and unemployment. In their work on welfare state convergence in OECD economies in the period between 1980 and 2005, Schmitt and Starke (2011) investigate conditional beta-convergence using an error correction model. They show that convergence is present in all types of social expenditure. Paetzold (2013) analyzes convergence in welfare state policies among the Old Member States using pension and unemployment net replacement rates, and public social expenditure as indicators of interest. Chybalski and Gomula (2018) examined the convergence of European pension systems following the definitions of the Pensions strand of the Social OMC but using multivariate statistical analysis based on synthetic indicators of the OMC. By employing agglomerative hierarchical clustering in three selected years authors conclude that European pension systems did not become more similar in terms of these objectives. Arčabić (2018) analyzed fiscal policy convergence and fiscal sustainability in EU-28 and found strong evidence of club convergence, but absolute divergence in fiscal policies.

Turning to the literature on the determinants of public pension expenditure, Verbič and Špruk (2014) analyzed macroeconomic determinants of public pension expenditure to GDP in OECD economies. Detecting the endogeneity problems, the authors chose the IV-2SLS fixed-effect estimator for their panel data model. Their results showed that the aging phenomenon is more "powerful than economic and institutional factors". However, post-socialist economies face additional challenges. Taylor's (2001) review of empirical studies of various European countries implies strong age discrimination in the labor market. Older workers that lost their jobs experience great difficulties in finding a new job and have no other option but early retirement. Polanec et al. (2013) found weak incentives for working in the older age in transition countries, especially in Slovenia. Desmet et al. (2005) and Smith (2006) made a distinction between "voluntary" early retirement, which comes for preferences for leisure relative to work, and "involuntary" early retirement, resulting from employment constraints. This was stimulated by "the large-scale industry restructuring in Europe, which caused employment constraints to older workers" (Dorn and Sousa-Poza, 2007). Dorn and Sousa-Poza (2007), based on international microdata in 19 industrialized countries, argue that "higher shares of involuntary retirements among early retirees prevail in countries facing economic recessions and

strict employment protection legislation". Besides the institutional factors related to the pension system design, other individual-level characteristics affect early retirement: bad health, impairments, company restructuring, financial affordability, characteristics of the spouse, etc. (Higgs et al., 2003; Fischer and Sousa-Poza, 2006; Van Solinge, 2007).

Public pension expenditure expressed as a share of GDP, which is the variable of our interest, is most commonly used as an indicator of pension sustainability (e.g. World Bank, 2008, and many more). In the empirical literature, pension spending is investigated using econometric methods, but also within coherent macroeconomic models, such as general equilibrium overlapping generation (OLG) models. These models provide a more thorough analysis of the interlinkages of variables and are therefore here mentioned with the explanations of the expected relationships. The OLG model provides a useful framework for evaluation of the effects of government policies, which is why it has been extensively used in modeling pension systems. Reforms are mostly parametric.

As previously mentioned, European societies have enforced early retirement as a measure to lower high unemployment rates in the 1970s. Gruber and Wise (1998) show that a decrease in the effective retirement age leads to continuous increases in overall and marginal tax rates, while the net replacement rate was already high in high-income OECD countries since and thus further burdens the system. Within the literature using OLG models, two strands can be distinguished for the topic of retirement age: the concept of optimal retirement age and a welfare analysis for a variety of the pension system reforms. Tyrowicz et al. (2016) show that increasing the retirement age may lower the labor supply of households, due to a prolonged period of mandatory contributions. This would result in the deterioration of the system dependency ratio. However, the authors as well prove that in a defined benefit pension system, later retirement reduces fiscal imbalances, allowing welfare gains. Under defined contribution schemes, there are no direct fiscal effects, but pension benefits increase substantially. These benefits are related to the replacement rate that can further aggravate pension sustainability through an indirect effect of increasing life expectancy, owing to its role in old-age poverty alleviation. This would multiply the negative effect of pension generosity on public pension expenditure. Additionally, Hviding and Merrete's (1998) simulations suggest that a reduction in the generosity of the public pension system would alleviate the problems linked to the rapidly aging populations also through an increase in national saving and future potential output.

Several papers have studied the effects of population aging on the pension system. For example, Fanti and Gori (2012) demonstrate that a decreasing birth rate does not necessarily cause a fall of pensions in the steady-state of a standard OLG model. They conclude that no pension reforms may be necessary to face the fertility drop. Cipriani (2014) extends the model by including life expectancy and concludes that, if the pension tax rate and the child-rearing cost are sufficiently high, a fall in fertility leads to an increase in pensions. However, an increase in longevity always negatively affects public pensions. Therefore, population aging resulting from increasing longevity and falling fertility has, in general, an ambiguous effect on pensions in this model, but the effect of an increase in longevity is always unambiguously negative. PAYG schemes were in their inception based on the

assumption of fertility rates above replacement levels, stationary population growth, and low share of the elderly population. In their seminal papers, Samuelson (1958) and Cass and Yaari (1966) proved that favorable stationary demographic characteristics constituted a necessary condition for PAYG schemes, whereas high effective retirement age was a sufficient condition for the relative solvency of these schemes (Verbič and Špruk, 2014).

Immigration is regarded as a potential solution to the demographic transition present in the industrialized world. Using a calibrated general equilibrium overlapping generations model, Storesletten (2000) argues that increased inflow of working-age immigrants with high and medium skills can remove the need for future fiscal reform in the United States. He suggests employing a system similar to the Canadian "point system" for allocating visas to prospective immigrants. He favors high-skilled immigrants in the age group 20-49 to maximize the public gain, which is calculated as the difference between the discounted value of future tax receipts and government expenditure. On the other hand, Fehr et al. (2005), using a multi-region OLG model show that even a significant expansion of immigration, regardless of the skills of workers, will have only a minor impact on the major capital shortage and tax hikes that can be expected together with the demographic transition. Thus, the relationship of net migration rate with pension expenditure is conditional on the age structure and work status of migrants, but its significance for fiscal sustainability depends on the type of economy.

The review of previous studies shows that analyses of welfare state convergence in these economies, as well as the investigation of macroeconomic, demographic, and institutional factors that are fundamental for pension systems' sustainability, are so far lacking in the scientific literature. To fill this literature gap, our paper covers both of the mentioned questions, providing evidence of convergence of the pension systems, and dealing with similar economic challenges.

3. Methodology

This section delivers the econometric analysis, selection of chosen variables, and the reasons behind the choice. The methodology is explained in detail, providing the results of descriptive statistics as well as the methods used in the assessment of the model. Further description of the variables and data sources is available in the Appendix.

