

The Contributions of Demographic Factors to Economic Growth

Wpływ czynników demograficznych na rozwój ekonomiczny

Mykola Pasichnyi*, Anton Nepyталиuk**

**Faculty of Finance and Accounting, Department of Finance,
Kyiv National University of Trade and Economics, Ukraine*

E-mail: m.pasichnyi@knute.edu.ua, ORCID: 0000-0001-7663-776X

***Faculty of Economics, Department of Management and Behavioral Economics,
Vasyl' Stus Donetsk National University, Ukraine,*

E-mail: anton.nepyталиuk@gmail.com, ORCID: 0000-0002-7890-3889

Abstract

In this paper, an updated approach to evaluate the contribution of demographic factors to economic development is proposed. The forecasted shifts in public production were considered with respect to the institutional framework. The relationship between the main demographic variables and the economic growth for the sample of 45 advanced and emerging market economies from 1990 to 2018 was examined, applying the unbalanced panel data method. Over the period, in the sample, an essential increase in life expectancy adversely affected the real GDP per capita growth rate. The empirical investigation pointed out that the above demographic variable was strongly linked to nominal GDP per capita. In advanced economies, the examined demographic indicator was considerably higher than in emerging ones. We found out that an increase in the working-aged stratum substantially reduced the real GDP dynamics, but that interconnection was not robust. In the long-run, the institutional framework should be taken into account to achieve favorable public performance. Demographic variables should be forecasted and calibrated, regarding the endogenous economic triggers. Both public and private investments matter.

Key words: demographic dividend, population, human capital, demographic sustainability, economic growth

Streszczenie

W artykule zaproponowano zaktualizowane podejście do oceny wkładu czynników demograficznych w rozwój gospodarczy. Prognozowane zmiany w produkcji publicznej rozpatrzono w kontekście ram instytucjonalnych. Zbadano zależność między głównymi zmiennymi demograficznymi a wzrostem gospodarczym dla próby 45 rozwiniętych i wschodzących gospodarek rynkowych w latach 1990-2018, stosując metodę nierównoważonych danych panelowych. W badanym okresie istotny wzrost średniej długości życia niekorzystnie wpłynął na dynamikę realnego PKB na mieszkańca. Badanie empiryczne wykazało, że powyższa zmienna demograficzna była silnie powiązana z nominalnym PKB na mieszkańca. W gospodarkach rozwiniętych badany wskaźnik demograficzny był znacznie wyższy niż w gospodarkach wschodzących. Okazało się, że wzrost liczby osób w wieku produkcyjnym znacznie zmniejszył dynamikę realnego PKB, ale połączenie to nie było silne. W perspektywie długoterminowej należy wziąć pod uwagę ramy instytucjonalne, aby osiągnąć korzystne wyniki publiczne. Należy prognozować i kalibrować zmienne demograficzne z uwzględnieniem endogenicznych czynników ekonomicznych. Liczą się zarówno inwestycje publiczne, jak i prywatne.

Słowa kluczowe: populacja, kapitał ludzki, zrównoważoność demograficzna, rozwój ekonomiczny

Introduction

There are reasons to investigate the population's impact on economic development – with its inherent social and demographic characteristics – regarding the growth theories. Firstly, the actual level of public welfare is described only through human consciousness. Secondly, a particular person with its desires and needs forms the tasks for public production. So, the population plays the roles of the aggregated producer and consumer of goods and services simultaneously. The agent's economic behavior causes and, at the same time, is caused by the upper interests, which are represented by the social groups (e. g., nations, economic classes, strata). The crucial changes in the population's number, density, and age structure affect public production. Passed through the centuries of slow and uneven growth, the world population reached 1.0 billion nearly two hundred years ago. Before the first so-called demographic transition, expected human life was critically short, both births and deaths were countless, while the population was generally young. After the transition mentioned above, mortality and eventually fertility severely declined; the population growth rates accelerated and then – considerably unequal for advanced and emerging countries – lowered again, matching low fertility, extended life span, and an aged population. In the second half of the past century, the total population growth rate accelerated. The global demographic changes have brought decisive transformations, reshaped both the economic and demographic life-cycles of the individuals and restructured communities. The current world population exceeds 7.7 billion, and its expansion is predicted to be persistent at least for several upcoming decades.

The above situation proposed a plethora of economic, social, and ecological issues (e. g., the societal costs of the elderly, the generations' responsibility redistribution, the lack of material provision, the global pollution, etc.). The population's characteristics were significant economic growth determinants. So, their composite effect on the development is everlasting and should be adequately examined. The issues related to the key economic growth factors have been at the center of economics since its origin. Five centuries of profound investigations produced several sustainable development theories, but the uncertainty still remained. In the vast majority of those theories, the main demographic variables are regarded as endogenous determinants. In the majority of those theories, the demographic variables are regarded as endogenous determinants. Firstly, each and every individual possesses a unique combination of productive capacities that should be considered as a part of human capital. Secondly, the population is jointly characterized by enormous economic potential, eventually resulted in GDP. Thus, modern demography and economics merged to produce some

methodological and practical statements on production improvement. Even though demographic issues are commonly associated with the rates of fertility and mortality, in this article, we exposed the demographic variables in a broad sense, including the aggregated knowledge, the purposeful skills of the workforce, the educational, and the public health potentials, etc. Some of the aforementioned characteristics are overlapped, so there is a crucial need to identify and to separate their impact on the development processes.

