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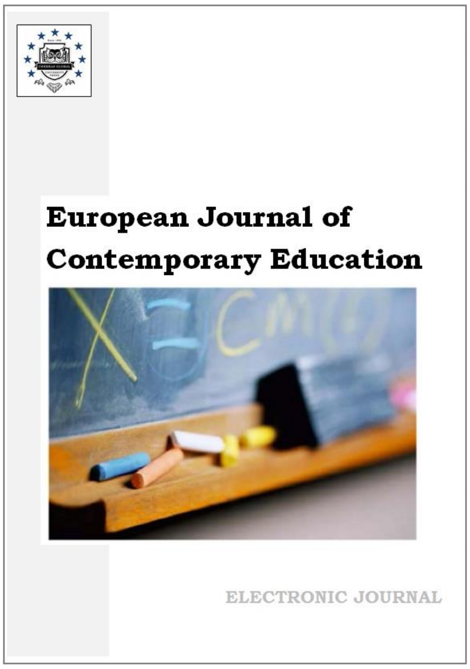

Does Higher Education Promote Human Capital Development: Comparison of Russia and OECD Countries

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Abstract

The aim of the study is to identify the key determinants of human capital in Russia compared to OECD states. This is done using the quantitative methodology, namely an OLS regression method. This method allows for indicating linear relationships between human capital represented by the human capital index developed by the World Bank and a set of factors potentially affecting this indicator. The explored factors include higher education enrolment, level of innovations, per capita income, inflation, unemployment rate, rankings of national universities and academic activity. The study is conducted for years 2010, 2012, 2017 and 2018 for which human capital index estimations are available.

The findings underline a significant and positive linkage between secondary and tertiary education enrolment and human capital. In addition, R&D expenditures appear to have a positive impact on human capital as well. This emphasises that investment in science-oriented higher education and innovations contribute to the economic wellbeing of future generations reflected by the human capital index. Also, some positive relationship between the university rankings and human capital is identified although not for all years.

The specific of Russian higher education is a huge gap between theoretic education and practice. The share of population with secondary and tertiary education and the number of published scientific articles is higher in Russia than the average across OECD. However, the share of practitioners in science and the percentage of R&D expenditures in GDP are significantly lower in Russia.

Keywords: human capital, higher education, R&D expenditures, innovation, economic growth.

1. Introduction

The present makes more and more demands to human actions, personal features, level of knowledge and quality of social interactions. The history of development of leading world economies evidences that economic growth and an increase in the life qualify of population are possible only under the condition of the transition to the knowledge economy. In this case, the wellbeing of entire countries is determined not only by the abundance of their natural resources but mostly by technical innovations and the ability to implement and benefit from theoretical findings (Barro, Lee, 2013). This transition to the post-industrial economy is only possible if appropriate human resources are available. In this light, the quality of education becomes the key factor of forming human capital (Morrisson, Murtin, 2013).

Human capital was argued to be the most productive factor in the modern world capable to provide sustainable competitive advantage (Soukiazis, Antunes, 2012). Islam et al. argued that human capital is mostly created and developed within the educational system, especially in its upper levels (Rabiul Islam et al., 2014). Therefore, the main question of the study is to what extent higher education is able to contribute to the development of human capital. Accordingly, the aim of the study is to estimate the significance of the relationship between higher education factors and human capital.

2. Literature review

The theory of human capital was developed as an attempt to answer the question "Why are investments into education made and are they necessary?" The pioneers of this theory such as Becker (Becker, 1967) and Schultz (Schultz, 1988) suggested that it is necessary to invest into education and in the quality of human's life since it further leads to an increase in productivity at the state level and stimulates economic growth. The directions of such investment may include expenses on formal education at all levels, professional training and health. What is important, these expenditures increase future productivity at the expense of current consumption which is why they are considered as investment (Olugbenga, Campbell, 2013).

Three arguments were suggested in favour of investing in human capital (Babaola, 2003). First, the author suggested that further generations should be given opportunities to obtain knowledge generated and accumulated by previous generations. Second, future generations might find new ways of applying the knowledge based on new technologies. Third, education will encourage people to develop new ideas, technologies, methods and processes using creative approaches. Fagerland and Saha argued that investment in human capital would ultimately stimulate economic growth of the society and transition to the knowledge-based economy (Fagerland, Saha, 1997). In this vein, van den Berg also argued that more educated labour force would ensure positive externalities for the society (Van den Berg, 2001). One of the possible channels of this transformation of education into the economic growth is through development and implementation of innovations as human capital ensures more creative and technically complicated approaches to addressing social challenges.

