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ECONOMIC USEFULNESS OF OLDER WORKERS IN TERMS OF PRODUCTIVITY IN THE MODERN WORLD

Janis Kudins

Daugavpils University, Vienibas street 13, Daugavpils, LV-5401, Latvia

E-mail: janis.kudins@du.lv

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Abstract. Along with the modern phenomenon of population aging, economists are also concerned about a shift in the composition of the workforce from relatively young to relatively old workers. This study is aimed to empirically prove the hypothesis that in the modern world the economic usefulness of older workers in terms of productivity is determined, in addition to the characteristics of the elderly workforce, by factors characterizing the level of territory development. The theoretical background and methodology of this study is formed on the basis of the concept of "specific human capital" by G. Becker and the conception of endogenous growth. The author uses the latest statistics for 63 countries of the world and several methods of quantitative data analysis: correlation analysis, regression analysis and cluster analysis – in order to detect not only correlational parallelism, but also causal relationships between the variables included in the proof of the research hypothesis. The results of the empirical analysis show that technological readiness, along with a high level of lifelong learning in the country, are the catalysts that ensure the economic usefulness of older workers in terms of productivity in the countries of the modern world. The author also concludes that a baseless raising the retirement age in the country, without considering the above factors that characterize the level of development of this country in technological and learning aspects, does not allow the effective use of the economic potential of older workers.

Keywords: older workers; economic usefulness; productivity; specific human capital; endogenous growth

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JEL Classifications: I38, J11, J14

Additional disciplines: sociology

1. Introduction

Along with the modern phenomenon of population aging, economists are also concerned about a shift in the composition of the workforce from relatively young to relatively old workers, i.e. a phenomenon that the researchers refer to as "workforce aging" (Aiyar et al., 2016). In most industrialized countries, the average age of the workforce has been growing rapidly during the recent years (Gobel & Zwick, 2011), and the share of older workers in the European labor force is expected to increase substantially over the next few decades (Cataldi et al., 2011; Aiyar et al., 2016). In particular, in his previous research the author found that over the past 10 years, Latvia has a rapid – almost 2 times – increase in the elderly (65+) employment, which quantitatively corresponds to the general EU's trend (Kudins, 2021). In this regard, a discussion about the economic usefulness of older

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workers is relevant in the research space (Verhaegen & Salthouse, 1997; Colonia-Willner, 1998; Skirbekk, 2003; Gobel & Zwick, 2011; Projektu un kvalitates vadiba, 2014; Borsch-Supan & Weiss, 2016; Boring & Grogaard, 2021 and others).

On the one hand, in the scientific literature in the framework of ageism there are (and even prevail) opinions that point to the unjustified recognition of older workers as necessary for the economy due to their low productivity compared to younger workers (Avolio & Waldman, 1994; Kahana et al., 2018). The manifestation of ageism in a broader socio-economic context is considered as part of the theory of modernization at the macro-level. The essence of the argument is that ageism increases as societies modernize, but social policies and management practices that emerged with industrialization are being rolled back over the last decades (De Tavernier et al., 2019).

The results of many studies show that the knowledge, skills and experience of older people are underutilized in the economy (Gobel & Zwick, 2011; PwC Global, 2018; Connie, 2020). The New England Journal of Medicine published a study in 2018, reporting that an extensive study in the USA found that the most productive age in human life is between 60-70 years of age. The second most productive stage of the human being is from 70 to 80 years of age. The third most productive stage is 50 to 60 years of age (Connie, 2020). Ageism leads to poorer health, social isolation, earlier deaths and cost economies billions: WHO report "Ageism is a Global Challenge: UN" calls for swift action to implement effective anti-ageism strategies (World Health Organization, 2021).

In addition to the aforementioned extreme positions, there are also compromise positions in the scientific literature in relation to the economic usefulness of older workers in terms of productivity. For example, V. Skirbekk in his study based on a literature survey about age and individual productivity concluded that the decreased cognitive abilities of older workers can lead to lower productivity, unless their longer experience and higher levels of job knowledge outweighs the declines in mental abilities (Skirbekk, 2003). He also found that productivity reductions at older ages are particularly strong for work tasks where problem solving, learning and speed are needed, while in jobs where experience and verbal abilities are important, older individuals' maintain a relatively high productivity level (Skirbekk, 2003).

Furthermore, the results of some studies also point to spatial differences in the professional potential of people of different age groups. For example, the researchers P. Boring and J.B. Grogaard (2021) examined the relationship between employees' age and their individual productivity potential (IPP). IPP is measured by individual characteristics which are related to skills utilization at work. Using data of the Programme for the International Assessment of Adult Competencies (PIAAC) for 27 European and non-European countries, they found that the oldest employees have a lower IPP score than the middle-aged employees in 17 of the 27 countries (Boring & Grogaard, 2021). Based on the results of this study, the author hypothesizes that in the modern world, the economic usefulness of older workers in terms of productivity is determined, in addition to the characteristics of the elderly workforce, by factors characterizing the level of territory (country, region, etc.) development.