The everlasting shifts into the demographic structure have enabled the economies to convert the considerable part of the benefits from factor accumulation and technological changes into real income per capita growth. The labor productivity and the development processes were generally enhanced via three main channels. Firstly, the downtrend in population growth has simultaneously limited the stock dilution and increased the number of resources per capita. Secondly, the lowered fertility sanctioned the resources reallocation from the number toward the quality of children, intensifying both the human capital formation and total labor productivity. Finally, the essential fertility rates' reduction modified the population's age distribution. Thus, if the labor force fraction in the population was temporarily increased, the productivity per capita had been raised mechanically.

The comprehensive influence of the population change on economic development and performance is somewhat ambiguous. The population growth could be supportive, restrictive, or neutral to economic growth. The population numbers and density's variation are commonly interconnected with considerable shifts into the respective community's age structure (described as the population's distribution across different age groups). The agents' behavior (e. g., economic) enormously varies depending on the stages of the individual's life. Hence, the nations with a high proportion of children are supposed to devote most of their inherent resources to the childcare programs. That fact depresses the economic growth in the short-run, but could be interconnected with intensified human capital acceleration in the strategic perspective. Contrastingly, if most of a nation's population belongs to the working-age stratum, the expanded productivity of the above group is able to produce the so-called *demographic dividend*. If the nation's population consists of the elderly, the effects can be reversed. In a particular situation, the result can be similar to the case of an extremely young population, when a significant share of resources is generally consumed by a relatively unproductive stratum, inhibiting economic development. The elderly population, due to the plurality of factors (e. g., effective public health care, etc.) can maintain productive capacity and demonstrate significant labor efficiency.

A demographic dividend should be appropriately assessed regarding both productivity and consumption. In contemporary scientific discourse, the above, as mentioned earlier, exists in two different forms. Its *first* form is caused by an increase in the share of the nations' working-age population. The economic agents form the crucial factor responsible for the development. So-called *second* dividend is much difficult for the examination. A rapid growth in the elderly population stratum presumably strains the financial and health care systems. That fact led to rather pessimistic forecasts concerning future economic performance. However, the nation's aging can be a source for the *second* dividend rather than an economic decline. While the productive population stratum is declining, the vital challenge for both the aging and the aged societies is to provide the most preferred framework for the specific old-age consumption and to achieve the desirable welfare.

Demographic dividends are indirect growth factors; their scale is primarily dependent on the public institutions' quality. The predictable weaknesses of the pension programs (e. g., the unsustainable enlargement in public pension benefits or unfavorable tax evasion) could offset plenty of the anticipated demographic dividends. If the major part of the expansion in labor supply is mostly concentrated in the non-formal sector, which does not contribute to social security, it can induce considerable imbalances and the decline in public welfare. The most significant for the sustainable growth demographic variables are represented by the qualitative and quantitative parameters of the working-age stratum. But the age dependency ratio does not represent the only characteristic that vitally matters. Both the fertility and mortality fluctuations affect the average life expectancy and determine the age distribution between the groups of the population. Although extended life expectancy is mutually interconnected with life quality, it often reshapes public finances and potentially induces the tax burden. The human capital's quality critically depends on the aggregate public and private productive spending. So, the model for sustainable economic growth should combine the elements related to human and physical capital creation.

Development trends in both advanced and emerging market economies are incomparable. Regarding a range of factors, amid the groups under study, a subgroup of commodity economies should be specified. Even though all the economies are dependent on similar endogenous development triggers, the scale and the proportion of the mentioned determinants significantly vary. We examine advanced and some emerging economies over the periods of institutional transformation and sustainable growth. We highlighted the widespread impact of the expansion in the working-aged stratum and the extended life expectancy on economic development.

Literature review

Reconsidering the Romer's conceptual model of endogenous technical change (1990), Malmberg (1994) suggested to combine it with human capital and the life-cycle of savings theories and argued that the population's age structure vitally mattered. Due to the analysis of the changes in the agents' financial behavior and human capital accumulation over the life-cycle, a theory of the economic growth effects' age pattern was generally disclosed. Bloom, Canning and Sevilla (2001, 2003) investigated the population change's impact on economic growth considering the possible positions that population growth restricted, promoted, or appeared to be neutral to the development trends. Not only the population's number and growth rate impacts on the economic performance were identified, but the age structural effects as well. The agents' behavior was described as tremendously dependent on the above-mentioned structure. On the theoretical concept of a demographic dividend, the general conclusion that the effect of an optimal working-age population combined with proper health care, educational, financial, and human capital policies could initiate virtuous cycles of wealth creation was made. Taking an enormous range of empirical cases into account, the evidence on the age structure shifts relevance for sustainable growth was emphasized. The demographic dividend concept was developed by Bloom, Canning, Fink and Finlay (2007, 2009). The age structure was regarded as the crucial economic growth's determinant and the main forecast objective. Boucekkine, de la Croix and Licandro (2002) identified and investigated the fact that endogenous growth was prompted by the generation-specific human capital accumulation. While advantageous shifts in the survival probabilities induced extended schooling period and relatively late retirement, their overall effect on economic growth was ambiguous. Generally, the observed demographic variables had significant medium-term economic effects, but the numerical interdependencies over the strategic perspective appeared to be not robust.