In addition, patterns in returns from higher education were explored (Montenegro, Patrinos, 2014). They found a descending trend in returns in the sense that additional years of schooling ensured positive effects but the surplus from each additional year was decreasing. Along with that, the authors argued that tertiary education provided the highest returns. A positive relationship between education, human capital and economic indicators was revealed by Tanzharikova (Tanzharikova, 2012). Botev et al. (Botev et al., 2019) proposed a new measure for human capital and compared its relationship with education and economic productivity for a set of well-known economic models. The results evidenced that a newly proposed indicator performed well in the tested models and also reflected a significant relationship between human capital and economic growth.

3. Data and variables

This section presents the variables employed in the study and reveals their sources. Moreover, it explains what results are expected in the regression analysis. The analysis captures the period from 2010 to 2020. However, the required data were available only for 2010, 2017, 2018 and 2020, therefore only these years are explored. The matter is that the data for human capital measurements are available only for these years. Accordingly, the data sample includes all 36 OECD countries that entered this organisation before 2021 plus China and Russia. The latter country is included as the focus of the study is on the comparison of Russian indicators with those of the leading world economies. Meanwhile, China is included due to its consistent efforts of modernising its economy through innovations and technical progress. Besides, China has the second largest number of universities included in the top 1000 world universities, behind only the USA, according to the Centre for World University Rankings (CWUR, 2022). Therefore, it looks that China can be included into the sample as one of the world's leading countries in the sphere of education.

The following variables are employed in the analysis. The dependent variable is the human capital index (HCI). This is a cross-country metric measuring the human capital that a child born today can expect to attain by her 18th birthday, given the risks of poor health and poor education prevailing in their country. The HCI brings together measures of different dimensions of human capital: health (child survival, stunting, and adult survival rates) and the quantity and quality of schooling (expected years of school and international test scores). Using estimates of the economic returns to education and health, the components are combined into an index that captures the expected productivity of a child born today as a future worker, relative to a benchmark of complete education and full health. The HCI ranges from 0 to 1, so that an HCI value of, for instance, 0.5 implies that a child born today will be only half as productive as a future worker as she would be if she enjoyed complete education and full health.

The education variables include secondary and tertiary school enrolment, state expenditures for research and development (R&D) as percentage of GDP, the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences and the university quality. Secondary and tertiary school enrolments are the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. These ratios show which part of the population have at least entered the secondary and tertiary education levels, respectively. The R&D expenditure reflects to which extent the state governments contribute to the development of science and innovations which in turn increase the level of productivity and thus contribute to human capital. The university quality variable is calculated as the number of universities included in the top 1000 ranking by CWUR. The number of research articles indirectly reflects the level of fundamental science in a country. In addition, the variables of the number of technicians and researchers per 1 million people are also included in the sample. These two variables demonstrate how many people in a country are involved in practical science and thus contribute to human capital development as well. It is expected that all these independent variables are positively connected with HCI which would mean that all of them contribute to human capital development.

Two control variables are also used in the analysis, namely per capita income growth and unemployment rate. The former is connected with human capital through the opportunities for self-development an individual obtains with higher income. On the other hand, this indicator reflects the level of life quality in a country which is directly connected with human capital. Meanwhile, the unemployment rate shows what portion of labour force remains beyond the official labour market and thus has less opportunities for enhancing their lives. The income growth rate is expected to be positively connected with human capital whereas the linkage between HCI and unemployment is expected to be negative.

The data for the analysis are taken from two sources. The data on university rankings are taken from CWUR (CWUR, 2022). The data for the remaining variables are taken in the World Development Indicators database (World Bank, 2022).

3. Methods

This section briefly describes the research design, outlines the research methods and provides the empirical model for the analysis.

Research Design

The study tests the hypotheses on the relationship between educational and R&D variables and human capital in Russia and OECD countries. To test these hypotheses, quantitative study is conducted which stipulates the use of mathematical and statistical methods of analysis. Secondary data are used in the study as these data have already been collected, refined and published for aims other than the aims of this study.