Within this study, productivity is a target function that depends (or does not depend, as the results of the study will show) on "workforce aging" (Aiyar et al., 2016). Productivity will be considered not at the individual level of workers, but at the macroeconomic level, i.e. at the level of productivity of the economy as a whole, as many regional economists do in their studies (Rice & Venables, 2004a, 2004b; Cusolito & Maloney, 2018; Komarova et al., 2021). Methodologically, the author will consider the macroeconomic aspect of productivity based on the theory of human capital, which emphasizes its impact both on economic growth as a whole (Romer, 1986, 1989a, 1989b; Barro, 2001; Becker, 1993, 2009; Pelinescu, 2015), and on the productivity of the economy and firms operating in it (Hellerstein & Neumark, 1995; Hellerstein et al., 1999; Abel et al., 2010; Cardoso & Guimaraes, 2010; Cocalia, 2015; Andretta et al., 2021).

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As sources of empirical data to prove the hypothesis of this study, the author uses the latest statistics from the World Health Organization, Trading Economics, PwC Global, as well as data from the report on the Global Talent Competitiveness Index for 63 countries representing different continents and different levels of economic development. However, the relatively small sample size and the lack of diachronic analysis are the main limitations of this study, reducing the stability of the results obtained. To compensate for the above limitations, the author uses several methods of quantitative data analysis: correlation analysis, regression analysis and cluster analysis – in order to detect not only correlational parallelism, but also causal relationships (Keim, 2020) between the analyzed variables.

2. Theoretical background

A large body of evidence supports the notion that cognitive abilities2 decline from some stage in adulthood. P. Verhaegen and T.A. Salthouse (1997) present a meta-analysis of 91 studies, which investigate how mental abilities develop over the life span. Based on the analysis of these studies, they conclude that the cognitive abilities reasoning, speed and episodic memory declines significantly before 50 years of age and more thereafter (Verhaegen & Salthouse, 1997). However, in relation to the productivity of older workers, some researchers emphasize that it is a widespread stereotype that older workers are probably less productive: "the arguments given in the literature are that the physical abilities decrease in general, cognitive abilities at least in some areas" (Barthel, 2008, p. 3).

An interesting sociological study of economic potential of the population of pre-retirement age was conducted by Latvian researchers (Projektu un kvalitates vadiba, 2014). They found that "older people believe that they have much more experience than younger people, but less skills in working with new technologies. Those older people who feel that they lack some kind of knowledge or skills most often cite computer skills, English proficiency and basic business knowledge as insufficient. In turn, employers also value the experience of older workers, their reliability and ability to make independent decisions. At the same time, abilities, skills and competencies such as openness to new ideas, working with new technologies and creativity, according to employers, are less common among workers aged 50 years and older compared to younger workers" (Projektu un kvalitates vadiba, 2014, p. 68).

Back in the 1960s, economists T. Schultz and G. Becker pointed out that education and training were investments that could add to productivity (Schultz, 1961; Becker, 1964). Later, throughout his life, G. Becker and his colleagues actively continued economic studies of human capital (Becker & Ghez, 1975; Becker, 1993, 2009; Becker et al. 2010). The most necessary for the methodology of this study is the separation of the concepts of "general human capital" and "specific human capital" proposed by G. Becker (the Recipient of the 1992 Nobel Prize in Economic Science) (Becker, 1993). In his opinion, the general human capital, as a rule, is developed by special "firms" (schools, colleges), and the special one is formed directly at the workplace. The term "specific human capital" has helped to understand why long-serving workers in the same job are less likely to change jobs, and why firms tend to fill vacancies through internal job travel rather than through external recruitment (Becker, 2009; Becker et al. 2010). Thus "specific human capital" by G. Becker accumulated over a long professional activity (and not even necessarily within one firm or organization, but on the labor market as a whole) can theoretically be considered a determinant of the economic usefulness of older workers in terms of productivity.

I.J. Deary with his colleagues provide an overview of surveys that focus on how age differences in productivity are estimated by employer-employee studies (Deary et al, 2000). They conclude that for 5 out of the 7 employer-employee studies, an inverted U-shaped work performance profile is found, where individuals in their 30s and 40s have the highest productivity levels. Employees above the age of 50 are found to have lower productivity than younger individuals, in spite of their higher wage levels. Exceptions to the notion of decreasing productivity is a notion by J.K. Hellerstein and D. Neumark who suggest that productivity increase over the life span in a study of

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Israeli manufacturing firms (Hellerstein & Neumark, 1995). Similarly, in a study of American firms, J.K. Hellerstein, D. Newmark and K. Troske suggest that those above 55 contribute the most to output levels. However, they find that the peak productivity shifts to 35-54-year-olds workers when they use the firms' value-added instead of output levels as an indicator of productivity (Hellerstein et al., 1999). A.R. Cardoso and P. Guimaraes using a panel of Portuguese private sector firms that spans for over 20 years find that older workers are, in fact, worthy of their pay, in the sense that their contribution to firm-level productivity exceeds their contribution to the wage bill (Cardoso & Guimaraes, 2010).