Lee (2001, 2003) outlined the main evidence of the demographic transition and the corresponding issues over the last three centuries. Regarding the data on the interrelations between population shifts and fiscal policy performance, the possible demographic changes, and their economic consequences for different types of economies were sketched. Considering the human capital theory, numerous articles were dedicated to the essential social and demographic determinants of both economic and population growth. Gador (2012) studied the main demographic theories' empirical validity and their relevance for the sound understanding of the transition from the stagnation phase to sustainable growth. A noteworthy increase in the aggregated demand for human capital in the development process was suggested to be the

main trigger for fertility reduction as well as the transition to the actual growth rates. Acemoglu and Johnson (2007); Hansen and Lønstrup (2015) explained that an increase in the life expectancy over the second part of the XXth century simultaneously reduced the real GDP per capita growth rate and fostered population growth. That binary conclusion was based on the fact that – due to the medical breakthroughs – lots of advanced countries have experienced high growth rates in life expectancy and population size combined with relatively low growth rates in per capita GDP. Considering the empirical evidence from the Western economies during the past century, Fernihough (2017) argued the demographic transition's importance as a supporting mechanism for the expansion in human capital. The education's impact on fertility rates and human capital accumulation was examined as well.

Lucas Jr. (2015) explored an aggregate innovative potential of the nation as a result of knowledge creation, based on consistent schooling and skills improvement. The actual knowledge management's role was dependent on the initial level of the country's economic development and the institutional framework's quality. Barro and Lee (2013) pointed out how the output was related to the stock of human capital, determined by the total years of schooling and by the composition of the workers' educational attainment. Schooling had a significantly positive effect on the GDP dynamics, while it mainly optimized the endogenous interrelations between the main components of the growth processes.

Considering human capital production and accumulation, some significant conclusions were made. Using the panel data method, Pelinescu (2015) substantiated the value of a good education and a flexible training system for sustainable economic growth. Knowledge diffusion in manufacturing goods and services, creative industries and rather explicit efforts to establish a research-intensive economy were identified as the main triggers for strategic development. Hanushek (2015) examined the possibilities for tertiary education based improvement in public production. No robust interdependencies between the mentioned indicators were obtained. Nevertheless, the reasonable effects of schooling were observed. Ahsan and Haque (2017) refuted the hypothesis that the number of completed years of education was unrelated to the growth dynamics. According to their empirical study, a decisive influence of schooling could be discerned after exceeding a threshold development level by a particular economy.

Using a growth model with integrated variables from the supply and demand side, Teixeira and Queirós (2016) evaluated both the direct and implicit human capital effects on output growth, tacking the interaction of human capital with the country's industrial specialization into account. The above factors were identified as the main economic growth determinants. Development was strongly affected by the

composite effect of human capital applications and structural change in the high knowledge-intensive industries. The sign of the observed effect was genetically dependent on the type of economic model and the period under investigation. Over the 1960-2011 period, for the OECD countries, the cumulative impact of the interaction between human capital and structural change in the respective economy was positive. Nagarajan, Teixeira and Silva (2016) examined the literature regarding aging and its tremendous impact on economic growth. They pointed out the profound mechanisms by which aging accelerated development. Applying the proper mathematical methods, Uddin, Alam and Gow (2016) examined the population's saving behavior regarding the age structure, dependency ratio, savings rate, real GDP, etc. The negative effect of the aging for the developed economies was statistically validated. McGrath (2016) stated that the indicators of GDP, capital stock and human capital were co-integrated. While the causalities from GDP to capital stock as well as from capital stock to human capital were bidirectional, the causality from GDP to human capital appeared to be unidirectional, but not vice versa. As a result, the hypothesis that growth was prompted by human capital has been generally refuted.

Focusing on the divergence in the mortality rate for comparative investigation, Cervellati and Sunde (2015) argued the unified development theory – covering both demographic and economic issues – and studied the respective transition's mechanics. The obtained results highlighted a significant part of the differences in economic development (e. g., the timing of the takeoff) across the states under study and the worldwide density distribution of the main variables. Acemoglu and Restrepo (2017) questioned the negative impacts of the aging society on economic growth. The principal theoretical statements on the aging population's adverse effects on the growth were empirically investigated. Both the lower labor force participation and the production decrease of the older employees were considered. The hypothesis that aging had a negative influence on the savings-to-investment ratio and led to secular stagnation was refuted. It should be noted that the authors applied the unique methodology: all the population older than 50 years were identified as *aged*, irrespectively its productive activity and behavior. Cooley, Henriksen and Nusbaum (2019) pointed out the persistent deceleration in the economic growth rates of the four largest advanced economies in Europe impacted by a shift in the age-cohort distribution. Defining the composite demographic impact-factors on the economic growth, some interdependencies between the aggregated factor productivity, capital accumulation, labor force supply, and population growth rates were disclosed. It was proved empirically that the effects of the aging population on economic growth were a distortion to the individual factor-supply choices, regarding the pension systems.

