

IMPACT OF HUMAN CAPITAL DEVELOPMENT ON PRODUCTIVITY GROWTH IN EU MEMBER STATES

Alma MAČIULYTĖ-ŠNIUKIENĖ¹, Kristina MATUZEVIČIŪTĖ^{2,*}

¹ *Vilnius Gediminas Technical University, Department of Business Technologies,
Sauletekio Ave. 11, Vilnius, Lithuania*

² *Siauliai University, Social Innovation Research Centre of Siauliai University Research Institute,
Visinskio str. 25, Siauliai, Lithuania*

Received 12 January 2018; accepted 06 May 2018

Abstract. In this research, we investigate the impact of human capital on labour productivity in European Union member states using panel data analysis. Results of the paper are estimated using the Pooled ordinary least squares (OLS) and Fixed effects model (FEM). The results show that human capital is positively significant in improving the growth of labour productivity in the EU. Our estimates also suggest that the impact occurs after three times lags in case of education expenditure.

Keywords: human capital, productivity, health care expenditure, education expenditure.

JEL Classification: J24, E24, I15, I25.

Introduction

The growing economic integration, globalization, international openness in the context of regionalization, more and more enhances the competitiveness of countries and regions. One of the most important economic policy goals in European Union is the development of national competitiveness. Social and economic development of a country and its standard of living depend on the ability to identify competitiveness problems, to anticipate problem solving approaches and to anticipate the extent to which such problems are solved. Low labour productivity is one of the indicators which negatively affects competitiveness of the EU countries. So, this encourages increasing interest in analysing a productivity and its impact factors. The importance of human capital for labour productivity growth has been discussed very intensively during the last two decades. Authors emphasize that productivity growth can be achieved improving labours skills and knowledge, together with physical and mental health.

The impact of human capital development on country productivity level is theoretically justified, but the results of empirical research vary. Differences in results may occur, as the

*Corresponding author. E-mail: matuzeviciute@gmail.com

effect may depend on the level of productivity already achieved by the country, as well as on the analysis period. The effect may not be determined due to the fact that the possible lagged effects are often not evaluated. Therefore, in order to eliminate these limitations of the previous research, we will seek to determine the effects of time lags and the achieved level of productivity.

The rest of the paper is organized as follows: Section 1 presents literature review on relationship between human capital and labour productivity. Section 2 describes research variables, hypotheses and model. Section 3 presents the estimation results and summarises research findings. The last section concludes the paper.

1. Impact of human capital on labour productivity: theoretical background

The concept of human capital was shaped by a change in the composition of the capital involved in the product development process. Potelienė and Tamašauskienė (2014) define human capital as a personal knowledge, acquired skills, education, innate abilities, experience, attitudes, behaviour, intellect, creativity, entrepreneurship, motivation, innovation, insights, accumulated experience, physical, emotional and mental condition of health, energy, orientation in the environment, the ability to properly and timely use the knowledge and skills, and other personal characteristics that increase the productivity and income in the form of wages. It is the most developed concept of human capital, covering both human capital components and the goals and result of its development (increasing labour productivity and labour income). Based on this definition, it can be said that the concept of human capital is multidimensional and includes elements of human capital and the impact of accumulation and utilization of its resources on individual income and can be analysed in a micro and macro level. As many authors note (Drucker, 1999, Delsen & Schonewille, 1999; Chani & Shahid, 2012; Whalley & Xiliang, 2013; and others) human capital influences the country's economic growth, labour productivity and increases national competitiveness.

In the model (see Figure 1), human capital is treated as the complex of two main elements: education and health, which are developed through investment in education and in the form of additional training and investment in health care. It should be noted that in all analysed researches, human capital is related to formal education and training in work (time-based learning, education level, or investment in education). Meanwhile, health as an element of human capital is ignored. According to Bloom, Canning, and Sevilla (2004), Pocas (2014) it can be stated that the impact of investment in health improvement on productivity can occur directly because a healthier person is working more productively, and also through life expectancy changes, increased population learning abilities and creativity, reduced income inequality, which makes it possible to accumulate more human capital resources due to higher investment in education and through active increase in the share of labour force in the population. The impact of human capital components on labour productivity occurs both directly and indirectly. The direct relationship between investment in employee training (in all forms) and experience also investment in employee health, which are measured at macro level by public and private investment in the education system and healthcare system, as well as private training costs, generates increasing labour productivity. Figure 1 presents channels of human capital impact on labour productivity.