The mention of high-tech Israel, in which "productivity increase over the life span" (Hellerstein & Neumark, 1995, p. 110), as well as the United States and Portugal, suggests that in the modern world the economic usefulness of older workers in terms of productivity is determined, in addition to the characteristics of the elderly workforce, by factors characterizing the level of development of the country as such. And, most likely, these factors relate to the development of technology, lifelong learning, etc. In a special edition of the Global Competitiveness Report issued by the World Economic Forum in 2020, a very interesting indicator is calculated (unfortunately, only for 37 countries of the world) - transformation readiness, which includes 11 structural elements (the so-called transformation economic priorities), namely (Schwab et al., 2020):

1) ensure public institutions embed strong governance principles and a long-term vision and build trust by serving their citizens;
2) upgrade infrastructure to accelerate the energy transition and broaden access to electricity and ICT;
3) shift to more progressive taxation, rethinking how corporations, wealth and labour are taxed, nationally and in an international cooperative framework;
4) update education curricula and expand investment in the skills needed for jobs and "markets of tomorrow";
5) rethink labour laws and social protection for the new economy and the new needs of the workforce;
6) expand eldercare, childcare and healthcare infrastructure, access and innovation for the benefit of people and the economy;
7) increase incentives to direct financial resources towards long-term investments, strengthen stability and expand inclusion;
8) rethink competition and anti-trust frameworks needed in the Fourth Industrial Revolution, ensuring market access, both locally and internationally;
9) facilitate the creation of "markets of tomorrow", especially in areas that require public-private collaboration;
10) incentivize and expand patient investments in research, innovation and invention that can create new "markets of tomorrow";
11) incentivize firms to embrace diversity, equity and inclusion to enhance creativity.

These 11 emerging priorities are vital for countries' achieving economic transformation: "moving towards a full integration of social, environmental and institutional targets into their economic systems over the next five years (approximately). Transformation readiness of countries assesses the extent to which countries today are on the way towards transforming their economies" (Schwab et al., 2020, p. 44). In combination with other characteristics of countries (macroeconomic productivity, lifelong learning), as well as indicators characterizing workforce aging, results are obtained that do not yet prove, but testify in favor of the hypothesis of this study. In the following table, the author compares data on some indicators regarding the economic usefulness of older workers in terms of productivity in the countries with the highest and lowest scores of transformation readiness.

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Table 1. Some indicators regarding economic usefulness of older workers in terms of productivity in the countries with highest and lowest scores of transformation readiness

Countries	Transformation readiness, score from 0 to 100, 2020	Lifelong learning, score from 0 to 100, 2021	Productivity of the economy* – GDP per capita (PPP), thousands USD, 2020	Retirement age for men, years, 2020-2021	Men's average life duration after retirement, years, 2020	% of people aged 65+ in employment. 2016
5 countries with highest scores of transformation readiness						
Finland	69.9	71.4	51.1	63.8	15.5	14.1
Sweden	68.5	77.8	54.6	62.0	18,8	21.9
Denmark	66.5	70.6	60.4	66.5	13.1	15.3
China	65.5	83.4	17.3	60.0	14.7	No data
Canada	64.2	73.7	48.1	65.0	15.4	24.6
5 countries with lowest scores of transformation readiness						
India	49.5	36.5	6.5	60.0	9.5	No data
Poland	48.8	28.1	34.3	65.0	9.5	9.5
Hungary	48.1	37.6	33.1	64.5	8.6	4.6
Greece	47.2	24.2	28.5	67.0	11.6	7.9
Mexico	46.9	40.6	18.8	65.0	8.1	38.1

* In the scientific literature, productivity at the macroeconomic level is usually measured using gross domestic product (GDP) per capita (Rice & Venables, 2004a, 2004b; Cusolito & Maloney, 2018).

Source: elaborated by the author based on Lanvin & Monteiro, 2021; PwC Global, 2017; Trading Economics, 2022; World Health Organization, 2020; Schwab et al., 2020 (data set is provided in the Appendix).

As can be seen from the data in Table 1, the five countries with the highest scores of transformation readiness are quite different from the five countries with the lowest scores of transformation readiness, not only in terms of the indicator of transformation readiness itself, but also in all other indicators given in the table. Thus, in countries with the highest scores of transformation readiness, the indicators of lifelong learning, productivity of the economy, share of people aged 65+ in employment (with the exception of Mexico), men's average life duration after retirement (indicating the state of health of the retiring workforce) are also obviously higher. The only thing that is not higher in the five countries with highest scores of transformation readiness than in the five countries with lowest scores of transformation readiness is the retirement age for men (with a few exceptions - India with a relatively low retirement age and Denmark with Canada with relatively high retirement age). It seems that in the modern world, an increase in retirement age should also be accompanied by at least a high level of life expectancy in the country, as well as high rates of lifelong learning and transformation readiness - only then will older workers be able to be economically useful and increase the productivity of their country's economy.

Thus, based on the analysis of the relevant scientific literature, as well as some empirical data that allow us to understand something about the economic usefulness of older workers in terms of productivity, the author believes that in the modern world the situation with the economic usefulness of older workers is ambiguous. Most likely, for the most complete economic implementation of the so-called "specific human capital" of older workers, some more educational and technological conditions are required, and not just an increase in retirement age while maintaining a relatively low life expectancy of the population and the transformation potential of the country. Further, the author will try to empirically prove this on a sample of 63 countries of the world using several methods of quantitative data analysis at once.

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3. Research methodology

The methodology of this study is based on the theory of human capital – G. Becker's classic study of how investment in an individual's education and training is similar to business investments in equipment (Becker, 1993, 2009; Becker et al. 2010), as well as on the theory of long-run growth (Romer, 1986, 1989a, 1989b; Barro, 2001; Barro & Sala-i-Martin, 2004). The main postulates of the theory of human capital and the theory of long-run growth, which the author uses to conceptualize the economic usefulness of older workers in terms of productivity, are the following:

- human beings can increase their productive capacity through greater education and skills training;
- productivity continues to increase due to on-the-job training investments.