Ahmad and Khan (2019) investigated whether the above transition and the dynamics of human capital mattered for the growth of the developing world. The economically active population and the labor force participation rate produced a positive lagged contribution to economic growth.

Regarding the shift in developed countries from industrial to knowledge economies, Faggian, Partridge and Malecki (2017) studied the underlying causes of the immanent economic development. The preconditions for the growth were referred to the intensified creativity, the sound entrepreneurship environment, and expanded human capital, etc.; those factors were interconnected with the nation’s demographic parameters. While the relation between intellectual capital – measured by the educational attainment – and the entrepreneurship environment (characterized by the intensity of small and medium-sized companies) appeared to be statistically interconnected with subsequent development, the other determinants (e. g., the share of creative class workers, the share of advanced technology industries) were labeled as insignificant. Cuaresma, Doppelhofer, Huber, and Piribauer (2018) assessed the potential contribution of the distant schooling attainment to economic development and the national income convergence. It was proposed that the income dynamics and human capital acted as the important drivers for the real income growth.

Methods and data

Even though sustainable economic growth is dependent on the dynamic interrelation between economic and demographic factors, their comprehensive effect could be described by a *production function (1)*:

$$Y = f(x_1, x_2, \dots, x_n), \tag{1}$$

where Y – the national production capacity or annual economic growth;

x_1, x_2, \dots, x_n – the most essential economic and demographic factors.

The above determinants are considerably interconnected with the category of human capital. All the vital components of the above category are inseparable and critically overlapped. In this investigation, we considered that the production of public goods and services is defined by the *general Cobb–Douglas function (2)*.

$$Y_{ij} = A_{ij} * L_{ij}^\alpha * K_{ij}^\beta, \tag{2}$$

where Y_{ij} – the real GDP of the country j in the year i ; A_{ij} – the total factor productivity coefficient of the country j in the year i ;

L_{ij} – the labor input of the country j in the year i ;

K_{ij} – the capital input of the country j in the year i ;

α, β – the output elasticities of labor and capital, respectively, while $\alpha + \beta = 1$.

From the strategic perspective, economic growth is hugely dependent on the compositional structure of the recourses actual application, aimed to encourage the agents’ voluntary activity. The demographic dependent expands generally affect economic activity, determining its scale and shape. Even though the investigated recourses theoretically could be described as the general substitutes, the evidence that the system’s added potential emerges from the combination of its components occurred. In another way, the system’s potential could be described by *the system (3)*, where the emergent potential significantly matters:

$$\begin{cases} P[B] \neq \sum_{i=1}^n b_i; \\ P[B] = \sum_{i=1}^n b_i + \sum_{j=1}^m b'_j \end{cases} \tag{3}$$

where $P[B]$ – the total potential of the examined system;

b_i – the potential of the economic systems’ i -th element;

b'_j – the emergent potential of the j -th interconnection between the systems’ components.

In the relevant conditions, all the production factors should be considered as the imperfect complements, and public welfare could be identified by the real annual GDP per capita growth rate. The latter is enormously dependent on the fundamental productive factors, e. g. physical and human capital. If the real GDP per capita growth rates are decomposed into several conditionally independent variables, the *multiplicative function 2* and considering the *system (3)* can be transformed into *the additive one (4)*:

$$growth_{ij} = \gamma_0 + \gamma_1 demogr_{ij} + \gamma_2 hum_cap_{ij} + \gamma_3 contr_{ij} + \varepsilon, \tag{4}$$

where $growth_{ij}$ – the real GDP per capita growth rate of the country j in the year i ;

$demogr_{ij}$ – the demographic variables of the country j in the year i ;

hum_cap_{ij} – the other human capital variables (indirectly related to demographic ones) of the country j in the year i ;

$contr_{ij}$ – the economic controls (related to the physical capital) of the country j in the year i .

Traditionally, all the demographic variables are interconnected with the fertility and mortality rates. The population’s dynamics is not dependent only on the natural factors, but on the mechanical / unpredictable (e. g., migration) ones as well. We believe that the overall demographic impact on economic growth is represented by the changes in the working-age stratum and expected life span dynamics. Thus, the demographic variables in this study consist of the working-age population growth rate ($WAPop_{gr}$) and the average life expectancy growth rate ($LifeExp_{gr}$). The composite public and private expenses represent the other essential economic growth determinant on research and development activities ($RD\%_{GDP}$), considered as a percentage of GDP.

We impose two controls: public expenditures ($Pu\text{-}bExp\%GDP$) and total investment ($TInv\%GDP$) as the percentages of GDP. Public spending generally characterizes the scale of the GDP redistribution and the government's role in welfare creation. The above variable supposedly aggregates both the productive expenses (related to the human capital formation) and the other spending with an ambiguous impact on economic growth (considered as unproductive). Aggregating public and private financial activity simultaneously, the total investment indicator is related to the physical capital production of the *Cobb–Douglas model* (2).