3.1 Selection of Variables

The key variable of our interest was *public pension expenditure as a share of GDP*, used as an indicator for pension sustainability, which is expressed as the annual growth rate, whereas the convergence coefficient is in front of the lagged value of the natural logarithm of public pension spending to GDP on the right-hand side, as will be explained later (Barro and Sala-i-Martin, 1992; Schmitt and Starke, 2011; Paetzold, 2013). Sapiri et al. (2010) and de la Fuente and Domenech (2013) decomposed public pension expenditure to GDP into four factors:

$$\frac{pension\ expenditure}{GDP} = \frac{population\ 65+}{working\ population\ 15-64} * \frac{1}{employment\ rate} * \frac{pensioners}{population\ 65+} * \frac{average\ pension\ benefit}{average\ productivity} \quad (1)$$

These factors are divided into a population-aging effect, represented by the old-age dependency ratio (the first multiplier on the right-hand side), an employment effect, represented with the inverse of the employment rate of the working-age population (the second multiplier), an eligibility effect, associated with the rate of pension coverage (the share of beneficiaries in the 65+ age group) (the third multiplier), and a benefit effect, reflecting the generosity of a pension system, expressed as the ratio between average pension and average labor productivity (average output per employed worker) (the fourth multiplier) (Marcinkiewicz and Chybalski, 2014).

Variables presenting pension systems' generosity and strictness of retirement criteria, which are believed to influence the public pension expenditure to GDP, include *replacement rate* and *average effective retirement age*. The replacement rate is the percentage of an employee's pre-retirement monthly income that an employee receives after retiring. This variable is mostly taken from the Eurostat database, but since a certain number of data were missing, the replacement rate was approximated by the ratio of average pension and the average wage for the beginning of the observed period. Higher average pension benefits, relative to average wage naturally lead to larger pension expenses, as well as early retirement and loose retirement criteria. Therefore, postponing retirement by increasing the statutory retirement age should decrease public pension expenditure to GDP. In the analysis instead of the statutory retirement age the variable *average effective retirement age* is used, defined as the average age of exit from the labor force for 5 years.

The first demographic variable is *the share of the elderly population*, calculated as a total of persons aged 65 and over, expressed as a ratio of the total population. This variable reflects the common pressure of an aging population on the European welfare states and its consequences for pension spending. It is expected that an increase in the number of persons aged 65 and over will undoubtedly worsen the financial sustainability of pension systems, due to larger pension expenditure. Aside from this variable, two other demographic variables are included: *life expectancy at age 65* and *the net migration rate*. The average effective retirement age is closely related to the expected life span because together they indicate the duration of the retirement of an individual. Since life expectancy at 65 shows the expected time the system will have to provide benefits for an individual, it should have a direct positive relationship with pension expenditure. Increases in longevity and life expectancy at 65 are causing lasting pressure on pension expenditure, especially when combined with decreasing fertility rates.

In their seminal papers, Samuelson (1958) and Cass and Yaari (1966) concluded that favorable stationary demographic characteristics constituted a necessary condition for PAYG schemes, whereas high effective retirement age was a sufficient condition for the relative solvency of these schemes (Verbič and Špruk, 2014). The rising share of the elderly influences public pension spending as a

share of GDP through many channels. Firstly, the old-age dependency is increasing, which directly adversely affects public pension schemes. Secondly, the aging population leads to an increasing consumption relative to saving, because retirees are considered dissaving and workers are saving. The fall of savings passes to investment, then falls the investment to GDP ratio, causing a decrease in physical capital (Abdessalem and Cherni, 2016) and economic output. Also, scarcity of physical capital increases its price, represented by the market interest rate, whose increase can drive up pension benefits, depending on pension indexation mechanisms.

Indicators *life expectancy at 65* and the *average effective retirement age* have been weighted by the proportion of the male and female population in each country in each year to obtain indicators that accurately represent the entire population. The net migration rate could have either a positive or a negative relationship with pension expenditure, conditional on the age structure, and work status of migrants. The labor market is presented by three variables: *the unemployment rate, labor productivity per person employed,* and *labor force participation rate*. For the given demographic variables and the given number of pensioners, a higher participation rate and higher employment rate leads to the lower system dependency ratio, increasing the number of workers who pay the contributions for the public pension system. This is the channel through which the labor market and government policies directed to the labor market have a major impact on the sustainability of the PAYG public pension scheme. This is especially important in situations in which the number of pensioners cannot be lowered further by some pension system reforms (raising the retirement age or restricting further the disability pensions, among others).

Labor productivity per person employed has an ambiguous and indirect relationship with pension expenditure. Within the OLG framework, labor productivity is examined by allowing intracohort heterogeneity with individuals differing in human capital, either because of their innate abilities or education. Cipriani and Makris (2006) and Fanti (2013) formulate a model where longevity of one generation depends on the average human capital level, following Ehrlich and Lui (1991) who found that rising longevity promotes growth by rising human capital investment in children and by reducing fertility. In this way, a combination of reduced fertility and greater longevity would deteriorate the fiscal position of pension systems. Lastly, GDP growth is included as a proxy for economic growth and business cycles (Schmitt and Starke, 2011 and Paetzold, 2013). Its inverse relationship with the public pension expenditure to GDP is expected.

3.2. Dataset

The analysis is based on annual data from 1995 to 2017 taken from the Eurostat, OECD, and World Health Organization databases, as described in the Appendix, where all the variables are explained in detail as well. It includes 11 New Member States of the European Union belonging to Central and Eastern Europe: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Table 1 gives an overview of basic descriptive measures for the dependent and independent variables.

Table 1 Summary Statistics

Variable	*Observations*	*Mean*	*Overall Std. Dev.*	*Between Std. Dev.*	*Within Std. Dev.*
pension	252	8.81	2.00	1.82	0.96
age	251	60.76	2.52	2.01	1.63
elder	253	15.44	2.35	1.58	1.80
gdp	253	3.32	4.10	0.81	4.02
labor	242	61.05	5.18	3.83	3.70
life	253	16.22	1.31	0.81	1.05
migr	253	-1.88	5.17	3.32	4.08
prod	253	88.31	19.05	3.85	18.69
repl	200	0.50	0.10	0.08	0.06
unemp	253	10.36	4.00	2.78	2.99

Variable	*Median*	*Skewness*	*Kurtosis*	*Min*	*Max*
pension	8.45	0.62	2.87	4.92	14.4
age	60.50	0.49	3.37	55.13	68.82
elder	15.42	-0.02	2.04	10.80	20.73
gdp	3.81	-1.52	7.70	-14.81	13.05
labor	61.0	-0.32	3.75	38.9	74.1
life	16.15	0.35	2.91	13.29	19.87
migr	-0.47	-1.67	10.53	-29.52	20.17
prod	93.4	-0.46	2.27	43.9	131.4
repl	0.49	-0.03	2.08	0.25	0.68
unemp	9.9	0.57	2.51	2.9	20.5

Source: Data were compiled from Eurostat, OECD, and World Health Organization databases.