Thus, the theory of human capital and the theory of long run growth point to lifelong learning as one of the most significant factors determining the economic usefulness of older workers in terms of productivity. The report on the Global Talent Competitiveness Index provides empirical data on the integrated indicator of lifelong learning in the countries of the modern world. This indicator includes the following structural elements (Lanvin & Monteiro, 2021):

- business and economics subject ranking – the World University Rankings in the subject "Business and Economics". The value is derived from the average score of the top three universities per country;
- prevalence of training in firms – this indicator refers to the percentage of firms that offered formal training programmes in the last complete fiscal year for its permanent, full-time employees;
- employee development – an average answer of experts to the question: In your country, to what extent do companies invest in training and employee development? (1 – not at all; 7 – to a great extent);
- formal and non-formal studies – this indicator refers to the share (%) of adults aged 16–65 who participated in formal and non-formal education and training in the 12 months prior to the interview.

Another significant factor potentially determining the economic usefulness of older workers in terms of productivity is longer working life, which according to the findings of PwC Global's study unlock a potential 3.5 USD trillion prize (PwC Global, 2018). In this study, the author uses the indicator of life expectancy at birth in the countries of the modern world (World Health Organization, 2020) as a characteristic that directly determines the very possibility of longer working life in a particular country. As the data of Table 1 in the previous section of the article showed, in countries with a relatively high productivity of the economy, men's average life duration after retirement, indicating the health status of the retiring workforce, in all compared cases is higher – sometimes 2 times – than in countries with a relatively low productivity of the economy.

The last significant factor that potentially determines the economic usefulness of older workers in terms of productivity is proposed within the conception of endogenous growth (Romer, 1986; Diene et al., 2016). The conception of endogenous growth emphasizes the role of technology and employment in knowledge-intensive industries and justifies the importance of investment in human capital. Investments in human capital have a positive multiplier effect on the economy and slow down the decline in the return on accumulated capital by stimulating people's innovative activities and extending their working life. Within this study, the author uses the indicator of country's technological readiness, calculated for the countries of the world by the World Economic Forum in the Global Competitiveness Report. Although this indicator was last calculated in 2017 (Schwab & World Economic Forum, 2017), the author considers it suitable for this study. Even if the technological readiness of the world's countries itself has changed during this time (most likely upwards), the ratio of technological readiness between countries has not changed enough to distort the results of quantitative analysis. For example, the US is still much more technologically advanced than Latvia (and this is exactly what the author needs to know in order to empirically prove the hypothesis of this study).

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The indicator of country's technological readiness includes the following structural elements (Schwab & World Economic Forum, 2017):

- availability of latest technologies – a weighted average answer of experts to the question: In your country, to what extent are the latest technologies available? (1 – not at all; 7 – to a great extent);
- firm-level technology absorption – a weighted average answer of experts to the question: In your country, to what extent do businesses adopt the latest technologies? (1 – not at all; 7 – to a great extent);
- FDI and technology transfer – a weighted average answer of experts to the question: To what extent does foreign direct investment (FDI) bring new technology into your country? (1 – not at all; 7 – to a great extent);
- Internet users – the share (%) of individuals using the Internet;
- fixed-broadband Internet subscriptions – fixed-broadband Internet subscriptions per 100 population;
- Internet bandwidth – international Internet bandwidth (kb/s) per Internet user;
- mobile-broadband subscriptions – active mobile-broadband subscriptions per 100 population.

The main concepts of this study – the workforce aging and productivity, the relationship between which has to be empirically proven. There are two methodological questions: the empirical interpretation of these concepts and the discovery of causal relationships between them. For the empirical interpretation of productivity, the author uses the experience of studies in which productivity at the macroeconomic level is empirically interpreted and measured using gross domestic product (GDP) per capita, which takes into account the difference between territories in terms of population (Rice & Venables, 2004a, 2004b; Cusolito & Maloney, 2018). In turn, for the empirical interpretation of the workforce aging, the author uses the indicator of retirement age for men (Trading Economics, 2022).

Then, the economic usefulness of older workers in terms of productivity will be empirically proven if the author manages to detect not only correlational parallelism, but also causal relationships between retirement age and GDP per capita (PPP) in 63 countries of the world included in object of this study. Since it is often very difficult to prove causality, the analysis will actually quantify correlation, and then we can either assume that correlation indicates causation (which is risky) (Keim, 2020) or attempt to demonstrate causation by applying additional methods of quantitative data analysis. The author will begin the data analysis by calculating the correlation between the indicators of retirement age for men and GDP per capita (PPP) – both general and partial correlation. In partial correlation, the influence of three factors that potentially determine the economic usefulness of older workers in terms of productivity will be blocked: lifelong learning, average life expectancy at birth and technological readiness in the country. Further, the author will apply additional methods of quantitative data analysis – linear regression (with a stepwise method of including variables) and cluster analysis – in order to confirm the causal relationships between retirement age and GDP per capita (PPP), as well as those conditions that are supposedly necessary for economic usefulness of older workers in terms of productivity.