We used a panel data analysis, which covered 45 advanced and transitional economies over the 1990-2018 period. The sample included 36 significantly different economies of the OECD states and Armenia, Belarus, Bulgaria, Croatia, Georgia, Kazakhstan, Romania, Russian Federation, and Ukraine. Regarding the critical lack of information on several emerging markets over the early 1990s, the panel data appeared unbalanced. Regarding the fact that the majority of the investigated emerging economies had successfully conducted institutional and structural reforms before joining the EU (its formation generally ended around 2004-2005), we examined two periods of 1990-2004 and 2005-2018 separately. The sources of the empirical data were represented by the World Bank's and the IMF's bases. Some essential data were drawn from the OECD and the European Commission's bases. Summary statistics data for the sample regarding three time periods are represented in Table 1.

Over the 1990-2018 period, the analyzed indicators varied critically. While the volatility of the public expenditures-to-GDP ratio was slightly reduced, the volatility of the other examined characteristics essentially increased. The highest standard deviation indicated the aforementioned ratio, which was equalled 9.53 %. That fact was due to the extraordinary differences in the sampled states' institutional framework, fiscal policy and economic model.

Results

In the long-run, sustainable growth is generally described as the economic policy's ultimate and upper objective. Different demographic variables are integrated into the development of national programs and strategies as their significant indices. Yet, the actual role of the above characteristics as the growth triggers remained undisclosed. Set by the respective authorities due to their electoral obligations in case of mutual interconnection between political and business cycles, some declarative goals in the distinct fields (e. g., demographics, public finances, etc.) can contradict each other and deteriorate the analyzed system's effect. Given the above, a complex investigation of both demographic and the other fac-

tors' contribution to economic growth was carried out.

Sanchez-Romero, Lee and Prskawetz (2018) proclaimed that the differences in life expectancy could be observed not only between the different countries but between the high and low socioeconomic groups. That hypothesis is profound when societies with significant inequality are analyzed. In our investigation, both life expectancy and economic development indicators were regarded as the universal characteristics of a particular population. Figure 1 represents the interrelation between the mean GDP per capita (in the current US\$) and the total life expectancy at birth (in years) in the mentioned sample over the 1990-2018 period. The observed interdependency appeared to be significant and robust ($R^2 = 0.59$). Considering the data on the mean GDP per capita, the sample was divided into three sub-samples. The 1st sub-sample included the states with the mean GDP per capita lower than 12 500.00 US\$, the 2nd sub-sample – the countries with the mean GDP per capita from 12 500.01 US\$ to 37 500.00 US\$, and the 3rd sub-sample – the countries with the mean GDP per capita higher than 37 500.01 US\$.

The majority of the post-Soviet states belonged to the 1st sub-sample due to their endogenous social and economic conditions in the early 1990s. The 1st sub-sample included Chile, Mexico, and Turkey as well. Over the entire period, Slovenia appeared to be the only post-Soviet-influenced country with a high average GDP per capita (equalled to 16 350.55 US\$). Regarding the sample, the countries of the 1st sub-sample were characterized by the lowest average life expectancy: the indicator changed from 67.47 years in Kazakhstan to 75.74 years in the Czech Republic. The average life expectancy in Slovenia (77.05 years) was lower than the same indicator in Chile (77.09 years). In the 2nd and the 3rd sub-samples, the interconnection was generally identical, but its statistical density appeared to be weak. The highest average life expectancy was observed in Japan (81.60 years). Australia, Italy and Spain (from the 2nd sub-sample) as well as Iceland, Sweden, and Switzerland (from the 3rd sub-sample) formed a group of countries with the average life expectancy that exceeded 80.00 years. Kazakhstan, Russian Federation, and Ukraine formed the group of states with the lowest average life expectancy that did not exceed 70.00 years. The last group was also marked by the lowest GDP per capita.

In the sample, Luxembourg was marked by an enormously high mean GDP per capita (equalled to 75 790.35 US\$). The indicator rose from 34 645.14 US\$ in 1990 to 116 639.89 US\$ in 2018. The life expectancy varied from 75.01 years to 82.74 years, respectively. We did not exclude the data on Luxembourg from the sample, but that case has been considered as essential for the analysis. It should be mentioned that the standard deviation of the average life expectancy at birth was equal to

Table 1. Summary statistics, source: Authors' own calculation based on IMF, World Bank, European Commission and OECD data.