Table 1 gives a detailed description of the measures of descriptive statistics for the selected variables. The average pension expenditure to GDP in the panel is estimated at 8.8%, with an overall standard deviation of 2 percentage points. The lowest expenditure was recorded in Latvia in 2007 and the highest in Poland in 1997. Of the analyzed countries, the least amount is set aside for pensions in Estonia, Lithuania, and Romania, and most in Poland, Slovenia, and Croatia. The average weighted effective retirement age was 60.50 and the average weighted life expectancy at 65 was 16.15, which means that the system must pay pensions for 20.65 years to a male or female who lives for 81.15 years in total. Slovaks retire the earliest and Romanians at the latest, while the retired Bulgarians live the shortest, and Slovenes the longest. The average replacement rate was estimated at 0.49, meaning that the pension was half the wage they received in the period before retirement. The most generous pension system is that of Hungary and Poland, whereas Bulgarians and Croats have the lowest pensions in relative terms.

The analyzed countries are mostly characterized by emigration, since the net migration rate is negative on average, and the lowest rates are recorded in Bulgaria. Among the countries with mostly positive migration balance are the Czech Republic, Hungary, and Slovenia. The largest variations can be seen in labor productivity, with the average difference of 3.85 points across countries and 18.69 points within a

country in the observed period. The detailed comparative analysis of the main indicators which are believed to influence the sustainability of pension systems of the NMS in the period between 1995 and 2017 can be found in Krpan et al. (2019).

Table 2 presents a correlation matrix, which should point to a potential multicollinearity problem if it exists.

Table 2 Pairwise Correlation Matrix

	pension	*age*	*elder*	*gdp*	*labor*	*life*	*migr*	*prod*	*repl*	*unemp*
pension	1.00									
age	-0.24 (0.00)	1.00								
elder	-0.13 (0.04)	0.37 (0.00)	1.00							
gdp	-0.19 (0.00)	-0.01 (0.90)	-0.16 (0.09)	1.00						
labor	-0.39 (0.00)	0.39 (0.00)	0.31 (0.00)	0.04 (0.50)	1.00					
life	0.24 (0.00)	0.23 (0.00)	0.46 (0.00)	-0.14 (0.03)	0.50 (0.00)	1.00				
migr	0.23 (0.00)	-0.29 (0.00)	-0.09 (0.17)	-0.07 (0.28)	0.06 (0.36)	0.19 (0.00)	1.00			
prod	0.11 (0.09)	0.28 (0.00)	0.72 (0.00)	-0.13 (0.04)	0.26 (0.00)	0.68 (0.00)	0.09 (0.13)	1.00		
repl	0.19 (0.01)	0.12 (0.10)	-0.28 (0.00)	0.00 (1.00)	-0.04 (0.55)	0.156 (0.03)	0.15 (0.03)	0.13 (0.07)	1.00	
unemp	0.19 (0.00)	-0.23 (0.00)	-0.19 (0.00)	-0.08 (0.22)	-0.59 (0.00)	-0.23 (0.00)	-0.27 (0.00)	-0.25 (0.00)	-0.29 (0.00)	1.00

Source: Authors' calculations

Observing the correlation matrix shown in Table 2, the correlation between the regressors is generally weak, so multicollinearity is not exhibited in any pair of the variables, with coefficients of correlation less than 0.8. Out of nine independent variables, all have a significant correlation with the dependent variable. As expected, the average effective retirement age and gross domestic product exhibit a negative correlation with pension expenditure as a share of GDP, and life expectancy at 65 and replacement rate a positive one.

3.3 Method

To investigate whether there is a convergence in public pension expenditure to GDP in the analyzed period among the NMS, we apply two widely concepts of convergence: sigma-convergence and beta-convergence that are introduced by Sala-i-Martin (1990).

3.3.1 Sigma-Convergence

The concept of sigma-convergence is defined as follows: "a group of economies is converging in the sense of sigma if the dispersion of their real per capita GDP levels tends to decrease over time" (Sala-i-Martin, 1995):

$$\sigma_{t+T} < \sigma_t, \tag{2}$$

where σ_t is time t standard deviation of the $\log(y_{it})$ across i, or countries in our case.

As a usual measure of relative variability, the coefficient of variation is used. In the definition of sigma-convergence, Sala-i-Martin (1995) relies on the Lewontin's result that the coefficient of variation can be replaced by the variance or standard deviation of the logarithms (to any base) of the measurements „if the measure of intrinsic variability is invariant under a multiplicative change“. The motivation was the possibility of performing the usual statistical tests. Therefore, in our assessment of sigma-convergence, or decreasing dispersion of public pension expenditure to GDP over time, the coefficient of variation is used. The coefficient of variation is equal to the ratio of the variable's standard deviation to its mean.

3.3.2 Absolute Beta-Convergence

Next, we explore the second main concept of convergence, the absolute beta-convergence. It is used in the context of poor economies tend to grow faster than rich ones (Sala-i-Martin 1995). In the welfare convergence context, it is assumed that economies are converging to a common steady-state level of welfare provisions, which consequently implies an inverse relationship between the initial level of social provisions and its growth (Paetzold, 2013). Therefore, it is said that the data set exhibits absolute beta-convergence if we find that $\beta < 0$ in the estimation of the following regression (Sala-i-Martin, 1995):

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = \alpha_i + \beta ln y_{i0} + \varepsilon_i, \tag{3}$$

where the dependent variable on the left-hand side of the equation represents the average growth rate of public pension expenditure as a share of GDP of economy i between 1995 ($t = 0$) and 2017 ($t = 23$), β is the convergence coefficient and ε represents the error term. The index i indicates the unit of cross-section, which is the economy in our problem (Sala-i-Martin, 1995). Variable lny_{i0} on the right-hand side represents the natural log of public pension expenditure in the initial period, which is 1995 in our case. Absolute convergence implies the common steady-state for the analyzed economies, $\alpha_i = \alpha$. More detail on the derivation of the upper equation can be found in Barro and Sala-i-Martin (1992) and Paetzold (2013).

3.3.3 Conditional Beta-Convergence

If various structural factors determine whether the countries converge or not, we are analyzing the conditional beta-convergence (Schmitt and Starke, 2011). As opposed to the absolute beta-convergence, conditional beta-convergence allows us to take advantage of the panel structure of our data and examine whether there is convergence in public pension expenditure expressed as a share of GDP in the period between 1996 and 2017. The indicator of conditional beta-convergence is the inverse relationship between the growth rate of pension expenditure to GDP on the left-hand side and the lagged value of the natural logarithm of public pension spending to GDP on the right-hand side. Furthermore, with the estimation of our dynamic panel model, we will be able to determine the impact of various macroeconomic and demographic variables, as well as variables representing characteristics of a pension system, on the

public pension spending. The model estimated in this research can be expressed as follows:

$$y_{it} = \alpha y_{i,t-1} + x_{it}\beta + \eta_i + \gamma_t + v_{it}, i = 1, \dots, N, t = 2, \dots T, \quad (4)$$

where y_{it} is the logarithm of pension expenditure to GDP, $y_{i,t-1}$ is the logarithm of pension expenditure to GDP lagged by one period, capturing the effect of the past economy, η_i and γ_t are included to control for country-specific characteristics and common trends and external shocks to which all the economies are jointly exposed (Bond et al., 2001). Vector x_{it} is a vector of explanatory variables.