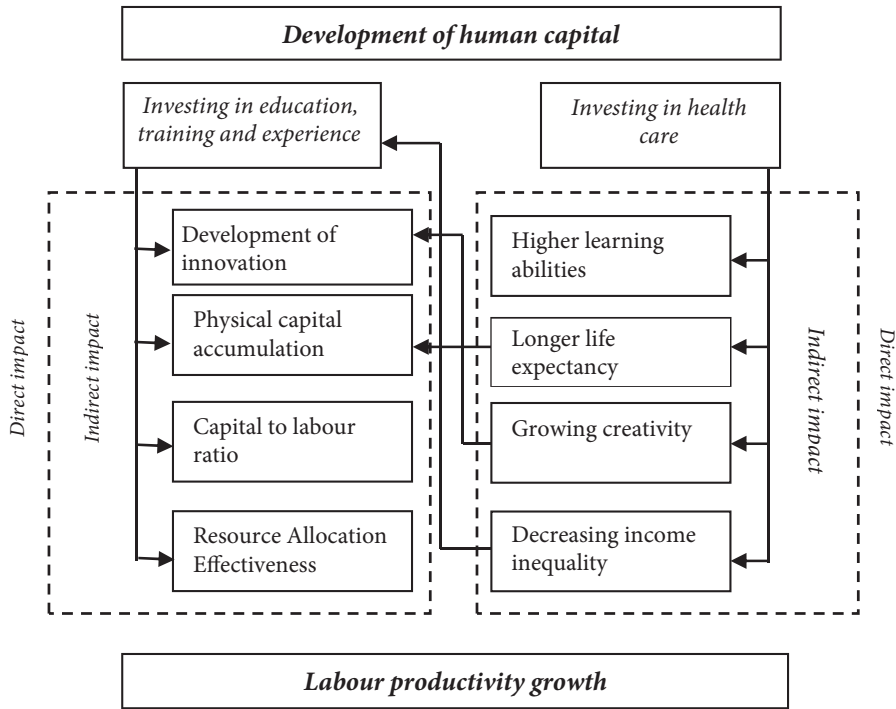


Figure 1. The model of human capital development impact on labour productivity (made by authors)

The macro level researches on the effect of human capital on productivity can be divided into two groups: single country (Afrooz, Rahim, Noor, & Chin, 2010; Umoru & Yaqub, 2013; Backman, 2014; Arshad & Ab Malik, 2015) and cross-country (Bloom et al., 2004; Rivera & Currais, 2003; Belorgey, Lecat, & Maury, 2006; Chansarn, 2010; Jajri & Ismail, 2010; Qu & Cai, 2011; Fleisher, Hu, Li, & Kim, 2011; Goos, Konings, & Vandeweyer, 2015). Some of the recent studies (Ucbasaran, Westhead, & Wright, 2008; Chansarn, 2010; Afrooz et al., 2010; Jajri & Ismail, 2010; Forbes, Barker, & Turner, 2010; Qadri & Waheed, 2014; Goos, Konings, & Vandeweyer, 2015; Chang, Wang, & Liu, 2016; Benos & Karagiannis, 2016; Goldin, 2016) have identified that human capital in terms of education has positive impact on labour productivity growth. While other researches by Bloom et al. (2004), Rivera and Currais (2003), Lopez-Casasnovas, Rivera, & Currais (2005), Howitt (2005), Becker (2007), Umoru and Yaqub (2013), Dillender (2016) included health aspects as well in measuring the magnitude of human capital influence on labour productivity. de la Escosura and Rosés (2010), Gano-takis (2012), Slaper, Hart, Hall, & Thompson (2011), McGuirk, Lenihan, & Hart (2015) pay attention to the innovations as a key driver of productivity. The investment in higher education enhances productivity in country (Annabi, Harvey, & Lan, 2011; Annabi, 2017). Bartel (1995) explored the impact of training of skilled workers on productivity and wage levels and found that the number of days spent in training did not have statistically significant impact on productivity. Black and Lynch (1996) found that formal education has a positive impact

on productivity, while other types of training, such as computer training, have no statistically significant impact. In many researches (Appleton, Hoddinott & Mackinnon, 1996; Nielsen & Westergaard-Nielsen, 2001; Teal, 2001; Wabba, 2000; Keswell & Poswell 2004; Burger & Teal, 2014) it was stated that education has a significant direct positive effect. Other authors (Delsen & Schonewille, 1999; Polasek & Schwarz-Bauer, 2011; Yunus, Said, & Hook, 2014) found that the level of education does not have statistically significant effect on productivity.

After analysing empirical research on the impact of human capital on productivity, it can be stated that the results of the research depend on the research sample, the analysis period, the level of research, the methods, the measurement of human capital and other parameters. The impact of human capital on productivity has a significant impact not in all countries.

2. Research methodology and data

In various scientific works, the development of human capital is measured by different indicators. In our research we have used education expenditure and health care expenditure to measure the development of human capital. The health expenditure, as an indicator of the human capital development, was used in the studies Tompa (2002), Reino, Kiander, and Matti (2006), Panopoulou and Pantelidis (2012), Razmi, Abbasian, and Mohammadi (2012), Eneji, Dickson, and Onabe (2013), Hartwig (2015), etc. Education expenditure as an indicator of human capital development used Annabi et al. (2011), Farzanegan (2011), Olimpia (2012), Panopoulou and Pantelidis (2012), Hartwig (2015), Annabi (2017), etc. This confirms the acceptability of the use of selected indicators. In the paper, we used added value per employee as a standard indicator to reflect the productivity.