Variables	Period	Observations	Mean	Standard deviation	Max	Min
$GDPpc_{gr}$	1990–2018	1077	2.36	3.63	23.99	-14.56
	1990–2004	465	2.89	3.25	15.31	-12.16
	2005–2018	612	1.90	3.88	23.99	-14.56
$LifeExp_{gr}$	1990–2018	1077	0.31	0.38	2.34	-1.59
	1990–2004	465	0.31	0.37	2.34	-1.59
	2005–2018	612	0.30	0.38	2.10	-1.03
$WAPop_{gr}$	1990–2018	1077	0.34	0.93	4.93	-4.08
	1990–2004	465	0.48	0.85	4.93	-4.08
	2005–2018	612	0.23	1.00	3.03	-2.48
$R\&D\%GDP$	1990–2018	1077	1.51	0.93	4.58	0.08
	1990–2004	465	1.41	0.81	4.19	0.19
	2005–2018	612	1.58	1.01	4.58	0.08
$PubExp\%GDP$	1990–2018	1077	41.37	9.53	68.03	13.79
	1990–2004	465	42.22	9.89	68.03	13.79
	2005–2018	612	40.68	9.06	65.05	18.63
$TInv\%GDP$	1990–2018	1077	23.70	4.42	43.81	10.22
	1990–2004	465	23.70	4.01	39.02	11.89
	2005–2018	612	23.70	4.99	43.81	10.22

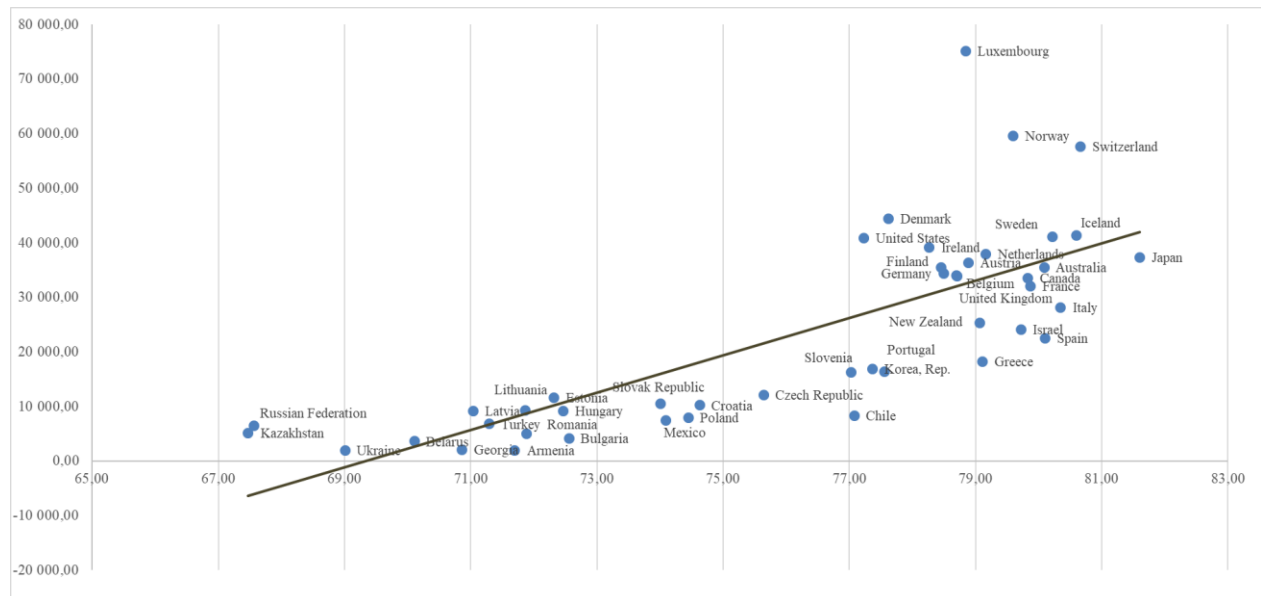


Figure 1. The average GDP per capita and the total life expectancy at birth in selected countries over the 1990-2018 period, source: The authors' own calculation based on World Bank data

3.96 years, while the same characteristic of mean GDP per capita equaled 17 780.53 US\$. Over the period, the total life expectancy in most advanced countries has achieved biological limits. The GDP per capita varied crucially. The results of the above analyses should be regarded in the subsequent investigation.

As it was proved, demographic variables have affected economic growth. Bloom et al. (2007) showed that the expansion in the world's population was primarily observed in the non-working-age stratum. That fact influenced both the agents' consumption and investment behavior and reduced growth. According to Pasichnyi et al. (2019), in advanced and

emerging economies, an increase in the total population number had a negative influence on their development. That situation was generally prompted by the negative shifts in the structure of the population's age. The influence of the human development index on the resultative variable unexpectedly appeared to be reversed.

Regarding the sample and the period, the real GDP per capita growth rates were unsustainable and dependent on the interconnections between the economic development factors. Over the 1990-2018 period, all the analyzed variables appeared to be significant (see Table 2, *OLS1*), while the demographic variables were harmful to economic development. If

Table 2. Regressions of economic growth on demographic variables and controls, the sample of 45 countries, 1990-2018, unbalanced panel

Variables	Period		
	OLS1	OLS2	OLS3
<i>LifeExp_{gr}</i>	-1.228* (0.268)	-0.355* (0.366)	-1.833* (0.364)
<i>WAPop_{gr}</i>	-0.579* (0.107)	-0.940 (0.162)	-0.624* (0.147)
<i>R&D%GDP</i>	-0.452* (0.115)	-0.551* (0.177)	-0.224 (0.147)
<i>PubExp%GDP</i>	-0.073* (0.012)	-0.078* (0.015)	-0.093* (0.017)
<i>TInv%GDP</i>	0.235* (0.023)	0.119* (0.035)	0.288* (0.029)
<i>R²</i>	0.219	0.195	0.278
<i>N</i>	1077	465	612

Notes: The numbers in parentheses are the standard errors of the estimated parameters.