Equivalently, this model can be written as a panel data version of the conditional β-convergence model:

$$\Delta y_{it} = (\alpha - 1) y_{i,t-1} + x_{it}\beta + \eta_i + \gamma_t + v_{it}, \quad (5)$$

where the dependent variable on the left-hand side is the log difference of pension expenditure as a share of GDP or the growth rate of pension expenditure to GDP and the right-hand side variable $y_{i,t-1}$ is the logarithm of pension expenditure to GDP lagged by one period that reflects the initial level of pension expenditure to GDP (Bond et al., 2001). The negative coefficient of this variable indicates convergence, $\alpha - 1 < 0$.

Therefore, we have a macroeconomic dynamic panel data model, in which the lagged dependent variable appears on the right-hand side of the equation. Consequently, the assumption of strict exogeneity of the regressors no longer holds. Additionally, the time dimension in macroeconomic panel data is usually larger, and the cross-sectional dimension is smaller than in the microeconomic panel data, as is our case. This context raises the question of the choice of the right set of estimators.

In panel datasets that are characterized by a large N and small T, it is customary to pool the observations, when assuming homogeneity of the slope coefficients. Two estimators that are often used for dynamic panels, Difference GMM and System GMM, are suitable for the analysis of relationships in which the dependent variable is dependent on its past values and when the independent variables are not strictly exogenous. However, these two estimators should not be used for a moderate N and a large T, because of overfitting problems (Di Casola and Sichlimiris, 2015). Moreover, GMM estimators take into account the specificity of each observation unit and allow heteroskedasticity and autocorrelation within observation units, but not between them (Roodman, 2009). Phillips and Moon (1999) emphasize that "it is common to assume cross-sectional independence in panel data because of the difficulties of modeling across section dependence. However, the assumption that the covariance of error terms equals zero could easily be violated." Westerlund and Edgerton (2008) support this by saying that, "in macroeconomic and financial studies, cross-sectional dependencies are likely to be the rule rather than the exception, because of strong inter-economy linkages" (Chen and Vujić, 2016).

According to Judson and Owen (1999), the best solution for long macro panels when N is only moderately large is the LSDVC estimator (bias-corrected Least-Squares Dummy Variable estimator), which works well when the covariates, other that the lagged dependent variable, are strictly exogenous. The LSDVC

estimator is obtained by correcting the bias of the LSDV estimator, known as the Nickell's bias (Nickell, 1981) since the LSDV estimator for the dynamic panel data model is not consistent for large N and finite T. This method of correcting the LSDV bias for samples when N is small or moderately large for balanced panels was offered by Kiviet (1995). Bruno (2004) extended the bias approximation formulas in Bun and Kiviet (2003) to accommodate unbalanced panels with strictly exogenous selection rules.

Aside from cross-sectional dependence, with a longer time dimension, another potential econometric concern is raised, and that is the non-stationarity of variables. With the increasing time dimension, some researchers, such as Robertson and Symons (1992) and Pesaran and Smith (1995) have brought into question the poolability of the data across heterogeneous units and suggest the use of panel time-series estimators (Baltagi, 2005). These estimators allow for heterogeneous slope coefficients across group members, such as the Pesaran and Smith (1995) Mean Group estimator (MG) and the Augmented Mean Group estimator (AMG) by Eberhardt and Teal (2010). The AMG estimator further allows for unobserved correlation across panel members – cross-sectional dependence. When using MG estimators, N time-series regressions are estimated and thereafter the estimated coefficients are averaged, not explicitly accounting for the cross-sectional dependence (Pesaran and Smith, 1995, Blackburne and Frank, 2007). Additionally, AMG treats unobservable common factors as something to be accounted for and estimates" the common dynamic process" (Eberhardt, 2012).

3.3.4 Unit Root Tests

Before the model assessment, unit root tests are carried out. Most of the tests assume a balanced panel dataset, but the Im-Pesaran-Shin (2003) test allows for unbalanced panels and is therefore suitable for our dataset. Im et al. (2003) test is based on the Dickey-Fuller procedure that aims to recognize spurious regression. IPS test combines information obtained from both time-series and cross-sectional dimensions, requiring fewer observations:

$$\Delta y_{it} = \alpha_i + \rho_i y_{it\,1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it} + \varepsilon_{it}, \tag{6}$$

for i = 1, ..., N and t = 1, ..., T. IPS uses separate unit root tests for N cross-sectional units. It is based on the average ADF statistics between groups. After estimating the ADF regressions, the mean of t-test statistics for ρ_i is calculated:

$$\bar{t}_{Nt} = \frac{1}{N} \sum_{i=1}^{N} t_{iT}(\rho_i \beta_i). \tag{7}$$

$\bar{t}$ is afterward standardized and it converges to standard normal distribution since N and T tend to infinity.

The null hypothesis assumes the variable is non-stationary, and where the null hypothesis would not be rejected, the first differences will be used (Barbieri, 2005).

The Pesaran (2007) test is, unlike the Im-Pesaran-Shin (2003) test, robust to the presence of cross-sectional dependence in the data, while at the same time allowing α_i to vary across panels. The test is based on the (augmented) Dickey-Fuller test in (6), but additional factors are included to filter out the effects of unknown common factors. The regression is augmented with the lagged cross-section mean of the variable and its differences (Di Casola and Sichlimiris, 2015).

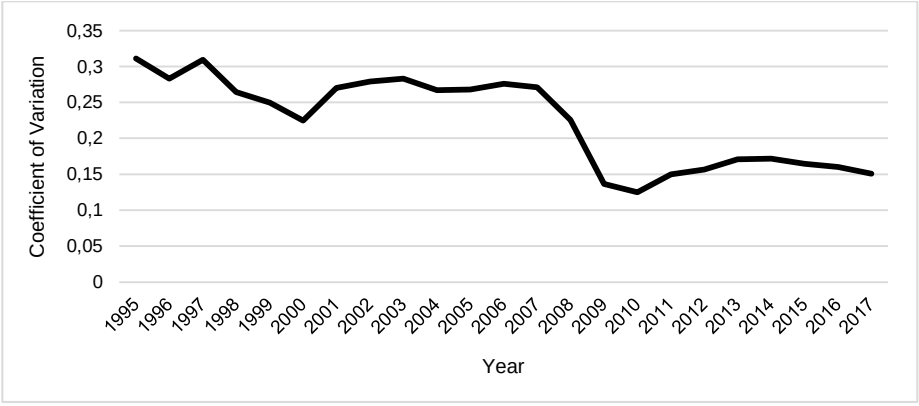
4. Results

This section reports the findings of our empirical analysis as described in Section 3. This section is divided into three parts: the first part presents the results on sigma- and absolute beta-convergence. As part of the testing of whether there is conditional beta-convergence, the second part presents the results on dynamic panel model estimation.