Multiple regression analysis was used to investigate the effect of human capital development on productivity. Regression analysis may use time series, cross sectional and panel data (Asteriou, 2009). In this study we used panel data. According Hsiao (2003), because of the higher degrees of freedom, the higher volatility and the lower amount of collaterals, the panel data models are more reliable than time series or cross sections. They enable to include in model a larger number of independent variables at a relatively short time; to include fictitious (pseudo) variables; allows to control the heterogeneity of variables, as well as check lagged effects. Using panel data, three regressive models are essentially applied: Pooled ordinary least squares (OLS), Fixed effects model (FEM) and Random effects model (REM). Because of the high number of variables used and the small number of objects, the regression analysis of random effects methods cannot be applied, so the analysis is done using two methods: fixed effects and least squares.

Gwartney et al. (2006) recommends use data of the longest possible period in order to minimize the impact of business cycles, the impact of various external shocks on economic indicators. We used the data of EU member states (except Luxembourg and Croatia) for 1995–2015 period from World Bank data base. The beginning of the period was determined by the fact that The World Bank (and other) database published statistics of new EU member states (joining in 2004) only since 1995. Data for 2016 is not yet published. Luxembourg was eliminated from the sample due to the excessive gap from other countries, Croatia – due to the lack of data.

In the *first stage* EU member states were assigned to clusters characterised by relatively high (RHP) and relatively low (RLP) productivity. Referring to Everitt, Landau, Leese, and Stahl (2001), for this assignment we used cluster analysis. We assigned countries in a way that differences in terms of productivity among them would be smaller within the cluster than between the clusters.

In the *second stage*, we aim to identify when, if any, the impact of human capital development on productivity occurs and for how long it lasts. Here we are testing the first hypothesis: *H1 – Development of human capital positively affects productivity in countries with relatively low, as well as with relatively high level of productivity, but it takes time for this effect to occur.*

On the basis of initial testing, the six-year period chosen to examine the impact of human capital on productivity.

Model realizing FE method:

$$\begin{aligned} \ln(Vape_{i,t}) = & \alpha + \delta_8 td2002_t + \dots + \delta_{21} td2015_t + \beta \ln(HelthEXPtot_{i,t}) + \\ & \beta_1 \ln(HelthEXPtot_{i,t-1}) + \beta_2 \ln(HelthEXPtot_{i,t-2}) + \beta_3 \ln(HelthEXPtot_{i,t-3}) + \\ & \beta_4 \ln(HelthEXPtot_{i,t-4}) + \beta_5 \ln(HelthEXPtot_{i,t-5}) + \beta_6 \ln(HelthEXPtot_{i,t-6}) + \\ & \lambda \ln(EducEXPtot_{i,t}) + \lambda_1 \ln(EducEXPtot_{i,t-1}) + \lambda_2 \ln(EducEXPtot_{i,t-2}) + \\ & \lambda_3 \ln(EducEXPtot_{i,t-3}) + \lambda_4 \ln(EducEXPtot_{i,t-4}) + \lambda_5 \ln(EducEXPtot_{i,t-5}) + \\ & \lambda_6 \ln(EducEXPtot_{i,t-6}) + v_{i,t} \end{aligned} \quad (1)$$

Model realizing OLS method:

$$\begin{aligned} \Delta \ln(Vape_{i,t}) = & \alpha + \delta_9 td2003_t + \dots + \delta_{21} td2015_t + \beta \Delta \ln(HelthEXPtot_{i,t}) + \\ & \beta_1 \Delta \ln(HelthEXPtot_{i,t-1}) + \beta_2 \Delta \ln(HelthEXPtot_{i,t-2}) + \beta_3 \Delta \ln(HelthEXPtot_{i,t-3}) + \\ & \beta_4 \Delta \ln(HelthEXPtot_{i,t-4}) + \beta_5 \Delta \ln(HelthEXPtot_{i,t-5}) + \beta_6 \Delta \ln(HelthEXPtot_{i,t-6}) + \\ & \lambda \Delta \ln(EducEXPtot_{i,t}) + \lambda_1 \Delta \ln(EducEXPtot_{i,t-1}) + \lambda_2 \Delta \ln(EducEXPtot_{i,t-2}) + \\ & \lambda_3 \Delta \ln(EducEXPtot_{i,t-3}) + \lambda_4 \Delta \ln(EducEXPtot_{i,t-4}) + \lambda_5 \Delta \ln(EducEXPtot_{i,t-5}) + \\ & \lambda_6 \Delta \ln(EducEXPtot_{i,t-6}) + v_{i,t} \end{aligned} \quad (2)$$

where:

- Dependent variable $Vape_{i,t}$ – value added per employee in the country i in the period t ;
- Independed variable: $HelthEXPtot_{i,t}$ – total health expenditure (USD) in the country i in the period t ; $EducEXPtot_{i,t}$ – total education expenditure (USD) in the country i in the period t ;
- β – the coefficient, which reflect impact of health expenditure on productivity in current time;
- $\beta_1 \dots \beta_6$ – the coefficients, which reflect impact of health expenditure on productivity after one to six years;
- λ – the coefficient, which reflect impact of education expenditure on productivity in current time;
- $\lambda_1 \dots \lambda_6$ – the coefficients, which reflect impact of health expenditure on productivity after one to six year.