* ** denotes significance at a 1 percent level. R^2 is the adjusted coefficient of determination.

the average life expectancy rose by 1.00 %, the decline in the real GDP per capita was equal to 1.23 %. It should be explicitly mentioned that the lowest volatility characterized the life expectancy growth rate. Its standard deviation equaled to 0.31 % and proved a slight growth over the period in almost all the countries of the sample. The decline in the above indicator was observed in Iceland in 1995. It was associated with a reduction in the real GDP per capita growth rate. The indexes under study were equal to -1.59 % and -0.43 %, respectively. Over the entire period, the highest life expectancy annual growth rate was identified in Croatia (2001). It was accomplished by rather high economic growth. The above variables equaled to 2.34 % and 7.51 %, respectively. The connection between the examined indicators was uneven and ambiguous due to the complex nature of the life expectancy growth rate, which was related to the life quality and the public finances' architectonics simultaneously.

Considering the periods of 1990-2004 (OLS2) and 2005-2018 (OLS3), in both cases, the impact of the life expectancy growth rate on economic development was negative and statically significant. Hence, an increase in the life expectancy growth rate by 1.00 % declined the real GDP per capita growth rate by 0.36 % and 1.83 %, regarding the period under study. The difference could be caused by the lack of information on some emerging economies over the 1990-1995 period.

Over the 1990-2018 period, the working-age population growth rate negatively affected economic development. Over the 1990-2004 period, if the working-age population growth rate increased by 1.00 %, the real output per capita growth rates reduced by 0.94 %. Regarding the same time-scale, the variable under study appeared to be statistically insignificant. Over the 2005-2018 period, if the working-aged stratum expanded by 1.00 %, the real output per capita growth rate reduced by 0.62 %, while the interrelation between the above variables was significant.

Consequently, over the 1990-2018 period, the interconnection vitally mattered and was negative. If the working-age stratum expanded by 1.00 %, the reduction in the GDP per capita growth rate equaled to 0.58 %. Over the entire analyzed period, the average annual working-aged stratum expansion equaled to 0.34 %, while the standard deviation was 0.94 %. Comparing the periods of 1990-2004 and 2005-2018, the average annual working-aged stratum growth rates equaled to 0.48 % and 0.23 %, respectively. Hence, it should be noted that an insufficient increase in the working-aged population accomplished by sustainable life expectancy growth produced the nation's aging.

Research and development expenditures (henceforth – R&DE) combined both public and private productive spending, closely associated with an increase in intellectual capital. The investigated interconnection between R&DE and the actual economic development level has been enormously dependent on a plethora of determinants. Generally, R&DE are regarded to be productive, but their comprehensive effect on the economy's development level should be adequately investigated. The structure of R&DE can deny the main aims of development. If the most significant advantages were received via direct government grants, the national economy could be determined as paternalistic. The data proved that their actual expansion was indifferent and rather negatively interconnected with the growth. Over the period, an increase in the R&DE-to-GDP ratio by 1.00 % declined the real GDP growth rates. In that case, the annual decline in the resultative variable was equal to 0.45 %.

Regarding the periods under study, the dynamic interrelation between the R&DE-to-GDP ratio and the real output growth rate was significant over the 1990-2004 period. The statistical significance of the investigated interconnection rapidly declined and appeared to be insignificant. Considering the 1990-2004 period, an increase in the R&DE-to-GDP ratio

by 1.00 % was accomplished by the reduction in the GDP per capita growth rate, which was equaled to 0.55 %. Over the 2005-2018 period, regarding the numerical investigation, the observed interrelation between the R&DE-to-GDP ratio and the real economic development rate was insignificant.

In line with Barro and Sala-i-Martin (2003), public expenditures could be and should be split into two separate groups, considering their overall impact on the production dynamics: the productive and the opposite. According to the data, the non-productive public spending causes a crucial decline in the real output. The above ratio was detrimental to economic development, considering the time-scales. The adverse impact of the investigated variable was observed, considering both advanced and emerging economies. The variable under investigation was enormously dependent on the national economy's model and the institutional framework's quality. Regarding an extended period and the sample's quality, the public spending-to-GDP ratio extremely varied. Its standard deviation changed from 9.89 % (1990-2004) to 9.06 % (2005-2018).

The R&DE are vitally dependent on their structure. If the aforementioned structure was rigid, it could be characterized as an inherent of the public spending policy. In the emerging market economies over the early 1990s, the latter was interconnected with the paternalistic public finances' doctrine. In that case, public spending was often determined by the political cycle than by the economic one. The electoral promises affected the economic performance and quite often deteriorated it.