4.1 Sigma- and Absolute Beta-Convergence

To examine sigma-convergence, the development of the coefficient of variation of pension expenditure as a share of GDP across the NMS in the period between 1995 and 2017 is depicted in Figure 1.

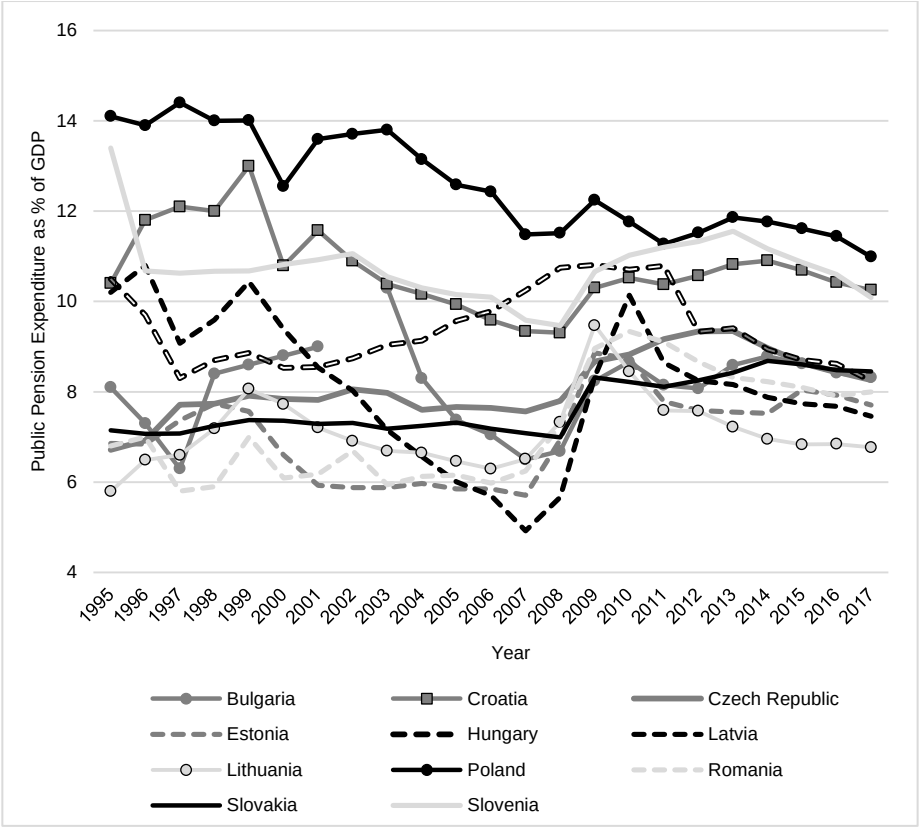
Figure 1 Coefficient of Variation of Pension Expenditure to GDP



Source: Data were compiled from Eurostat (2020).

Generally speaking, the trend of sigma-convergence is present when the coefficient of variation is declining. Our data show that the coefficient of variation is declining, but periods of divergence, or the increasing coefficient of variation, can be distinguished: 1996-1997, 2000-2003, 2010-2014, and 2015-2017. However, looking at the overall tendency, it can be concluded that the NMS are converging in the sense of sigma-convergence concerning public pension expenditure to GDP. This is corroborated by Figure 2, which presents the development of public pension expenditure as a share of GDP for each country over time.

Figure 2 Public Pension Expenditure as a Share of GDP for New EU Member States in the Period between 1995 and 2017

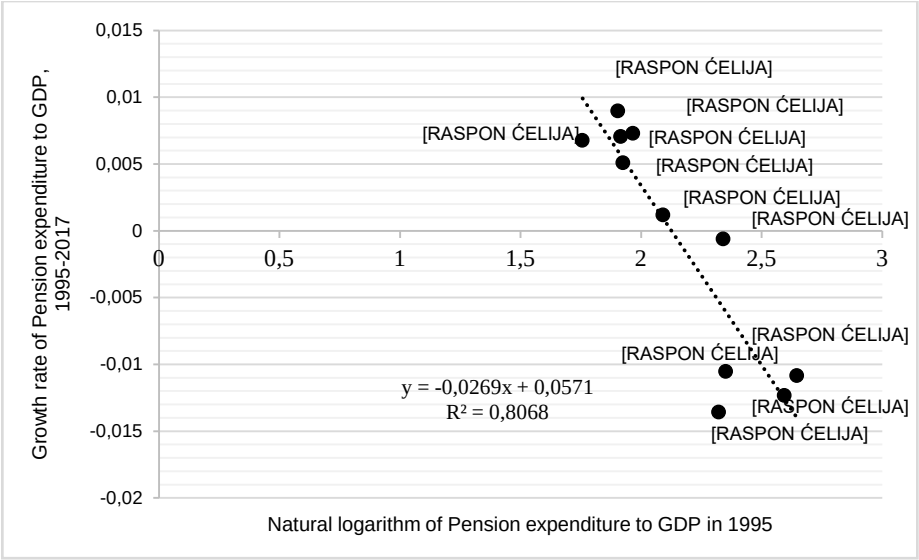


Source: Data were compiled from Eurostat (2020).

The coefficient of variation decreased from 0.31 in 1995 to 0.18 in 2017, implying an average growth in sigma-convergence of 3.2 % per year, $\frac{1}{23}\ln\left(\frac{CV_{2017}}{CV_{1995}}\right) = \frac{1}{23}\ln\left(\frac{0.15087}{0.311174}\right) = -0.031475$.

Below the concept of absolute beta-convergence is explored. As a preliminary indication of absolute beta-convergence, a scatter plot is used and is shown in Figure 3. It shows a negative relationship between the initial level of pension expenditure to GDP and the growth rate of pension expenditure to GDP. This result is an indication of the existence of absolute beta-convergence among the economies between 1995 and 2017.

Figure 3 Average Growth Rate of Pension Expenditure to GDP and Initial Level in 1995



Source: Data were compiled from Eurostat (2020).

Figure 3 suggests there is evidence of absolute beta-convergence. The NMS that recorded relatively high levels of pension expenditure to GDP in 1995 were on average decreasing its value, while the countries that recorded relatively low levels of pension expenditure expressed as a share of GDP in 1995 were on average recording its increasing values over the observed time. Comparison of values in 2017 to 1995 reveals that the following economies increased their pension spending with the average growth rate in parentheses, in descending order of magnitude: Czech Republic (0.90%), Slovakia (0.73%), Romania (0.70%), Lithuania (0.68%), Estonia (0.51%), and Bulgaria (0.12%). On the other hand, countries that decreased their public pension spending as a share of GDP were Latvia (-1.36%), Slovenia (-1.23%), Poland (-1.08%), Hungary (-1.05%), and Croatia (-0.06%). Table 7 confirms conclusions based on the scatter plot.

