THE IMPACT OF HUMAN CAPITAL ON INNOVATION AND ECONOMIC GROWTH IN ROMANIA

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Abstract
The goal of the Europe 2020 strategy: smart, sustainable and inclusive growth would be achieved by using human capital and its abilities to innovate, to diffuse knowledge in manufacturing services, to develop creative industries and by making a great effort to create a research-intensive economy. The present paper highlights the impact of human capital on innovation and economic growth based on an econometric model. In our paper using annual data during 2000-2015, from UNESCO and Eurostat we prove a positive influence of human capital (expressed as gross enrolment in secondary school and the average personnel costs per employee in the Knowledge-intensive high-technology services) and innovation (expressed by patent application) on economic growth and productivity.

Key words: *human capital, innovation, economic growth, econometric methods*

JEL Classification: *C1, O1, O3, O4*

Introduction

Human capital is defined as "the knowledge, skills, competence and other attributes embodied in individuals that are relevant to economic activity" (Hartog, 1999, p. 1). It has an significant impact on innovation and on economic growth, based on the human abilities to create new products, technologies, services.

There is a large body of literature dedicated to human capital and its interaction with other economic variables like economic growth, competitiveness and productivities. Some of them refer to economic growth (Barro, 1999, Mankiw et al., 1992, De la Fuente and Doménech, 2000); other to labor productivity (Romer, 1990, Mankiw, Romer and Weil, 1992); and many to innovation and technological diffusion (Pistorius, 2004 Siggel, 2000, 2001, Horwitz, 2005, Bontis et all, 2000, Fuente and Ciccone, 2003, Diebolt and Hippe, 2016). The key values of human capital are knowledge as the result of formal and informal learning, experience and native abilities.

We investigate the relation between human capital, innovation and growth in Romania based on regression analysis. The Human development report for 2016 shows that Romania has an overall index of 74.99, ranked 38th from 130 countries included in report, close to Eastern Europe and Central Asia (75.02), that is third in the world after North America and Western Europe. Very important is the fact that the index has a strong performance (rank 25th) in the "65 and over age group" pillar, which reveals that Romania benefits from formally well-educated older population. The Report also highlights large diversity skills in the work force based on LinkedIn's membership profiles, but the perceptions of quality of member states' education system, staff training and the ease of finding skilled employment are still in deficit. Considering the future, the digital skill will dominate the demand for labor, and Romania must be prepared for these developments.

The paper is divided into four parts: first, a short introduction, second part deals with presenting literature review, the third focuses on the data and the model, and the last part presents the results of the model and conclusions.

1. Literature review

Bontis (1999, cited by Bontis et all, 2000, p. 89) argues that "human capital is important because it is a source of innovation" and could be considered an important factor of economic growth.

De la Fuente and Ciccone (2003) consider that human capital has a key role in increasing technological change and diffusion and is an important growth factor.

Kuznetsova and all (2016, p. 516) argued that "innovation is one of the mechanisms to ensure the country's economic growth" and that "the progress in the field of innovation can only be achieved by a person, his abilities, and opportunities" with other words, by human capital.

Mattalia (2012) used a model based on endogenous growth theory which reproduces the aspects of digital economy that focus on human capital accumulation, and proved that human capital accumulation is the engine of growth and that the productivity of schooling affects the economic growth in the long run.

Baldacci and other (2004, p. 15) using panel data with fixed-effect (LSDV) model for 120 developing countries from 1975-2000, argued that "GDP per capita is robustly and positively correlated with both education and health capital. This indicates that higher income levels and greater human capital reinforce each other and contribute to a virtuous circle of growth and higher human capital". They also proved that "an increase in education spending of 1 percentage point of GDP is associated with 3 more years of schooling on average and a total increase in growth of 1.4 percentage points in 15 years" (Baldacci and other, 2004, p. 27).

Diebolt and Hippe (2016,) using literacy and numeracy for human capital, patent applications per million inhabitants for innovation and GDP per capita (in PPS) for economic development, found a significant and positive impact of human capital on the innovation and economic development.

Pelinescu, Elisei (2014) using a panel data for 28 European countries that cover 2000-2012 period, showed a positive and significant correlation between innovation expressed as number of patents and human capital expressed as graduate per 1000 of population aged 20-29, with a 4 year lags, that could be explained by the experience build-up within this period.

2. The data and the model

According to Lynch (1991), human capital can be accumulated by formal education, by experience in the working place and by informal education. However, measuring human capital is a difficult task.