Research Methods

An ordinary least squares (OLS) regression analysis is employed for testing the research hypotheses. This procedure stipulates estimation of linear relationships between the dependent variable and a range of independent variables through determination of appropriate parameters of a fitted regression line which would be as close to real observations as possible. The overall sample is examined using a panel regression analysis. As the data in the sample changes in two dimensions, namely between OECD countries and over time, the panel analysis looks to be the optimal method. Observations across countries may vary considerably so that the standard regression error term might be unable to account for the dependent variable variance. Thus, additional components should be introduced into the model to account for the excessive variance. This can be done through the use of either fixed effects (FE) or random effects (RE).

The FE specification suggests that observations across countries vary so significantly that dummy variables for each observation have to be used to distinguish between them. Meanwhile, the RE specification suggests that there is no need to introduce a large number of dummy variables, and it is possible to absorb excessive variance by introducing a single additional variable. This method consumes less degrees of freedom compared to the FE-specification and thus is easier to apply, but it may produce inconsistent outcomes. The Hausman specification test is conducted to determine which type of effects should be applied. The p-value of the test statistic is compared with the threshold level 0.05. If the p-value is higher than this level, then the null hypothesis suggesting that RE-model outcomes are consistent is accepted. In the opposite case, this hypothesis is rejected, and the FE-model is applied.

Besides conducting the panel analysis, cross-sectional analysis for particular years (2010, 2017, 2018 and 2020) is run. The matter is that while the data on HCI were available for these years, the data on university ranking staring only from 2012 were available. Also, the data on several variables in 2020 were unavailable as well. Besides, the analysis of a comparatively small sample for only four years and a substantial share of lacking observations would produce biased outcomes. The cross-sectional analysis in which data change only over countries add to the understanding of relationships between educational and scientific variables and the level of human capital in the entire sample.

Model

The model is specified as follows:

$$HCI_{i,t} = \beta_0 + \beta_1 Secondary_{i,t} + \beta_2 Tertiary_{i,t} + \beta_3 Researchers_{i,t} + \beta_4 Technicians_{i,t} + \beta_5 RD_{i,t} + \beta_6 Unemployment_{i,t} + \beta_7 Article_{i,t} + \beta_8 Income_{i,t} + \beta_9 University_{i,t} + \varepsilon_t$$

Where for country I and year t, Secondary is the secondary school enrolment, Tertiary is the tertiary school enrolment, Researchers is the number of researchers per 1m of population, Technicians is the number of technicians per 1m of population, RD is the R&D expenditure as % of GDP, Unemployment is the share of unemployed labour force, Article is the number of published scientific and technical articles, Income is the income per capita growth, University is the university quality, β_0 is the intercept, $\beta_1 - \beta_9$ are the regression coefficients, ε_t is the error term.

Hypotheses

The following hypotheses are tested in the study:

H01: There is no significant relationship between the share of population with higher education and human capital.

H02: There is no significant relationship between the quality of universities and human capital.

H03: There is no significant relationship between the level of practical research and human capital.

Although the research hypotheses are formulated to deny significant relationships between explored variables, this is done in line with the statistical test formulations. In fact, it is expected that all these variables are significant determinants of human capital.

4. Results

This section presents the outcomes of the analysis. First, the indicator values for Russia are compared with the corresponding average values for the remaining sample that includes all OECD countries and China. After that, the regression analysis is conducted. Finally, the obtained results are discussed in the light of the research aims and previous literature.

Comparison of Scientific Indicators in Russia and OECD

The analysis section starts with exploring the trends in the data. In particular, the mean variable values across the OECD + China sample are compared to those in Russia for different periods. In particular, the means for the entire sample are compared as well as means for each of the explored years, namely 2010, 2017, 2018 and 2020. The mean values of the variables for the OECD countries and for Russia are presented in Table 1.