Table 3 Absolute Beta-Convergence Estimation

Variable	*Coefficient*	*Std. Error*	*t-statistic*	*p-value*
initial_level	-0.03	0.004	-6.13	0.00
Constant	0.06	0.01	5.97	0.00
Number of observations	11		Adjusted R^2	0.79
F(1,9)	37.59 (0.00)		Mean of Dependent Variable	-0.001
R^2	0.81		Std. Error of Dependent Variable	0.009

Source: Authors' calculations.

Results of simple regression analysis support findings of absolute beta-convergence. The initial level of pension expenditure as a share of GDP and its subsequent growth have an inverse relationship as the estimated parameter is of negative sign and convergence is significant at a 1% significance level. Summarizing, the estimations of all the concepts of convergence reveal a catching-up process in terms of public pension expenditure since the year 1995.

4.2 Conditional Beta-Convergence

In this section, the results of conditional beta-convergence are presented. First, it was necessary to examine the stationarity of the series. Table 4 shows the results of the Im-Pesaran-Shin (2003) and Pesaran (2007) tests for detecting unit roots in panel data. Im-Pesaran-Shin (2003) test belongs to the first generation of unit root tests that were all constructed under the assumption that the individual time series in the panel are cross-sectionally independently distributed. This was refuted by a large amount of literature providing evidence of co-movements between economic variables. To overcome this difficulty, the second generation of tests rejecting the cross-sectional independence hypothesis has been proposed (Barbieri, 2005) and the Pesaran (2007) test is such a test.

Table 4 Panel Unit Root Test Results

Variable	*Im-Pesaran-Shin t-Statistic levels*	*Im-Pesaran-Shin t-Statistic first differences*	*Pesaran CADF t-Statistic levels*	*Pesaran CADF t-Statistic first differences*
pension	-2.06 (0.05)	-4.53 (0.00)	-2.42 (0.01)	-5.03 (0.00)
age	-0.84 (1.00)	-4.00 (0.00)	-1.73 (0.04)	-6.94 (0.00)
elder	0.22 (1.00)	-2.64 (0.00)	-0.32 (1.00)	-2.84 (0.03)
gdp	-3.15 (0.00)	-5.70 (0.00)	-3.30 (0.00)	-5.40 (0.00)
labor	-0.53 (1.00)	-3.28 (0.00)	-2.25 (0.05)	-7.15 (0.00)
life	-2.69 (0.00)	-5.93 (0.00)	-3.02 (0.01)	-5.54 (0.00)
migr	-3.36 (0.00)	-6.01 (0.00)	-2.99 (0.00)	-5.22 (0.00)
prod	-1.62 (0.38)	-4.14 (0.00)	-2.52 (0.23)	-4.68 (0.00)
repl	-1.65 (0.30)	-4.09 (0.00)	0.28 (0.61)	-8.95 (0.00)
unemp	-1.34 (0.70)	-2.96 (0.00)	-2.37 (0.02)	-3.55 (0.00)

Source: Authors' calculations.

Notes: Tests for variables elder, life, and prod include a time trend component since visual inspection suggests they are dominated by a trend. Due to unbalanced data, Z[t-bar] statistic is displayed for variables age, labor, and repl. The results are obtained from Stata 13 using the "xtunitroot ips" and "xtcadf" commands. p-values are provided in the brackets.

It can be observed from Table 4 that, according to the Im-Pesaran-Shin (2003) test, 6 variables have unit root in levels: average effective retirement age, the share of elderly, labor force participation rate, labor productivity, replacement rate, and

unemployment rate; whereas 4 variables are stationary: pension expenditure, gross domestic product, life expectancy at 65 and net migration rate. There is no ambiguity in the results of the tests in levels and first differences. It is worth mentioning the one variable that was initially used was of second-order integration $I(2)$, old-age dependency ratio, so the analysis had to include another, similar variable - the share of elderly persons.

The second part of Table 4 contains the results of the Pesaran (2007) CADF test, which works with unbalanced data. Test results partly confirm the inferences from the Im-Pesaran-Shin (2003) test. This second-generation unit root test rejects the null hypothesis of a unit-root process for pension expenditure, gross domestic product, life expectancy at 65, and net migration rate; but also for the average effective retirement age, labor force participation rate, and unemployment rate.

Table 5 Fixed Effects Estimation and Cross-Sectional Dependence Test Results

Variable	*(1)LSDV*	*(2)MG*
Constant	0.39 (1.38)	3.56*** (3.91)
pension $_{t-1,}$ *ln*	-0.35*** (-6.65)	-0.68*** (0.15)
labor	-0.004** (-2.37)	-0.02*** (-2.60)
d.prod	0.04 (1.35)	-0.01 (-0.78)
d.elder	0.03*** (4.08)	0.10** (-0.78)
migr	0.0001 (0.09)	-0.02 (-1.41)
life	0.01 (1.04)	0.0004 (0.02)
d.repl	0.34** (2.42)	0.36 (1.46)
gdp	-0.01*** (-8.9)	-0.01** (-2.54)
age	0.007 (1.48)	-0.01 (-1.02)
A group-specific linear trend	-	0.01* (1.94)
Breusch-Pagan LM test	63.70 (0.20)	-
Modified Wald test	589.81 (0.00)	-

Source: Authors' calculations

Notes: The LSDV estimation results are obtained from Stata 13 by implementing command "xtreg" for the regression. The Breusch-Pagan test for cross-sectional dependence is carried out by the command "xtttest2" in Stata 13. The modified Wald test for groupwise heteroscedasticity is carried out by the command "xttest3". p-values for these two tests are provided in the brackets.

In Table 5 the results of the model estimation are presented, obtained by implementing the LSDV and the MG estimators. Since in our case the time dimension is greater than the cross-sectional one, the Breusch-Pagan LM test for cross-sectional dependence is employed. The test shows that we cannot reject the null hypothesis, and conclude that the errors do not exhibit contemporaneous correlation when fit by the dynamic FE (De Hoyos and Sarafidis, 2006). Additionally, a modified Wald test for groupwise heteroscedasticity was implemented. The null hypothesis is rejected at a 1% significance level, which means that the errors exhibit

groupwise heteroscedasticity. Finally, within panel autocorrelation in the error terms is present. By using the command *cluster (id)*, SE estimates are robust to disturbances being heteroscedastic and autocorrelated (Hoechle, 2007). As a robustness check, the results of the MG estimator are also presented. When using the MG estimators, N time-series regressions are estimated and thereafter the estimated coefficients are averaged (Pesaran and Smith, 1995, Blackburne and Frank, 2007). By estimating the model with the MG estimator, a linear time trend term is added to "specify each group-specific regression" (Eberhardt, 2012).