H1 hypothesis approval conditions: $\beta > 0, p > 0,05$; $\lambda > 0, p > 0,05$; at least one $\beta_{1\dots 6} > 0, p < 0,05$; at least one $\lambda_{1\dots 6} > 0, p < 0,05$.

In the *third step* we explore the impact of human capital development on productivity growth through productivity level. Based on theoretical assumptions and retrospective studies, we are testing hypothesis: *H2 – the quantitatively higher human capital impact on productivity is manifested in the countries with relatively low productivity.*

Two econometric models were conducted for hypothesis testing. In econometric models we used cluster of RLP countries as the base category that will be the starting point for impact assessments. In this group, the estimated impact coefficient will be evaluated directly, and for the RHP countries cluster, the coefficients determined will show the difference from the base category. It should be noted that, we have chosen a time lags taking into account the results obtained in the second stage of the research.

Model realizing FE method:

$$\begin{aligned} \ln(Vape_{i,t}) = & \alpha + \delta_6 td2000_t + \dots + \delta_{21} td2015_t + \beta_{21} \ln(HelthEXPtot_{i,t-2}) + \\ & \beta_{22} \ln(HelthEXPtot_{i,t-2}) \cdot RHP_{i,t} + \beta_{31} \ln(HelthEXPtot_{i,t-3}) + \\ & \beta_{32} \ln(HelthEXPtot_{i,t-3}) \cdot RHP_{i,t} + \lambda_{31} \ln(EducEXPtot_{i,t-3}) + \\ & \lambda_{32} \ln(EducEXPtot_{i,t-3}) \cdot RHP_{i,t} + \lambda_{41} \ln(EducEXPtot_{i,t-4}) + \\ & \lambda_{42} \ln(EducEXPtot_{i,t-4}) \cdot RHP_{i,t} + v_{i,t}. \end{aligned} \quad (3)$$

Model realizing OLS method:

$$\begin{aligned} \Delta \ln(Vape_{i,t}) = & \alpha + \delta_7 td2001_t + \dots + \delta_{21} td2015_t + \beta_{21} \Delta \ln(HelthEXPtot_{i,t-2}) + \\ & \beta_{22} \Delta \ln(HelthEXPtot_{i,t-2}) \cdot RHP_{i,t} + \beta_{31} \Delta \ln(HelthEXPtot_{i,t-3}) + \beta_{32} \Delta \ln(HelthEXPtot_{i,t-3}) \cdot RHP_{i,t} + \\ & \lambda_{31} \Delta \ln(EducEXPtot_{i,t-3}) + \\ & \lambda_{32} \Delta \ln(EducEXPtot_{i,t-3}) \cdot RHP_{i,t} + \lambda_{41} \Delta \ln(EducEXPtot_{i,t-4}) + \\ & \lambda_{42} \Delta \ln(EducEXPtot_{i,t-4}) \cdot RHP_{i,t} + v_{i,t}, \end{aligned} \quad (4)$$

where:

- Dependent variable $Vape_{i,t}$ – value added per employee in the country i in the period t ;
- Independent variable: $HelthEXPtot_{i,t}$ – total health expenditure (USD) in the country i in the period t ; $EducEXPtot_{i,t}$ – total education expenditure (USD) in the country i in the period t ;
- β_{21} – the coefficient reflecting the impact of health expenditure on productivity in the base group of countries (RLP) in the second year after the costs incurred;
- β_{22} – the coefficient reflecting the difference between the impact of health expenditure on productivity in the RHP countries relative to the RLP countries, in the second year after the costs incurred;
- β_{31} – the coefficient reflecting the impact of health expenditure on productivity in the base group of countries (RLP) in the third year after the costs incurred;
- β_{32} – the coefficient reflecting the difference between the impact of health expenditure on productivity in the RHP countries relative to the RLP countries, in the third year after the costs incurred;
- λ_{31} – the coefficient reflecting the impact of education expenditure on productivity in the base group of countries (RLP) in the third year after the costs incurred;
- λ_{32} – the coefficient reflecting the difference between the impact of education expenditure on productivity in the RHP countries relative to the RLP countries, in the third year after the costs incurred;
- λ_{41} – the coefficient reflecting the impact of education expenditure on productivity in the base group of countries (RLP) in the fourth year after the costs incurred;

- λ_{42} – he coefficient reflecting the difference between the impact of education expenditure on productivity in the RHP countries relative to the RLP countries, in the fourth year after the costs incurred.