In the following figure, the author schematically presented the hypothesis of this study, which requires proof: in the modern world, the economic usefulness of older workers in terms of productivity is determined, in addition to the characteristics of the elderly workforce, by factors characterizing the level of country development.

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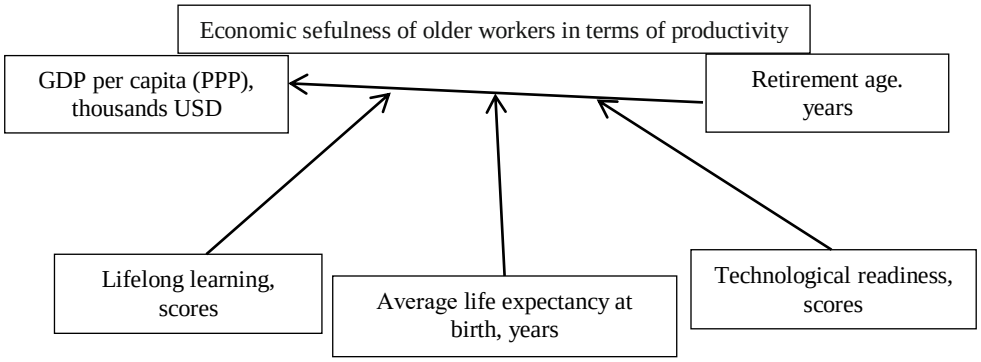

Figure 1. Hypothetical economic usefulness of older workers in terms of productivity, determined by the level of country development

Source: elaborated by the author.

The scheme presented in Figure 1 shows that increasing a country workforce's retirement age, as an indicator of workforce aging, hypothetically stimulates macroeconomic productivity measured by GDP per capita (PPP). This proves the economic usefulness of older workers in terms of productivity, but only on the condition that a sufficiently high level of lifelong learning, average life expectancy at birth and technological readiness are achieved in this country. Otherwise, it is impossible to increase macroeconomic productivity in a country with a low level of lifelong learning, average life expectancy at birth and technological readiness by just raising retirement age. In other words, the economic usefulness of older workers in terms of productivity is determined not so much by the characteristics of the workforce as by the level of development of a country that is able or unable to effectively use the "specific human capital" (Becker, 1993) of older workers.

4. Results and discussion

In accordance with the algorithm presented in the research methodology, the author will begin the data analysis by calculating the correlation between the indicators of retirement age for men and GDP per capita (PPP) – both general and partial correlation. In partial correlation, the influence of three factors that potentially determine the economic usefulness of older workers in terms of productivity will be blocked: lifelong learning, average life expectancy at birth and technological readiness in the country. To assess the effect from blocking variables, the author will also include them in the general correlation analysis. The following table presents the results of correlation analysis between five variables (Fig. 1), showing the degree of correlational parallelism between them, but not causal relationships.

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Table 2. The results of correlation analysis between the variables included in the proof of the research hypothesis, Pearson correlation coefficient, n = 63 countries

Variables	Correlation with GDP per capita (PPP), thousands USD, 2020	Statistical significance, p-value
Retirement age for men, years, 2020-2021	0.397**	0.001
Lifelong learning, scores, 2021	0.744**	0.000
Men's average life expectancy at birth, years, 2020	0.702**	0.000
Technological readiness, scores, 2017	0.826**	0.000

** Correlation is significant at the 0.01 level (2-tailed).

Source: calculated and elaborated by the author using SPSS software based on the data of Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017 (data set is provided in the Appendix).

The results of the general correlation analysis presented in Table 2 show that there is a statistically significant (p-value < 0.05) correlation between GDP per capita (PPP) and all other variables included in the proof of the hypothesis. But this relationship is especially strong not between retirement age for men and GDP per capita (PPP), but between GDP per capita (PPP) and all the significant factors presented in the research methodology that potentially determine the economic usefulness of older workers in terms of productivity – especially between GDP per capita (PPP) and technological readiness.

In the following table, the author compares the results of a general and partial correlation analysis between retirement age for men and GDP per capita (PPP). A partial correlation analysis shows a correlation between retirement age for men and GDP per capita (PPP) if we alternately block the effects of such variables as lifelong learning, men's average life expectancy at birth and technological readiness in a country.

Table 3. Comparison of results of general and partial correlation analysis between retirement age for men and GDP per capita (PPP), Pearson correlation coefficient, n = 63 countries

Variables	GDP per capita (PPP), thousands USD, 2020	Statistical significance, p-value
Retirement age for men, years, 2020-2021	0.397**	0.001
Results of partial correlation between retirement age for men and GDP per capita (PPP), when the effect of the following variables is blocked:		
Lifelong learning, scores, 2021	0.256	0.044
Men's average life expectancy at birth, years, 2020	0.063	0,625
Technological readiness, scores, 2017	-0.141	0.274

** Correlation is significant at the 0.01 level (2-tailed).

Source: calculated and elaborated by the author using SPSS software based on the data of Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017 (data set is provided in the Appendix).