The main inference that can be drawn from the estimation results is that convergence can be found in the panel. In both estimated models, the $(\alpha - 1)$ coefficient is significantly smaller than zero, at a 1% level, indicating that there exists a consistent negative relationship between the growth of pension expenditure to GDP and their initial levels. Two independent variables also have a significant negative relationship with the annual change in pension expenditure as a share of GDP: labor force participation rate and gross domestic product. A higher participation rate leads to a lower system dependency ratio, and an increasing number of employees who pay the contributions for the public pension system, which translates into greater sustainability. Conversely, a significant positive relationship with an annual change in public pension expenditure to GDP has the share of the elderly. A generosity indicator of the pension system, the replacement rate has a significant, positive impact on pension expenditure, when estimated with the LSDV estimator. Life expectancy at 65 shows a positive, however, insignificant effect, whereas average effective retirement age, net migration rate, and labor productivity have an ambiguous and insignificant relationship with the dependent variable.

Being aware of the bias of the LDSV estimator in dynamic panel models, and the existence of the LSDVC estimator, which is obtained by correcting the bias of the LSDV estimator, in what follows we present the results of the model estimation with LSDVC estimator. Therefore, as a robustness check, we present the results of the models estimated by the Generalized Method of Moments (GMM) estimator. Since N is moderate, we had to restrict the number of regressors next to the lagged dependent variable to 3 to satisfy the rule of thumb that the number of instruments being less than the number of groups. For the same reason, time dummies are not included, although recommended (Roodman, 2009). Finally, the results of two additional estimators are presented. Unlike the MG estimator, the AMG estimator takes into account the cross-sectional dependence and estimates the "common dynamic process" (Eberhardt, 2012).

The Breusch-Pagan LM test for cross-sectional dependence shows that we reject the null hypothesis of no cross-sectional dependence at a 10% significance level. Moreover, the modified Wald test for the groupwise heteroscedasticity points to its presence in both models. , the Wooldridge test for autocorrelation shows that we cannot reject the null hypothesis of no first-order autocorrelation, so the *xtscc* command in Stata 13 is used (Hoechle, 2007) for the dynamic FE (LSDV) estimation with Driscoll-Kraay standard errors. The results obtained by using the AMG estimator are added to the results obtained by the MG estimator. Since the LSDVC estimator automatically creates the lagged dependent variable as a regressor, an equivalent model is estimated, in which the dependent variable is the natural logarithm of public pension expenditure to GDP, instead of its growth rate. In this

case, the estimated indicator of the conditional beta-convergence is equal to the estimated coefficient in front of the lagged dependent variable reduced by one, $(\alpha - 1)$.

Table 6 presents the results of the estimation of models. Five estimators have been used: GMM, LSDV, LSDVC, AMG, and MG. Only the models with correct diagnostics are shown, while the other models, including the rest of the independent variables, are not presented.

Table 6 Dynamic Panel Data Model Estimation

Variable	*GMM*	*LSDV*	*LSDVC*	*MG*	*AMG*
Constant	0.75 (4.17)	0.55*** (3.96)	-	0.72*** (12.82)	0.66*** (2.86)
pension $_{t-1,}$ ln	0.68*** (5.09)	0.71*** (10.56)	0.78*** (9.33)	0.63*** (10.62)	0.52*** (5.98)
life	-0.002 (-0.16)	0.01 (1.23)	0.003 (0.42)	0.07 (0.55)	0.03 (1.56)
d.repl	1.36*** (3.17)	0.68** (2.55)	0.69*** (3.14)	0.58*** (3.75)	0.32*** (4.08)
d.prod	-0.01*** (4.17)	-0.01*** (-2.9)	-0.01*** (-5.21)	-0.01*** (-3.16)	-0.05*** (-1.78)
Common dynamic process	-	-	-	-	0.59*** (3.18)

Post estimation tests for GMM					
Root Mean Squared Error	0.04	Groups/ Instruments	11/9	AR (2)	0.67
Sargan Statistic	0.51	Hansen Statistic	0.67		

Variable	*GMM*	*LSDV*	*LSDVC*	*MG*	*AMG*
Constant	0.60*** (8.36)	0.58*** (6.52)	-	0.70*** (4.88)	0.84*** (5.81)
pension $_{t-1,}$ ln	0.74*** (25.25)	0.74*** (19.55)	0.83*** (25.6)	0.67*** (2.38)	0.60*** (8.95)
d.elder	0.02*** (3.21)	0.03*** (3.65)	0.03* (1.88)	0.08** (2.38)	0.06* (1.89)
d.prod	0.01*** (2.03)	0.01*** (4.05)	0.01*** (2.81)	0.07* (1.69)	0.002 (0.66)
gdp	-0.02*** (-5.57)	-0.01*** (-3.92)	-0.01*** (-6.7)	-0.01*** (1.69)	-0.01* (-1.8)
Common dynamic process	-	-	-	-	0.56*** (3.17)

Post estimation tests for GMM					
Root Mean Squared Error	0.04	Groups/Instruments	11/9	AR (2)	0.920
Sargan Statistic	0.12	Hansen Statistic	0.42		

Notes: ***, ** and * are statistical significance at the 1%, 5%, and 10% levels, respectively; t-statistics (in parentheses) for GMM are based on White heteroskedasticity-consistent standard errors; p-values are reported for AR (2) and Sargan and Hansen statistic.

The main inference that can be drawn from the estimation results is that the convergence concerning public pension expenditure to GDP among the NMS in the period between 1996 and 2017 can be found in the panel. In all estimated models, the $(\alpha - 1)$ coefficient is significantly smaller than zero at a 1% level, indicating that

there exists a consistent negative relationship between the growth of pension expenditure to GDP and their initial levels.

Another demographic variable, the share of the elderly turned out to be significant in explaining the trends of the public pension expenditure to GDP. A one percent increase in the share of the elderly is expected to increase pension expenditure as a share of GDP by 0.02-0.08 percentage points, ceteris paribus. This is following the economic theory, showing a fiscal burden that population aging represents for pension systems. Other authors who have used the old-age dependency ratio instead, have come to the same conclusion, and this indicator has proved to have a strong influence on pension sustainability (Seshamani and Gray, 2002; Stensnes and Stølen, 2007; Verbič and Špruk, 2014). Furthermore, an indicator of pension systems' generosity, the replacement rate, is also significant. A one percent increase in the replacement rate would cause the rise of pension expenditure to GDP of 0.32-1.36 percentage points on average, depending on the estimator. Growth in the replacement rate directly causes a rise in pension spending. This is why a reduction in the generosity of the public pension system is often regarded as a solution to problems linked to the rapidly aging populations. Life expectancy at 65 in the first model proved insignificant. As expected, a rise in the growth rate of the gross domestic product has an inverse relation to the public pension expenditure to GDP at 1% or 10% levels in the estimated models. Lastly, a labor market indicator, the real labor productivity per employed person has also an expected negative relationship with the public pension expenditure to GDP in the first model, but positive in the second, due to the different regressors set.