One challenge in our model was to choose the right indicator that could be a good proxy for human capital, taking into consideration that there are a lot of indicators used as proxy, such as: education expenditure as percent of GDP (Nonnemen, Vanhoudt,1996), the average years of schooling of people under 25 year (Barro, Lee,1993; María Serén, 2001), the number of R&D personnel from private sector (Izushi and Huggins, 2004); the number of graduates of tertiary level in the labor force (Baldwin, 1971; Outreville; 1999), „the share of the population that has attained qualification at the tertiary level" (Mattalia, 2012, p..602)

There are many indicators used as proxy for human capital and to choose the best for our study we investigated the Pearson correlation coefficient between the most used indicator (expected years of schooling) and others. The Pearson correlation coefficient between the expected years of schooling (years) usually used as measure for human capital in many studies, and gross enrolment rate as percent of population in secondary school was 0.9060 and the average personnel costs per employee in the Knowledge-intensive high-technology services was 0.843091. Also, we evaluated the power of these human capital indicators in relation with economic growth expressed as GDP per capita and found a high positive coefficient of correlation between GDP per capita and gross enrolment rate as percent of population in secondary school (0.87455) and the personnel costs in the Knowledge-intensive high-technology services (0.993492).

Consequently, we decided to use in our study two indicators as proxy for human capital: the gross enrolment rate as percent of population in secondary school and the personnel costs in the Knowledge-intensive high-technology services. In order to highlight the relation between economic growth and innovation we used the patents application that it is a good proxy for innovation, because it reveals the impact of innovation in production and many other studies use it.

In our paper we used annual data during 2000-2015, from UNESCO Institute for Statistics, World Development Indicators, gross enrolment rate as percent of population in secondary school noted (gross_enrol_sec), and data from Eurostat: GDP per capita in euro (noted GDP_cap); average personnel costs per employee in Knowledge-intensive high-technology services (I64, K72 and K73, from table [htec_emp_sbs], noted pers_cost_kis) and patent applications to the EPO by priority year at the national level (from table [pat_ep_ntot], noted pat).

The data stationary in first difference are GDP_cap, pers_cost_kis and pat and the rest of variable are stationary in logarithm in second difference (the gross_enrol _sec).

Table 1 shows results for statistical descriptions of the model variables: mean, median, the maximum and minimum value, standard deviation, skewness and kurtosis and J. Bera coefficient.

Table 1 Descriptive statistic of variable

	GDP_CAP	**L_GROSS_ ENROL_SEC**	**PAT**	**PERS_COST_ KIS**
Mean	5075	4.50	41.81	1287.19
Median	5950	4.51	31.85	1457.00
Maximum	8100	4.61	102.10	1920.00
Minimum	1800	4.37	6.00	540.00
Std. Dev.	2198.03	0.09	32.16	490.25
Skewness	-0.29	-0.05	0.84	-0.27
Kurtosis	1.54	1.38	2.33	1.46
Jarque-Bera	1.65	1.76	2.19	1.77
Probability	0.44	0.41	0.33	0.41
Sum	81200.00	71.98	668.99	20595.00
Sum Sq. Dev.	72470000.0	0.11	15515.19	3605248.0
Observations	16	16	16	16

Source: the authors computation

The statistical analysis of the model reveals significant differences with a relative large standard deviation. Also, there is an asymmetry on the left side for the data series except for Pat, while Kurtosis increases from 1.38 (L_GROSS_ENROL_SEC) to a maximum of 2.33% (PAT).

The model is a multiple linear regression expressed as:
D(GDP_CAP) = C(1)*D(L_GROSS_ENROL_SEC,2) + C(2)*D(PAT(-3)) + C(3)*D(PERS_COST_KIS) + C(4)
The model is valid, the errors are non-correlated, homoscedastic and with normal distribution, according to the tests made.

3. The results and conclusion

The coefficients, probabilities and the T statistic of the model are presented in table 2

Table 2 The results of the model

Variable	Coefficient	Std Error	T Statistic	Prob
D(L_GROSS_ENROL_SEC,2)	13309.80	3463.158	3.843255	0.0049
D(PAT(-3))	12.67298	4.213519	3.007695	0.0169
D(PERS_COST_KIS)	1.697806	0.367444	4.620583	0.0017
C	259.1342	60.52794	4.281232	0.0027

Source: the authors computation

The R squares was 0.970913, the Adjusted R squared 0.9600 and the DW 2.45. The econometric model shows a clear positive relation between human capital, innovation and economic growth, that is aligned with existing economic theory. The limit of the model is linked with the small number of series. These results are also in compliance with the results of other studies. Sianesi and Reen (2003) concluded that the education has important effects on growth. Diebolt and Hippe (2016, p.7) cited a large literature on the impact of human capital and innovation on economic development and concluded that “both the relative patent application and higher education variable are shown to have a significant impact”. Their study show that “human capital is the most significant historical factor to explain current patent applications per capita and current GDP per capita” (Diebolt and Hippe, 2016, p.25)

Aghion and Howit (2007) proved that the growth of output per worker is caused by technological progress in the sense of Schumpeterian theory in the long run.