Table 1. Comparison of Indicators between OECD countries and Russia

Indicator	Total		2010		2017		2018		2020	
	Sample	Russia	Sample	Russia	Sample	Russia	Sample	Russia	Sample	Russia
Human capital index (HCI)	0.744	0.685	0.734	0.601	0.754	0.729	0.750	0.729	0.740	0.681
Secondary education enrolment (%)	111.9	103.6	104.4		115.2	103.4	115.3	103.8		
Tertiary education enrolment (%)	72.8	83.2	67.2		73.7	81.9	75.9	84.6		
Technicians per 1 m people	1 189	454	1 034	474	1 376	451	1 136	4 305	4 634	2 722
Researchers per 1 m people	4 150	2 852	3 499	3 098	4 212	2 822	438	2 784		
R&D expenditures (% of GDP)	1.98	1.08	1.8	1.1	1.9	1.1	2.0	1.0	2.2	1.1
Number of scientific articles	49 262	62 077								
Income per capita growth, %	0.53	4.52								
Unemployment, % of labour force	7.07	5.75								

Several cleat tendencies can be observed from the sample analysis. First, the values of HCI are consistently higher for OECD countries that in Russia. The highest mean value of HCI was in 2017, namely 0.754, whereas the lowest one in 2010, namely 0.734. Meanwhile, the highest HCI value in Russia was in 2017 and 2018, namely 0.729 which is quite close the OECD values, whereas the lowest HCI value was in 2010, namely 0.601. These values imply that although the index of human capital has been growing in Russia during the last decade, from 0.601 in 2010 to 0.729 in 2017 and 2018, it remained lower that the average across OECD countries. Remarkably, the highest average HCI values can be observed for Japan and South Korea, both equal to 0.826.

Secondary education enrolment in Russia was lower compared to the OECD average level, namely 103 % versus 111 %, respectively. What is interesting, tertiary education enrolment in Russia was over 10 % higher than the OECD average, 83 % against 72 %, respectively. Similarly, the average number of scientific articles equal to 62k was higher in Russia while this number was only 49k in OECD countries despite a huge contribution of the US where about 420k publications are made annually. Along with that, the number of technicians and researchers per 1 million people in Russia was 450 and 2850 specialists, respectively. This can be compared to over 2000 technicians and over 5000 researchers per million in Luxembourg, Switzerland or Scandinavian countries. In addition, the share of R&D expenditures in the Russian budget is almost twice lower than on average in OECD countries and three times lower than in Switzerland, Sweden and the US.

This likely reveals a large problem of the Russian science. While the share or tertiary education students and the number of scientific articles is higher than in the OECD, the number or science practitioners and R&D expenditures are much lower. This, in turn, points to a great gap between the theoretic research and practice and Russia. It looks that, a large number of theoretical developments are implemented in practice with lower intensity and efficiency than in the leading innovative economies of the world.

Regression Analysis

The main step of the analysis is the statistical estimation of the influence of scientific variables on the HCI. In this analysis, Russia is included into the overall sample. As mentioned in the Methodology section, several regressions are run. Specifically, a panel regression analysis is conducted for the entire sample while a cross-sectional regression analysis is conducted for 2010, 2017, 2018 and 2020 separately. The outcomes of all regression models are presented in Table 2.

Table 2. Regression Analysis

Variable	Coefficient (Standard Error)					
	Total sample, FE	Total sample, RE	2010	2017	2018	2020
Secondary	0.002 (0.000) ***	0.002 (0.000) ***	0.000 (0.001)	0.002 (0.001) *	0.001 (0.000) **	
Tertiary	0.001 (0.000) **	0.001 (0.000)	0.001 (0.001)	0.000 (0.001)	0.001 (0.000) *	
Researchers						0.058 (0.017) ***
Technicians	0.020 (0.012)	0.022 (0.009) **	0.017 (0.015)	0.008 (0.014)		
RD	0.015 (0.009)	0.019 (0.007) ***	0.035 (0.020) *	0.027 (0.011) **	0.016 (0.007) **	0.006 (0.011)
Unemployment		0.000 (0.002)	-0.003 (0.002)	-0.005 (0.002) *	-0.003 (0.002)	
Article			0.007 (0.006)	0.009 (0.010)	-0.016 (0.011)	
Income			-0.001 (0.002)	0.005 (0.003)	0.009 (0.003) **	-0.002 (0.002)
University			0.001 (0.012)	0.030 (0.013) **	0.003 (0.007)	
_cons	0.265 (0.071) ***	0.304 (0.054) ***	0.430 (0.121) ***	0.343 (0.170) *	0.663 (0.106) ***	0.249 (0.130) *
R-squared	0.567	0.669	0.767	0.845	0.700	0.678
F-stat (p-value)	22.55 (0.000) ***	107.32 (0.000) ***	6.1 (0.003) ***	6.8 (0.003) ***	7.00 (0.000) ***	8.41 (0.000) ***

***significant at the 1 % level; **significant at the 5 % level; *significant at the 10 % level

Prior to analysing each model, it is necessary to explore their explanatory ability measured by two indicators, namely R-squared and the p-value of the F-statistics. R-squared indicates what portion of the HCI variance can be explained using the independent variables in each model. All models have high explanatory power as R-squared varied between 0.567 and 0.845. This means that the constructed models were able to able between 56 % and 85 % of HCI variance.