The results of the partial correlation analysis presented in Table 3 show that when the effect of lifelong learning, men's average life expectancy at birth and technological readiness is blocked, the correlation between retirement age for men and GDP per capita (PPP) becomes much weaker (as in the case of blocking the influence of the indicator of lifelong learning) or disappears (as in the case of blocking the influence of the indicators of men's average life expectancy at birth and technological readiness). This is probably because the factors of increasing macroeconomic productivity are, rather, exactly those variables, the influence of which was blocked during the

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implementation of the partial correlation analysis, and not the retirement age itself. A regression analysis will help to define and characterize this putative causal relationship more precisely. In a regression analysis, the resulting variable is the productivity of the economy at the macro level, measured by GDP per capita (PPP), and the factor variables are all other variables included in the proof of the research hypothesis.

$$y = -54.1 + 15.4x_4 + 0.3x_2, \quad (1)$$

where:
y – GDP per capita (PPP), thousands USD, 2020
x_4 – technological readiness, scores, 2017
x_2 – lifelong learning, scores, 2021
Excluded variables:
x_1 – retirement age for men, years, 2020-2021
x_3 – men's average life expectancy at birth, years, 2020

Source: calculated by the author using SPSS software based on the data of Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017 (data set is provided in the Appendix).

The results of the regression analysis show that of all the variables included in the proof of the research hypothesis, the real factors of the increase in macroeconomic productivity are technological readiness and lifelong learning in the country, with the former clearly dominating. Thus, technological readiness, along with a high level of lifelong learning in the country, are the catalysts that ensure the economic usefulness of older workers in terms of productivity in the countries of the modern world.

These results of the author's empirical analysis on a sample of 63 countries of the world are consistent with the results of a sociological survey of economic potential of the population of pre-retirement age conducted in Latvia (Projektu un kvalitates vadiba, 2014). Latvia ranks 37th out of 137 countries in terms of technological readiness (Schwab & World Economic Forum, 2017) and 37th out of 134 countries in terms of lifelong learning (Lanvin & Monteiro, 2021). Latvian researchers found that "explaining the reasons why employers, when choosing workers for their enterprise, would give preference to younger workers and avoid hiring older people, they refer to working conditions (hard, physically intensive work), as well as inflexibility of thinking older workers, difficulties in accepting changes and in learning, their health condition that reduces their ability to work.

The inertia of older people in improving their knowledge, skills and qualifications is also confirmed by the data of a survey of older workers themselves, which show that they are almost two times less involved in lifelong learning than representatives of other age groups" (Projektu un kvalitates vadiba, 2014, p. 68-69). Thus, the results of the Latvian sociological survey on the example of one country also confirm the hypothesis of this study that in the modern world, the economic usefulness of older workers in terms of productivity is determined, in addition to the characteristics of the workforce itself, also by factors characterizing the level of development of the country. Most of all, it is a factor of technological readiness, which makes it possible to minimize the necessity to perform the hard, physically intensive work mentioned by Latvian employers.

To obtain more complete and stable results of empirical analysis, the author will additionally conduct a cluster analysis, dividing the countries into groups based on the all variables included in the proof of the research hypothesis.

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Table 4. Defining the number of clusters of countries based on the all variables included in the proof of the research hypothesis, the part of agglomeration schedule of hierarchical cluster analysis, n = 63 countries

Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	2	3	0.080	0	0	8
2	14	19	0.098	0	0	4
3	35	51	0.138	0	0	21
…						
60	5	28	8.196	59	57	62
61	1	12	8.667	55	53	62
62	1	5	14.948	61	60	0

Source: calculated by the author using SPSS software based on the data of Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017 (data set is provided in the Appendix).

As the coefficients in the agglomeration schedule of hierarchical cluster analysis presented in Table 4 show, the research object, consisting of 63 countries of the world, is clearly divided into two clusters (the number of countries (63) minus the step number (61), after which the coefficient increases abruptly). The following table shows the results of comparing clusters in terms of means of the variables included in the proof of the research hypothesis.

Table 5. Comparing clusters in terms of means of the variables included in the proof of the research hypothesis, t-test for equality of means, n = 63 countries

Variables	Means of the variables		Statistical significance of differences between clusters, p-value
	Cluster 1 n = 37 countries	Cluster 2 n = 26 countries	
GDP per capita (PPP), thousands USD, 2020	23.2	56.2	0.000
Retirement age for men, years, 2020-2021	63.1	64.3	0.043
Lifelong learning, scores from 0 to 100, 2021	31.6	68.3	0.000
Men's average life expectancy at birth, years, 2020	72.8	79.5	0.000
Technological readiness, scores from 1 to 7, 2017	4.6	5.9	0.000

Source: calculated and elaborated by the author using SPSS software based on the data of Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017 (data set is provided in the Appendix).

The countries of the world participating in the analysis were divided into the two clusters described above as follows:

1) Albania, Algeria, Armenia, Azerbaijan, Bangladesh, Brazil, Bulgaria, Chile, Croatia, Cyprus, Estonia, Georgia, Greece, Hungary, India, Indonesia, Italy, Kazakhstan, Latvia, Lithuania, Malaysia, Mexico, Moldova, Mongolia, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, Tajikistan, Turkey, Ukraine, Vietnam (37 countries);
2) Australia, Austria, Belgium, Canada, China, Czechia, Denmark, Finland, France, Germany, Iceland, Ireland, Israel, Japan, Korea, Luxembourg, Malta, Netherlands, New Zealand, Norway, Saudi Arabia, Singapore, Sweden, Switzerland, UK, USA (26 countries).