Hypothesis approval conditions: $\beta_{21}, \beta_{31}, \lambda_{31}, \lambda_{41} > 0, p < 0,05; \beta_{22}, \beta_{32}, \lambda_{32}, \lambda_{42} > 0$ or $< 0, p < 0,05$.

3. Estimation results and discussion

As it was explained above, in *the first stage* of estimation EU member states (except Luxembourg and Croatia) were divided into relative high productivity (RHP) and relative low productivity (RLP) clusters (see Table 1).

Table 1. EU member states by productivity level (results of cluster analysis)

RHP cluster	Ireland, Austria, Belgium, Denmark, Spain, Finland, France, United Kingdom, Italy, Netherlands, Sweden, Germany.
RLP cluster	Bulgaria, Cyprus, Czech Republic, Estonia, Greece, Latvia, Lithuania, Poland, Malta, Portugal, Romania, Slovakia, Slovenia, Hungary.

In *the second study stage*, effect of all countries education and health expenditures on productivity were examined in order to determine the duration of impact and confirm or deny H1 hypothesis. To achieve this goal regression analysis was used: fixed effects and ordinary least squares models (equations 1 and 2).

The results of the research indicate that statistically significant positive effect of health expenditure on productivity is manifested in the second and third years after the costs incurred. Statistically significant positive effect of education expenditure on productivity is manifested in the third and fourth years after the costs incurred. This result was obtained by using both regression analysis methods (FE and OLS), which confirms the reliability of the results obtained. These estimation results are in line to prove first hypothesis. It is not surprising, that it takes time for health and education expenditures to transit into higher productivity.

According to the results of estimation, it can be argued that 1% increase the total health expenditure, in two statistically significant years of impact, productivity would increase on average by 0.26% (based on the FE model) to 0.31%. (based on the OLS model). The 1% increase in education expenditure, over a period of statistically significant impact, would result an increase in productivity by an average of 0.18%. (based on the FE model) to 0.23% (based on the FE model). Therefore, estimations additionally disclosed that increase of health expenditure influences productivity more comparing with increase of education expenditure. These results are surprising. In traditional point of view education is more important for productivity improvement comparing with society health. Nevertheless, such result could occur due to the high level of education achieved by EU countries.

In the *third study stage*, we have investigated differences in human capital impact on productivity in EU relatively high and relatively low productivity clusters. The estimation was conducted taking into account that, statistically significant positive impact of human capital on productivity is manifested after time lag. Estimation results are presented in table 2 (3 ir 4 equations).

Table 2. Research findings on the impact of the human capital development on labour productivity in European Union countries clusters

Coefficients	1 and 2 equations		Coefficients	3 and 4 equations	
	FE	OLS		FE	OLS
α	0,724*	0,030***	α	-0,365	-0,053***
δ_8	0,049***		δ_6	-0,079***	-
δ_9	0,103***	0,036***	δ_7	-0,060**	0,074***
...			...		
δ_{20}	0,009	-0,076***	δ_{20}	0,236***	-0,002***
δ_{21}	0,067***	-0,017	δ_{21}	0,262***	0,104***
β	-0,008	0,039	β_{21}	0,148***	0,181**
β_1	0,013	0,033	β_{22}	-0,122**	-0,190**
β_2	0,135***	0,181***	β_{31}	0,131**	0,159**
β_3	0,127***	0,130***	β_{32}	-0,135**	-0,133**
β_4	0,048	0,025	λ_{31}	0,110**	0,093**
β_5	0,016	0,045	λ_{32}	-0,125***	-0,051**
β_6	0,025	0,029	λ_{41}	0,102***	0,082***
λ	0,001	0,003	λ_{42}	-0,089**	-0,091**
λ_1	0,050	0,019			
λ_2	0,022	0,008			
λ_3	0,108***	0,093***			
λ_4	0,121***	0,083**			
λ_5	0,055	-0,007			
λ_6	0,009	0,012			
n	390	364	n	442	416
$R^2_{kor.}$	0,793	0,682	$R^2_{kor.}$	0,488	0,579
DW	1,771	1,867	DW	0,403	1,825
Information criteria					
Schwarz	-1137	-1113	Schwarz	-556	-1075
Akaike	-1334	-1210	Akaike	-762	-1176
Hannan-Quinn	-1257	-1171	Hannan-Quinn	-680	-1136

Note: * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Before discussing the results of the research, first of all it should be noted that realized FE and OLS models differ in reliability. This conclusion is based on information criteria. The lower value of Schwarz, Akaike and Hannan-Quinn criteria means higher reliability (Konishi & Kitagawa, 2008). So, based on the obtained values, it is concluded that the results of the realization of OLS models are more reliable. For this reason, when assessing the impact of human capital development on productivity in RHP and RLP clusters, discussion of findings are based on the OLS model results.