As for the F-statistics, they test particular models for the presence of significant coefficients. The nature of the F-test is the following. The null hypothesis is that there are no significant coefficients, and the explanatory power of the model is not higher than that of the intercept-only model. However, if the null hypothesis is rejected, then the alternative hypothesis of the significance of at least one coefficient is accepted. This is checked by comparing the p-value of the F-statistic with the threshold level which is equal to 0.05 for the 5 % significance level. The tests showed that p-values were lower than 0.05 for all the models. Therefore, all of them contain significant coefficients that have to be determined using t-tests. T-tests are conducted using the same logic, but the significance of particular coefficients in a model is estimated.

First, the full sample was explored using a panel regression analysis. The analysis of the full model appeared to be impossible both for the FE and RE specifications. For the FE-model, the unemployment rate, number of scientific articles, income growth rate and the university variables were omitted because of multicollinearity. This can be explained by a small size of the sample and lacking observations. As for the RE-model, the insufficient number of observations was also the reason for the model test failure. Once the correlated variables were omitted, both models were analysed using a restrained number of variables including secondary and tertiary education enrolment, number of technicians per 1 m people and countries' R&D expenditures as percentage of GDP.

The FE-specification indicated that secondary and tertiary enrolments were significantly and positively related with human capital. Meanwhile, the RE-specification indicated that secondary education enrolment, share of technicians and R&D expenditures had a significant linkage with the human capital variable. The Hausman specification test showed that the RE-model results are inconsistent which means that the FE-model outcomes have to be used for the analysis.

Next, the cross-sectional regressions are run for each of the four explored years. For 2010, only the R&D expenditures are shown to have significant impact on HCI. The linkage was positive and significant but only at the 10 % level. For 2017, secondary school enrolment, R&D expenditures and university ranking were shown to have a positive and association with human capital. Meanwhile, a negative impact of unemployment at the 10% level was also detected. For 2018, both secondary and tertiary school enrolment as well as R&D expenditures and were shown to have a significant impact on human capital. In addition, per capita income growth was shown to have a positive influence on the dependent variable. For 2020, most observations for the variables for secondary and tertiary school enrolment and number of scientific articles and technicians were unavailable, so the regression model included only 5 independent variables. Accordingly, only the number of researchers per 1m people had a significant and positive effect on HCI.

5. Conclusion

The study aimed to determine the main determinants of human capital in Russia compared to OECD countries. The findings indicated a significant and positive relationship between involvement of population into the system of secondary and tertiary education and human capital. This is in line with the findings by Montenegro and Patrinos (2014) who also underlined a substantial role of higher education in the development of human capital. Also, the research detected a positive relationship between government spending on R&D and the level of human capital. This implies that investment in science-oriented higher education and innovations have a positive impact on the economic wellbeing of future generations represented by the HCI. Some positive linkage between the quality of universities and human capital has also been revealed although not for all years.

As for Russia, a gap between theoretic and practical education was revealed. In particular, the share of population with secondary and tertiary education and the number of published scientific articles were higher in Russia than the average across OECD countries whereas the concentration of practitioners in science represented by the number of technicians and researchers, and R&D expenditures were significantly lower in Russia. This finding might point to one of the most significant problems of the Russian science that inhibits the country's economic growth. The study showed that not only investments in human capital, but also the appropriate implementation of theoretical developments is important. These findings can be interesting and useful for policy makers seeking the ways of stimulating innovative production in Russia.

Along with the findings, some limitations of the study should be underlined. First of all, the availability of data on HIC for only several years significantly limited the longitudinal scope of the research. Second, there is still no consensus in the academic science on how to measure and represent human capital. This is explained by the fact that while most researchers recognise the importance of this concept in the post-industrial economy and necessity of investing into development of human abilities, the particular factors comprising this concept are still debated.

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