Thus, the results of the cluster analysis showed a fairly clear division of the countries of the world into two clusters, in the first of which the value of all analyzed variables is statistically significantly lower. This group of countries has relatively lower levels of GDP per capita (PPP), retirement age for men, lifelong learning, men's average life expectancy at birth and technological readiness. Moreover, the indicator of retirement age for men is the only variable, the difference between the means of which in both clusters is very close to the threshold value (0.05). If the p-value for retirement age for men were slightly higher and exceeded the threshold value, then the

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author would have to state that, despite the relatively large difference in the level of GDP per capita (PPP), lifelong learning, men's average life expectancy at birth and technological readiness between the countries of the two clusters, retirement age for men is the same in them. In reality, the countries of the world are very close to just such a situation, indicating a low economic usefulness of older workers in terms of productivity in the countries of the first cluster, determined by the relatively low level of technological readiness and lifelong learning in these countries.

5. Conclusions

Within this study, the author tried to prove that older workers are economically useful in terms of productivity, based on the concept of "specific human capital" by G. Becker (1993) and the conception of endogenous growth stimulated by the technological readiness of the economy. An empirically, the economic usefulness of older workers in terms of productivity was interpreted by the author as a correlation of the country's GDP per capita (PPP) (the indicator of macroeconomic productivity) with retirement age in a country (the indicator of workforce aging). Using several methods of quantitative data analysis for 63 countries of the world, the author proved the hypothesis that in the modern world the economic usefulness of older workers is determined by factors characterizing the level of development of the country, namely: technological readiness as a dominant factor, as well as lifelong learning as an additional factor.

The author also argues that a baseless raising the retirement age in the country, without considering the above factors that characterize the level of development of this country in technological and learning aspects, does not allow the effective use of the economic potential of older workers. Although, perhaps, raising the retirement age is a rather strong incentive for a long-term change in the economic behavior of the population and awareness of the economic efficiency of lifelong learning - not formal, but real and internally motivated. According to the results of a sociological survey of economic potential of the population of pre-retirement age, conducted in Latvia, Latvian employers rate the economic usefulness of older workers rather highly: "only a small number of workers aged 50 and over are assessed by employers as low-skilled and with a poor ability to work. Almost half of employers characterize pre-retirement age workers as not bad specialists who are necessary for the enterprise, and 25% of employers - as very good and needful specialists" (Projektu un kvalitates vadiba, 2014, p. 69).

However, as also shown by the results of previous studies by scientists from Daugavpils University (Latvia) on higher education and its contribution to the economic performance of the world's countries, there are some factors that enable highly skilled specialists to potentially turn their knowledge into innovation and national income. These factors are the quality of higher education and the level of technological development in business (Stankevics et al., 2014). This emphasis on the technological development of the country, confirmed by results of many studies, combined with high-quality lifelong learning, the author considers the most important condition that determines the economic usefulness of older workers in terms of productivity in the countries of the modern world.

The author is ready to argue with the Latvian researchers of economic potential of the population of pre-retirement age, who concluded that "realizing and developing the economic potential of older workers requires specific employment and learning activities specifically targeted at this age group, as well as the support of employers" (Projektu un kvalitates vadiba, 2014, p. 70). Although, based on the results of his empirical research, the author agrees with the importance of lifelong learning for the most efficient use of the economic potential of older workers, he believes that without an appropriate level of technological development of the country, the process of lifelong learning turns into a formal activity "for ticks".

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Appendix

Table 1. Data set of indicators regarding economic usefulness of older workers in terms of productivity, n = 63 countries