Results of regression analysis show, that higher education and health expenditure positively correlate with productivity in both clusters. However, differences of human capital impact on productivity between clusters are statistically significant. It is seen that impact of education and health expenditure on productivity is bigger in countries with relatively low productivity level compared with countries that have relatively high productivity level. This evidence is in line with *H2* hypothesis.

Estimation results show that the increase in total health expenditure by 1% determines the average increase in productivity by 0.34% in relatively low productivity countries and 0.17% in relatively high productivity countries during a statistically significant period of impact. After increase in total education expenditure by 1%, productivity increases by 0.18% in relatively low productivity countries and 0.03% in relatively high productivity countries in two years of a statistically significant period of impact.

It is likely that EU countries with relatively low productivity can increase productivity investing in education and health care more comparing with relatively low productivity countries because RHP countries have exhausted their productivity potential. Over 1995–2015 period, productivity in RLP countries on average increased by 52%, while in RHP countries – by 237%. Over the analysis period, the value added per employee increased in Lithuania (489%), Latvia (435%) and Romania (426%). At the same time, it has grown in Germany (15%), UK (30%) and Finland (34%).

Conclusions

Theoretical analysis reveals that results of empirical research vary according to analysis period and primary productivity level. Low labour productivity is one of the main indicators decreasing EU competitiveness. So it is important to analyse the factors influencing labour productivity. As it was show in theoretical analysis human capital is treated as education and health and it influences country's economic growth productivity and national competitiveness.

Results of examining the impact of human capital development, expressed by health and education expenditure, on EU member states productivity revealed positive and significant impact. This effect occurs with two years lag and lasts for two years in case of health expenditure, and after three times lag and also lasts for two years in case of education expenditure. This allows us to argue that human capital is one of source of productivity growth.

It was also found that impact of human capital development on productivity is bigger in countries with relatively low productivity level compared with countries that have relatively high productivity level. It can be assumed that this result is influenced by the high level of productivity achieved by RHP countries, i.e. there is probable that these countries have exhausted their productivity potential.

References

- Afroz, A., Rahim, K. B. A., Noor, Z. B. M., & Chin, L. (2010). Human capital and labor productivity in food industries of Iran. *International Journal of Economics and Finance*, 2(4): 47-51. <https://doi.org/10.5539/ijef.v2n4p47>
- Annabi, N. (2017). Investments in education: what are the productivity gains?. *Journal of Policy Modeling*, 39, 499-518. <https://doi.org/10.1016/j.jpolmod.2017.03.003>