In the presented GMM models, groups outnumber instruments, so the rule of thumb of keeping the number of instruments less than the number of groups is satisfied. The results of Sargan and Hansen's tests for overidentifying restrictions suggest that the null hypothesis cannot be rejected, indicating that the exclusion restrictions are valid. The null hypothesis of the Arellano and Bond (1991) test for autocorrelation assumes no autocorrelation and is applied to the differenced residuals. The test for AR (1) process in the first differences usually rejects the null hypothesis, which is the case in this analysis as well. However, the test for AR (2) in first differences is more important, because it detects autocorrelation in levels. The corresponding null hypothesis could not be rejected, so diagnostics of both GMM models are satisfactory. Although this estimator does not fit the type of the panel, serving as a robustness check, its results confirmed the conclusions obtained by other estimates.

5. Conclusion

The aim of this paper is twofold. First, we analyze the impact of various macroeconomic, demographic, and institutional variables on public pension expenditure to GDP in the New Member States of the European Union in the period between 1995 and 2017. Second, because of similar demographic and economic challenges that the pension systems of the chosen economies are facing, and their response to these challenges, we hypothesize there exists convergence in pension spending among these economies and examine it empirically. Econometric analyses were performed by using dynamic panel data models that enabled a simultaneous

examination of convergence and identification of the main determinants of public pension expenditure in the analyzed period. Aside from conditional beta-convergence, which our panel data model tests, sigma-convergence and absolute beta-convergence are examined. Since the time dimension of our panel was greater than the cross-sectional dimension, the LSDV and LSDVC estimators are used, which were recommended in studies based on Monte-Carlo simulations for long panels. As a robustness check, System GMM, MG, and AMG estimators are used.

The main inference that can be drawn from the estimation results is that convergence can be found in the panel. In all of the estimated models, the convergence coefficient is significantly smaller than zero at a 1% level, indicating that there exists a consistent negative relationship between the growth of public pension expenditure to GDP and their initial levels. The share of elderly in the total population and the replacement rate are significant and positive determinants of the public pension expenditure to GDP. Growth in the replacement rate directly causes a rise in pension spending. This is why a reduction in the generosity of the public pension system is often regarded as a solution to problems linked to the rapidly aging populations. As expected, a rise in the growth rate of the gross domestic product is inversely related to public pension expenditure to GDP. Lastly, real labor productivity per employed person has an ambiguous relationship with the public pension expenditure to GDP. Turning to sigma- and absolute beta-convergence, both have been confirmed by the results. The coefficient of variation indicates a decreasing dispersion over time. As a preliminary indication of absolute beta-convergence, a scatter plot shows an inverse relationship between the initial level and the growth rate of pension expenditure as a share of GDP, and this is confirmed by simple regression analysis.

This paper contributes to the existing literature in two ways. To our knowledge, it is the first that examines convergence in public pension expenditure among the NMS. As opposed to numerous studies on welfare state convergence that concentrate on OECD economies and the Old Member States due to the limited availability of data, we find evidence of convergence in this important segment of public finances. Second, our results emphasize demographic and economic factors that are key for understanding pension spending, providing an important guideline for policies aimed at increasing the sustainability of public pension schemes.

Several limitations, however, should be taken into account. The first limitation refers to data unavailability, which is why we estimated an unbalanced panel data model. The second limitation of empirical studies naturally includes the selection of variables, since the list of variables can always be longer. Third, the paper has focused only on the New EU Member States. Future research could further develop and confirm these initial findings by using a different or a broader set of variables for constructing a sample encompassing both Old and New EU Member States or developing economies. Fourth, this paper addresses only a small part of the complexity of the pension systems, and there is scope for future research. We encourage future studies to consider these issues more carefully.

There are many recommendations from this study. First, our estimates confirm the convergence hypothesis of the public pension expenditure to GDP among the NMS in the observed period. Driven by similar demographic and economic challenges, the NMS are directing pension systems reforms to maintain

trends in public pension expenditure, leading to a more uniform pension system framework. Second, our data prove the fiscal burden that population aging represents for pension systems of the NMS because the share of the elderly is a significant determinant. Therefore, the shift focuses on parametric reforms of the PAYG scheme, which means that the countries are on the right track, gradually raising the statutory retirement age for both genders and defining stricter conditions for early retirement. Third, according to the estimates, the generosity of the pension system represented by the replacement rate also plays a major role. However, public policies cannot be aimed at reducing pension benefits but should encourage improving labor market conditions both on the micro and macro level, to increase wages and, consequently, pensions.

Table A1 Description of Variables

Variable	*Mnemonic*	*Definition*	*Source (Period 1995-2017)*
Public pension expenditure as a percentage of gross domestic product	*pension*	Public pension expenditure to GDP includes all cash expenses on old-age and survivors pensions divided by GDP.	Eurostat. National statistical offices and pension insurance offices for Bulgaria (1995-2004), Croatia (1995-2007), Estonia and Hungary (1995-1998), Latvia (1995 and 1996), Lithuania and Slovenia (1995), and Poland and Romania (1995-1999).
The average effective age of retirement, weighted	*age*	The average effective age of retirement is defined as the average age of exit from the labor force for 5 years.	OECD for average effective retirement age. Weights were obtained using the Eurostat data for the number of men and women aged 55-69, which is considered an early retirement "window" when all countries are observed together.
Share of the elderly population	*elder*	The share of the elderly population is calculated as a total of persons aged 65 and over, expressed as a ratio of the total population.	Eurostat. National statistical office for Croatia (1995-2000).
Gross domestic product annual growth rate	*gdp*	GDP growth is the rate of growth of the value of all final goods and services produced within a state in a given year.	OECD. World Bank for Bulgaria, Croatia, Latvia, Lithuania, Romania and Slovenia (1995).
Labor force participation rate	*labor*	Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period.	Eurostat. World Bank for Bulgaria (1997), Croatia (1998, 2000-2002), Czech Republic, Poland and Romania (1995-1997), Latvia (1996), and Estonia, Hungary, Slovakia, and Slovenia (1995-1996).
Life expectancy at age 65, weighted	*life*	Life expectancy at age 65 is the average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant.	World Health Organization. Eurostat for 2017 for all countries and weighting data. Weights were calculated as a share of men and women aged 65 in each year, each country.
Net migration rate	*migr*	The net migration rate represents the difference between the immigrants and emigrants during the year, per 1,000 persons (based on midyear population).	Eurostat. World Bank and the International Labor Organization for Bulgaria (1995-2000).
Real labor productivity per person employed	*prod*	Labor productivity represents output (in terms of GDP) produced per unit of labor (in terms of the number of employed persons) during a given time reference period.	Eurostat.
Replacement rate	*repl*	The replacement rate is the percentage of an employee's pre-retirement monthly income that an employee receives after retiring.	Eurostat. Data before 2005 are proxied by the average pension to average wage ratio. These data were obtained from national statistical offices and pension insurance offices.
Unemployment rate	*unemp*	Unemployment refers to the share of the labor force that is without work but available for and seeking employment.	Eurostat. World Bank for Bulgaria (1995-1999), Croatia (1995-2001), Czech Republic, Estonia, Poland and Romania (1995-1996), Hungary and Slovenia (1995), and Latvia, Lithuania and Slovakia (1995-1997).

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