References

1. Aghion P., Howitt P., 2007, Capital, innovation and growth accounting, *Oxford Review Policy*, Volume 23, Number 1, pp.79-93
2. Baldwin, R.E. , 1971, Determinants of the commodity structure of US trade, *American Economic Review,* Vol 61(1), pp. 126–146.
3. Barro R. J, 1999, Human capital and growth in cross-country growth regressions, *Swedish Economic Policy review,* Vol. 6, Number 2, Autumn 1999, pp 237-277
4. Barro R, Lee J.H, 2011, A New data Set of Educational Attainment in the World, 1950-2010, http://www.barrolee.com/papers
5. Baldacci E, Clements B, Gupta S, Cui Q., 2004, Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs, *IMF Working Paper No217,* International Monetary Fund
6. De La Fuente, A., Domenech, R., 2000, Human capital in growth regressions: how much difference does data quality make? Paris: OECD, 2000 (ECO / WKP (2000) 35);
7. De la Fuente A. , A. Ciccone, 2003, Human capital in a global and knowledge-based economy, European Commission
8. Diebolt C., Hippe R., 2016, The long run impact on human capital on innovation and economic development in the regions of Europe, *Documents de Travail*, nr.2016-31, Bureau d'économie théorique appliquée (BETA) UMR 7522, Strasbourg
9. Hartog, J., 1999, Human Capital, in *OECD Observer No 215,* January 1999, Accessed: 15/07/2014
10. Horwitz, F. , 2005, HR can advance competitiveness. Executive Business Brief, 10, 50-52.
11. Izushi H., Huggins R., 2004, Empirical analysis of human capital development and economic growth in European regions, *Cedefop Reference series*, 54, Office for Official Publications of the European Communities.
12. Natalia Victorovna Kuznetsova , Ekaterina Victorovna Kocheva, Nikolay Anatolievich Matev, 2016, Modeling of Human Potential Parameters in the Context of Innovation and Technological Development of the Country: Case of Asia-pacific Countries, *International Journal of Economics and Financial Issues*, 2016, 6(2), pp.515-522.
13. Lynch, L. M. 1991, The Role of Off-the-job versus On-the-job training for the Mobility of Women Workers, *American Economic Review, Papers and Proceedings*, vol. 81, pp. 151–6.

14. Mankiw N. G; D. Romer; DN Weil, 1992 Contribution to the Empirics of Economic Growth, *The Quarterly Journal of Economics*, Vol. 107, No. 2 (May, 1992), pp. 407-437;
15. Mattalia C, 2012, Human Capital Accumulation in R&D-based Growth Models, Economic Modelling, 29, pp.601-609
16. NonnemanY., Vanhouldt P., 1996, A futher Augmentation of the Solow and the empirics of Economic Growth for OECD Countries, The Quarterly Journal of Economics, 111(3), pp.943-953
17. Outreville J. François, 1999, Financial Development, Human Capital and Political Stability, UNCTAD Discussion Papers, No. 142
18. Pistorius, C., 2004, the Competitiveness and innovation. Elektron, Vol. 21, No.3;
19. Riley G., 2012, Economic Growth - The Role of Human & Social Capital, Competition & Innovation, http://www.tutor2u.net/
20. Richard R. Nelson; Edmund S. Phelps, 1966 Investment in Humans, Technological Diffusion, and Economic Growth, *The American Economic Review*, Vol. 56, No. 1/2. (Tues, 1966), pp. 69-75;
21. Romer, P., 1990, Human capital and growth: theory and evidence, *Carnegie Rochester Conference Series on Public Policy* 32, pp.251-286.
22. Siggel, E., 2000, Uganda's policy Reforms, Competitiveness and Regional Integration Industry: A comparison with Kenya. *African Economic Policy. Discussion paper 24*;Washington: United States Agency for International Development: Bureau for Africa.
23. Sianesi, B., Reenen Van J. , 2003, The return to Education: Macroeconomics, *Journal of Economic Surveys,* 17, (2), pp.157-200
24. Serén María J. Freire, 2001, Human capital accumulation and economic growth, Investigaciones Económicas, vol.XXV(3), pp.585 602
25. Pelinescu Elena, Elisei C., 2014, The Human Capital in the Knowledge Society. Theoretical and Empirical Approach, *Manager Journal*, Volume 20, issue 1, 2014
26. *** World Economic Forum, The Human Capital Report 2016.