- Annabi, N., Harvey, S., & Lan, Y. (2011). Public expenditure on education, human capital and growth in Canada: an OLG model analysis. *Journal of Policy Modeling*, 33, 852-865.
<https://doi.org/10.1016/j.jpolmod.2011.08.020>
- Appleton, S., Hoddinoti, J., & MacKinnon, J. (1996). Education and health in sub-Saharan Africa. *Journal of International Development*, 8(13), 307-339.
[https://doi.org/10.1002/\(SICI\)1099-1328\(199605\)8:3<307::AID-JID394>3.0.CO;2-D](https://doi.org/10.1002/(SICI)1099-1328(199605)8:3<307::AID-JID394>3.0.CO;2-D)
- Arshad, M. N., & Ab Malik, Z. (2015). Quality of human capital and labor productivity: a case of Malaysia. *International Journal of Economics, Management and Accounting*, 23(1), 37-55.
- Asteriou, D. (2009). Foreign aid and economic growth: new evidence from a panel data approach for five South Asian countries. *Journal of Policy Modeling*, 31(1), 155-161.
<https://doi.org/10.1016/j.jpolmod.2008.04.012>
- Backman, M. (2014). Human capital in firms and regions: impact on firm productivity. *Papers in Regional Science*, 93(3), 557-575. <https://doi.org/10.1111/pirs.12005>
- Bartel, A. P. (1995). Training, wage growth, and job performance: evidence from a company database. *Journal of Labor Economics*, 13(3), 401-425. <https://doi.org/10.1086/298380>
- Becker, G. S. (2007). Health as human capital: synthesis and extensions. *Oxford Economic Papers*, 59(3), 379-410. <https://doi.org/10.1093/oeq/gpm020>
- Belorgey, N., Lecat, R., & Maury, T. P. (2006). Determinants of productivity per employee: an empirical estimation using panel data. *Economics Letters*, 91(2), 153-157.
<https://doi.org/10.1016/j.econlet.2005.09.003>
- Benos, N., & Karagiannis, S. (2016). Do education quality and spillovers matter? Evidence on human capital and productivity in Greece. *Economic Modelling*, 54, 563-573.
<https://doi.org/10.1016/j.econmod.2016.01.015>
- Black, S. E., & Lynch, L. M. (1996). Human-capital investments and productivity. *AEA Papers and Proceedings*, 86(2), 263-267. Harvard University, Cambridge.
- Bloom, D. E., Canning, D., & Sevilla, J. (2004). The effect of health on economic growth: a production function approach. *World development*, 32(1), 1-13. <https://doi.org/10.1016/j.worlddev.2003.07.002>
- Burger, R. P., & Teal, F. J. (2014). The effect of schooling on worker productivity: evidence from a South African Industry panel. *CSAE Working Paper WPS/2014-10*.
- Chang, C. F., Wang, P., & Liu, J. T. (2016). Knowledge spillovers, human capital and productivity. *Journal of Macroeconomics*, 47, 214-232. <https://doi.org/10.1016/j.jmacro.2015.11.003>
- Chani, M. I. & Shahid, M. (2012). Human capital formation and economic development in Pakistan: an empirical analysis. *Aktual'ni problemi ekonomiki*, (6), 486-495.
- Chansarn, S. (2010). Labor productivity growth, education, health and technological progress: a cross-country analysis. *Economic Analysis and Policy*, 40(2), 249-261.
[https://doi.org/10.1016/S0313-5926\(10\)50027-4](https://doi.org/10.1016/S0313-5926(10)50027-4)
- de la Escosura, L. P., & Rosés, J. R. (2010). Human capital and economic growth in Spain, 1850-2000. *Explorations in Economic History*, 47(4), 520-532. <https://doi.org/10.1016/j.eeh.2010.02.002>
- Delsen, L., & Schniewille, M. (1999). *Human capital and labour productivity. Integration of Institutions and endogenous growth*. Paper for the EALE conference in Regensburg.
- Dillender, M. (2016). The potential effects of the affordable care act on disability insurance and workers' compensation. *The Economics of Health*, 81-102.
- Drucker, P. (1999). Knowledge – worker productivity: the biggest challenge. *California Management Review*, 41(2), 78-94. <https://doi.org/10.2307/41165987>
- Eneji, M. A., Dickson, V. J., & Onabe, B. J. (2013). Health care expenditure, health status and national productivity in Nigeria (1999-2012). *Journal of Economics and International Finance*, 5(7), 258-272.
<https://doi.org/10.5897/JEIF2013.0523>

- Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2001). *Cluster analysis* (5th ed.). London: John Wiley & Sons.
- Farzanegan, M. R. (2011). *Education spendings and productivity in Iran: where have the education expenditure gone?* Selected Paper of Politics and Economic Development ERF 17th Annual Conference, Turkey.
- Fleisher, B. M., Hu, Y., Li, H., & Kim, S. (2011). Economic transition, higher education and worker productivity in China. *Journal of Development Economics*, 94(1), 86-94.
<https://doi.org/10.1016/j.jdeveco.2010.01.001>
- Forbes, M., Barker, A., & Turner, S. A. (2010). The effects of education and health on wages and productivity. *Productivity Commission Staff Working Paper* 1-97.
- Ganotakis, P. (2012). Founders' human capital and the performance of UK new technology based firms. *Small Business Economics*, 39(2), 495-515. <https://doi.org/10.1007/s11187-010-9309-0>
- Goldin, C. (2016). Human capital. In C. Diebolt & M. Hauptert (Eds.), *Handbook of cliometrics* (pp. 55-86). Berlin, Heidelberg: Springer-Verlag. https://doi.org/10.1007/978-3-642-40406-1_23
- Goos, M., Konings, J., & Vandeweyer, M. (2015). Employment growth in Europe: the roles of innovation, local job multipliers and institutions. *Local Job Multipliers and Institutions*. No. 15-10.
- Gwartney, J. D., Holcombe, R. G., & Lawson, R. A. (2006). Institutions and the impact of investment on growth. *Kyklos*, 59(2), 255-273. <https://doi.org/10.1111/j.1467-6435.2006.00327.x>
- Hartwig, J. (2015). Structural change, aggregate demand and employment dynamics in the OECD, 1970–2010. *Structural Change and Economic Dynamics*, 34, 36-45.
<https://doi.org/10.1016/j.strueco.2015.06.001>
- Howitt, P. (2005). Health, human capital, and economic growth: a shumpeterian perspective. In G. Lopez-Casasnovas, B. Rivera, & L. Currais (Eds.), *Health and economic growth. Findings and policy implications* (pp. 19-40). The MIT Press, Cambridge, MA.
- Hsiao, Ch. (2003). *Analysis of panel data* (2nd ed.). Cambridge: Cambridge university press.
<https://doi.org/10.1017/CBO9780511754203>
- Jajri, I., & Ismail, R. (2010). Impact of labour quality on labour productivity and economic growth. *African Journal of Business Management*, 4(4), 486.
- Keswell, M., & Poswell, L. (2004). Returns to education in South Africa: a retrospective sensitivity analysis of the available evidence. *The South African Journal of Economics*, 72(4), 834-860.
<https://doi.org/10.1111/j.1813-6982.2004.tb00136.x>
- Konishi, S., & Kitagawa, G. (2008). *Information criteria and statistical modeling*. Kyushu University: Springer. <https://doi.org/10.1007/978-0-387-71887-3>
- Lopez-Casasnovas, G., Rivera, B., & Currais, L. (2005). Introduction: the role health plays in economic growth. In G. Lopez-Casasnovas, B. Rivera, & L. Currais (Eds.), *Health and economic growth. Findings and policy implications* (pp. 1-16). The MIT Press, Cambridge, MA.
- McGuirk, H., Lenihan, H., & Hart, M. (2015). Measuring the impact of innovative human capital on small firms' propensity to innovate. *Research Policy*, 44(4), 965-976.
<https://doi.org/10.1016/j.respol.2014.11.008>
- Nielsen, H. S., & Westergaard-Nielsen, N. (2001). *Returns to schooling in LDCs: new evidence from Zambia*. Centre for Labour Market and Social Research, Denmark.
- Olimpia, N. (2012). *Labour productivity and human capital in the EU countries: an empirical analysis*. Retrieved from <http://steconomiceuoradea.ro/anale/volume/2012/n1/048.pdf>.
- Panopoulou, E., & Pantelidis, T. (2012). Convergence in per capita health expenditure and health outcomes in the OECD countries. *Applied Economics*, 44(30), 3909-3920.
<https://doi.org/10.1080/00036846.2011.583222>