Countries	% of people aged 55-64 in employment. 2016	% of people aged 65+ in employment. 2016	Retirement age for men, years, 2020-2021	Men's average life duration after retirement, years, 2020	Men's average life duration after retirement, years, 2020	GDP per capita (PPP), thousands USD, 2020	Lifelong learning, score from 0 to 100, 2021	Transformation readiness, score from 0 to 100, 2020	Technological readiness, scores from 1 to 7, 2017
Albania	No data	No data	65.0	76.3	11.3	13.8	32.2	No data	4.1
Algeria	No data	No data	60.0	76.2	16.2	11.3	13.2	No data	3.4
Armenia	No data	No data	63.0	72.5	9.5	13.3	19.6	No data	4.1
Australia	62.5	25.1	66.0	81.3	15.3	52.5	71.9	62.0	5.7
Austria	49.2	9.3	65.0	79.4	14.4	55.1	70.1	60.3	6.0
Azerbaijan	No data	No data	65.0	68.8	3.8	14.5	30.1	No data	4.6
Bangladesh	No data	No data	59.0	73.0	14.0	5.1	11.3	No data	2.8
Belgium	45.4	4.9	65.0	79.3	14.3	52.0	65.3	63.6	5.9
Brazil	No data	No data	65.0	72.4	7.4	14.8	40.5	51.0	4.6
Bulgaria	No data	No data	64,3	71.6	7.3	24.4	19.6	No data	5.1
Canada	61.6	24.6	65.0	80.4	15.4	48.1	73.7	64.2	5.9
Chile	63.8	38.8	65.0	78.1	13.1	25.1	52.5	53.0	5.2
China	No data	No data	60.0	74.7	14.7	17.3	83.4	65.5	4.2
Croatia	No data	No data	65.0	75.5	10.5	28.5	25.0	No data	5.0
Cyprus	No data	No data	65.0	80.7	15.7	38.5	47.6	No data	5.5
Czechia	58.5	10.7	63.8	76.3	12.5	41.7	51.6	54.0	5.5
Denmark	67.8	15.3	66.5	79.6	13.1	60.4	70.6	66.5	6.1
Estonia	65.3	29.2	63.8	74.7	10.9	38.4	51.3	61.0	5.9
Finland	61.4	14.1	63.8	79.2	15.4	51.1	71.4	69.9	6.0
France	49.8	5.9	62.0	79.8	17.8	46.2	64.7	62.7	5.9
Georgia	No data	No data	65.0	68.8	3.8	14.9	15.2	No data	4.3
Germany	68.6	14.5	65.8	78.7	12.9	53.7	71.7	62.9	6.2
Greece	36.3	7.9	67.0	78.6	11.6	28.5	24.2	47.2	4.8
Hungary	49.9	4.6	64.5	73.1	8.6	33.1	37.6	48.1	5.1
Iceland	84.6	54.4	67.0	80.8	13.8	55.2	51.8	No data	6.2
India	No data	No data	60.0	69.5	9.5	6.5	36.5	49.5	3.1
Indonesia	No data	No data	57.0	69.4	12.4	12.1	22.4	55.3	3.9
Ireland	57.2	19.5	66.0	80.2	14.2	93.6	57.1	60.9	6.0
Israel	66.5	36.4	67.0	80.8	13.8	41.9	49.2	62.7	6.2
Italy	50.3	8.6	67.0	80.9	13.9	41.8	36.4	51.9	5.1
Japan	71.6	41.5	65.0	81.5	16.5	42.2	66.4	61.9	6.0
Kazakhstan	No data	No data	63.0	70.0	7.0	26.7	25.4	No data	4.6
Korea	66.1	44.8	62.0	80.3	18.3	43.1	56.9	61.2	5.6
Latvia	No data	No data	63.8	70.6	6.8	32.0	45.1	No data	5.3
Lithuania	No data	No data	64.0	71.2	7.2	38.7	39.6	No data	5.6
Luxembourg	39.6	5.3	65.0	80.6	15.6	118.4	70.1	No data	6.5
Malaysia	No data	No data	60.0	72.6	12.6	27.9	46.6	No data	4.9
Malta	No data	No data	63.0	79.9	16.9	42.6	49.6	No data	5.9
Mexico	54.9	38.1	65.0	73.1	8.1	18.8	40.6	46.9	4.2
Moldova	No data	No data	63.0	69.3	6.3	13.0	21.3	No data	4.6
Mongolia	No data	No data	60.0	63.8	3.8	12.1	27.9	No data	4.2
Netherlands	63.5	13.1	66.3	80.4	14.1	59.2	78.2	66.3	6.3
New Zealand	76.1	40.6	65.0	80.4	15.4	44.3	70.1	64.0	6.1
Norway	72.6	28.9	62.0	81.1	19.1	63.2	64.2	No data	6.1

Poland	46.2	9.5	65.0	74.5	9.5	34.3	28.1	48.8	4.9
Portugal	52.1	18.2	66.5	78.6	12.1	34.5	44.5	56.1	5.7
Romania	No data	No data	65.0	72.0	7.0	31.9	17.3	No data	4.8
Russia	No data	No data	60.5	68.2	7.7	28.2	28.2	50.4	4.5
Saudi Arabia	No data	No data	60.0	73.1	13.1	46.8	52.0	No data	4.9
Serbia	No data	No data	65.0	73.5	8.5	19.2	28.2	No data	4.2
Singapore	No data	No data	62.0	81.0	19.0	98.5	81.7	No data	6.1
Slovakia	49.1	5.2	62.7	74.8	12.1	31.8	44.8	49.7	5.1
Slovenia	38.6	6.7	60.0	78.6	18.6	39.6	47.8	No data	5.4
South Africa	No data	No data	60.0	62.2	2.2	12.1	24.0	50.4	4.6
Spain	49.1	4.9	66.0	80.7	14.7	38.3	50.2	56.5	5.7
Sweden	75.5	21.9	62.0	80.8	18.8	54.6	77.8	68.5	6.3
Switzerland	73.9	21,9	65.0	81.8	16.8	71.4	89.7	62.5	6.4
Tajikistan	No data	No data	63.0	67.6	4.6	3.9	16.5	No data	3.0
Turkey	33.4	19.4	60.0	76.4	16.4	28.1	29.3	45.2	4.4
UK	63.4	21.1	66.0	79.8	13.8	44.9	77.2	61.4	6.3
Ukraine	No data	No data	60.0	68.0	8.0	13.1	28.5	No data	3.8
USA	61.8	30.8	66.2	76.3	10.1	63.5	90.1	62.2	6.2
Vietnam	No data	No data	60.0	69.6	9.6	8.7	21.5	No data	4.0

Source: elaborated by the author based on the data of PwC Global, 2017; Lanvin & Monteiro, 2021; Trading Economics. 2022; World Health Organization, 2020; Schwab & World Economic Forum, 2017.

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Data Availability Statement: all data provided in the Appendix

Janis KUDINS is a Doctoral Candidate at the Doctoral Program "Management Science" at Faculty of Education and Management of Daugavpils University (Latvia). His research interests: silver economy, workforce aging, sustainable development, lifelong learning, knowledge economy.
ORCID ID: https://orcid.org/0000-0002-5870-8023