The total investment indicator – represented by the composite public and private financial efforts – positively affected the growth processes. Over the 1990-2018 period, an increase equaled to 1.00 % in the total investment-to-GDP ratio was accomplished by an increase in the real GDP per capita growth rate that was equal to 0.24 %. The overall effect of investment over the 1990-2004 period (coefficient equaled to 0.12 %) was less essential compared with the 2005-2018 period (coefficient equaled 0.29 %). That fact proved that the composition of the investment really mattered. Considering the entire period, in the model, the total investment-to-GDP ratio was the only variable that showed a sustainable positive influence on production.

Discussion

Taking the empirical data into account, over the past three decades, economic development was extremely dependent on different demographic determinants. The examined social and demographic indicators – the working-age stratum and the average life expectancy growth rates – harmed the real output. In the case of the negative interrelation between the working-age stratum and the real GDP growth rates, the possible explanation can be derived from

the labor force quality. In our investigation, the working-aged stratum of the population was defined according to the ILO methodology. Moreover, the people aged from 15 to 64 objectively possess the incomparable working abilities and competencies. The observed expansions in the aforementioned stratum could be caused by an increase in the low-skilled and unskilled sub-strata. The latter was generally described by relatively weak productive capacities and an insignificant contribution to public production.

Further investigations should cover the structural peculiarities of the working-aged stratum and related issues. The general adverse influence of an extended life expectancy can be explained due to the same changes in the population's distribution through the age strata. In advanced and emerging economies, longevity is directly connected to the tax burden: an increased life expectancy induces actual social contributions. Seriously aged population increases the share of medical and recreation spending – both public and private – in GDP significantly. Furthermore, investment and consumption behavior are crucially dependent on the population's age structure. Longevity was described as the natural and direct consequence of the high economic development.

In this paper, the indirect human-capital-related economic growth determinant was represented by the R&DE share in GDP. In actual economic discourse, R&DE are traditionally defined as productive. However, in our investigation, an increase in R&DE was associated with the downtrend in public production. The possible explanation was interconnected with the inherent structure of R&DE. In a number of countries, R&DE were primarily financed through public funds. If the structure of government spending was inaccurate, the public expenditures' efficiency significantly declined. Thus, the possible solution was closely interconnected with R&D activities and private business convergence. If the scientific programmers were connected to the business programs, their comprehensive effect was generally high. If R&D activities were unconnected to the public needs, real output has been crucially reduced.

Conclusion

Public production can be described as a complicated multidimensional process substantially dependent on a set of social, demographic, and economic factors. Being a producer and a consumer of goods and services simultaneously, a person enormously influences the economic dynamics. The demographic determinants contribute to economic development, while the nature of their influence should be investigated accurately. We studied 45 advanced and emerging market economies over the 1990-2018 period. In this article, we considered that there were three main groups of the impact factors on economic growth. The 1st group was represented by demographic determinants, directly related to human cap-

ital quality. That group included the working-age stratum and the average life expectancy growth rates. The 2nd group of the impact factors was connected to human capital and knowledge management closely but indirectly. The investigated variable referred to the R&DE-to-GDP ratio. The 3rd group was represented by the economic controls primarily related to physical capital: the public spending-to-GDP and total investment-to-GDP ratios. The entire period under study was divided into two separate periods referred to 1990-2004 and 2005-2018, respectively. The general sample was divided into three sub-samples, considering the average GDP per capita and the mean life expectancy. We pointed out that the aforementioned economic and demographic characteristics were directly interconnected: the highest life expectancy was observed in the most developed countries. Moreover, that connection was bilateral: significantly high real GDP per capita prompted life expectancy. We identified three sub-samples, regarding low, medium and high average GDP per capita. It was shown that the states with the lowest average life expectancy were simultaneously characterized by relatively low real GDP per capita. High life expectancy was regarded as the logical and natural consequence of an effective public production structure. Over the periods under investigation, regarding the sample of 45 advanced and emerging economies, the general interdependency – represented by *the model 4* – appeared to be statistically significant and quite robust, while the impact of the leading indicators critically varied. The vast majority of the highlighted variables had a significant adverse impact on the scale of public production. An increase in the life expectancy growth rate by 1.00 % reduced the real output growth rate by 1.23 %. If the working-age stratum grew by 1.00 %, GDP was reduced by 0.58 %. Surprisingly, an increase in the R&DE-to-GDP ratio by 1.00 % slowed down the real GDP per capita growth rate by 0.45 %. An increase in the public spending-to-GDP ratio by 1.00 % declined the output dynamics by 0.07 %. The total investment-to-GDP ratio was the only independent variable that had a robust positive influence on public production: if the mentioned ratio increased by 1.00 %, the output expanded by 0.24 %.

Taking the selected time scales into account, the independent variables had, in general, a similar impact on the output dynamics. Over the 1990-2004 period, the impact of the working-age stratum growth rate on economic development happened to be statistically insignificant. The same results were obtained when the entire sample was divided into two sub-samples, considering the actual development of the examined economies. The empirical investigation proved a robust adverse interconnection between the observed variables. Henceforth, the actual impact of demographic determinants should be investigated profoundly.

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