- Pocas, A. (2014). Human capital dimensions – education and health – and economic growth. *Advances in Business-Related Scientific Research Journal (ABSRJ)*, 5(2), 111-120.
- Polasek, W., & Schwarzbauer, W. (2011). Human capital and regional growth in Switzerland. *Review of Economic Analysis*, 3, 46-58.
- Potelienė, S., & Tamašauskienė, Z. (2014). Žmogiškojo kapitalo konceptualizacija: raida, samprata ir formavimas. *Verslo sistemos ir ekonomika*, 4(1), 89-106.
- Qadri, F. S., & Waheed, A. (2014). Human capital and economic growth: a macroeconomic model for Pakistan. *Economic Modelling*, 42, 66-76. <https://doi.org/10.1016/j.econmod.2014.05.021>
- Qu, Y., & Cai, F. (2011). Understanding China's workforce competitiveness: a macro analysis. *Journal of Chinese Human Resources Management*, 2(1), 8-22. <https://doi.org/10.1108/20408001111148702>
- Razmi, M. J., Abbasian, E., & Mohammadi, S. (2012). Investigation the effect of government health expenditure on HDI in Iran. *Journal of Knowledge Management, Economics and Information Technology*, 5, 1-13.
- Reino, H., Kiander, J., & Matti, V. (2006). *Are government expenditures productive? Measuring the effect on privat sector production*. Government Institute for Economic Research (VATT) Discussion Paper, Helsinki.
- Rivera, B., & Currais, L. (2003). The effect of health investment on growth: a causality analysis. *International Advances in Economic Research*, 9(4), 312-323. <https://doi.org/10.1007/BF02296180>
- Slaper, T. F., Hart, N. R., Hall, T. J., & Thompson, M. F. (2011). The index of innovation: a new tool for regional analysis. *Economic Development Quarterly*, 25(1), 36-53. <https://doi.org/10.1177/0891242410387592>
- Teal, F. (2001). *Education, incomes, poverty and inequality in Ghana in the 1990's*. University of Oxford.
- Tompa, E. (2002). *The impact of health on productivity: empirical evidence and policy implications* (pp. 181-202). The Review of Economic Performance and Social Progress.
- Ucbasaran, D., Westhead, P., & Wright, M. (2008). Opportunity identification and pursuit: does an entrepreneur's human capital matter?. *Small Business Economics*, 30(2), 153-173. <https://doi.org/10.1007/s11187-006-9020-3>
- Umoru, D., & Yaqub, J. O. (2013). Labour productivity and health capital in Nigeria: the empirical evidence. *International Journal of Humanities and Social Science*, 3(4), 199-221.
- Whaba, J. (2000). *Returns to education and regional earnings differentials in Egypt*. University of South Hampton.
- Whalley, J., & Xiliang, Z. (2013). The contribution of human capital to China's economic growth. *China Economic Policy Review*, 2(1), 135-157. <https://doi.org/10.1142/S1793969013500015>
- Yunus, N. M., Said, R., & Hook, L. S. (2014). Do cost of training, education level and R&D investment matter towards influencing labour productivity?. *Journal Economic of Malaysia*, 48(1), 133-142. <https://doi.org/10.17576/JEM-2014-4801-11>