Relationship between human capital and economic growth: The case of Austria

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Abstract. Impact of education, more precisely impact of skills and knowledge (human capital) to increase individual productivity and wealth of a nation, was already emphasized by classical economists. However, their opinions and findings were not included in detailed analyses and systematically processed. Comprehensive concepts of theory of human capital were introduced in the early Sixties of 20th century. In the last twenty years, the influence of human capital was confirmed by many economic studies, more precisely influence of education on economic growth and productivity. On the contrary, some experts criticize this unambiguous and inconclusive relation and some of them even disprove this hypothesis, publishing their studies. This paper considers the relationship of human capital and economic growth in Austria. The importance of human capital in the economic growth of this country is being proven by using two types of econometric analyses. One of them is cointegration test, which is followed by error correction model. In terms of concept simplification, the value of human capital is expressed by the level of education. We found out that positive long-run relationship exists between human capital and economic growth, i.e. national competitiveness.

Keywords: economic growth, human capital, cointegration, error correction model.

JEL Classification: J24, C30
AMS Classification: 62P20

1 Introduction

„Changing economic and social conditions have given knowledge and skills – human capital – an increasingly central role in the economic success of nations and individuals. … The key role of competence and knowledge in stimulating economic growth has been widely recognised by economists and others.“ [19]

The influence of education, actually of knowledge and skills respectively (human capital) to increase the productivity of individuals and the nation's wealth has been emphasized already by classical economists. For example, A. Smith in his book *An Inquiry Into the Nature and Causes of the Wealth of Nations* (1776) expressed the view that education is a form of investment that should bring individual returns which exceed the training costs and time spent learning [3]. Another important economist A. Marshall, in his book *Principles of Economics* (1890) also notes that the most valuable capital is the one which is invested in human beings [3].

Education, however, was considered in the past to be social consumption. The change in the view of education and comprehensive concept of human capital theory in particular, was brought by the Chicago School of economists especially, namely T. W. Schultz [22] with his book *Investment in Human Beings* (1962) and G. S. Becker in his book *Human Capital* (1964). Becker [8] defined human capital as skills and adequate motivation to apply these skills. The main premise, which the human capital theory is based on, postulates that education increases the productivity of the individual. Each individual tries to optimise the return on their investment in education and will continue in the study until the rate of return on her investment in education will exceed the rate of returns of alternative investments. The benefit to the society is then the increased labor productivity of better educated members of society and also technological progress. Schultz in his work focused primarily on the problems of developing countries, where he believes that the source of growth in these countries can be an investment in human capital. Generally, economists of the 1960's were trying to determine how various factors contribute to economic growth.

Human capital as a production factor is included in the new growth theory models. Total product in the endogenous growth models is determined by both physical capital and labor and human capital which is

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accumulated in through education in every individual. The new growth theory applies the extended Solow's model and production function presented in the following form [6]:

$$Y_t = (A_t L_t)^{1-\alpha-\beta} K_t^{\alpha} H_t^{\beta} \tag{1}$$

where Y is the product, A shows the level of technology, L is the labour, K is the physical capital, H is the human capital, α and β determine the proportions of individual factors on the overall product.

P. M. Romer, R. E. Lucas (see [17]) and also N. G. Mankiw, D. Romer and D. Weil contributed significantly to the development of endogenous growth models. Overall, the research in this area confirms the existence of a relationship between the development of education and economic growth. One of the conclusions of endogenous growth models is that economic growth depends partly on the level of human capital. It assumes that human capital is the source of production of new ideas. It is true that the more developed economy, the stronger the relationship of education to the economic growth. While in less developed countries the primary task of starting economic growth nationwide is to ensure primary education, in the developed countries on the other hand is to drive further economic growth primarily on ensuring tertiary education. Romer [21] in his work addresses the issue of differences between the education and experience on the one hand, and technological progress on the other. The main source of economic growth is technological progress, in his opinion. Mankiw, Romer and Weil [18] in their work tried to eliminate shortcomings of the Solow's model by including the human capital expressed as an investment in education. Simplified representation of the value of human capital, respectively identification of human capital investment in education, with the achieved level of education or the number of students in various stages of study, is often a prerequisite in empirical studies examining the human capital at the macroeconomic level.

Barro [4] and others find a strong positive correlation between schooling enrollment and the subsequent growth rate gross domestic product (GDP) per capita. Barro [5] states that the growth of human capital expressed as an average length of education by one year corresponds to an increase of GDP growth by four percentage points a year. Bassanini and Scarpetta [7] states, that their results point to a positive and significant impact of human capital accumulation to output per capita growth. If the average length of study period is ten years, one additional year of study will increase production by six per cent. The existence of correlations between human capital, in this case the number of university graduates, and economic growth in their work was also confirmed by De la Fuente and Donénech [11]. Through that research the need for investment in human capital can be justified. However, there are views that refute or do not confirm the influence of human capital on economic growth. Bils and Klenow [9] in their study do not disprove any correlation between economic growth and human capital. However, they concluded that it is the level of gross domestic product, respectively its growth, leading to a higher level of human capital in the economy. Unlike previous studies on the causality of these variables this one is seen in the reverse order. Söderbom and Teal [24] came to the conclusion that human capital has a small, and not statistically significant effect, on the level of output.

The main aim of this paper is to investigate the relationship between human capital and economic growth. We test the hypothesis whether educational expansion could affect economic growth in case of Austrian economy. Furthermore, we assume the higher economic growth the greater improvement in the competitiveness at the national level. There are many definitions and concepts of national competitiveness and therefore there is not only one approach and definition is still not unique [28]. In accordance with Porter [20] the only meaningful concept of macroeconomic competitiveness is national productivity. Based on this conception and relating approaches (e.g. Schwab [23]) someone could consider productivity and competitiveness as a synonym words. We can thus apply the approach in Hančlová [13] and express competitiveness easier way by means of GDP per capita.

The paper is structured as follows. In Section 2, we introduce and describe the dataset and specify the used methods. In Section 3, we present and discuss the results obtained from testing. Section 4 concludes the paper with summary of crucial findings.

2 Data and econometric methodology

We employ annual data for Austria between 1971 and 2008. GDP per capita at constant prices (2005) in USD was used as a proxy variable of economic growth, while for human capital we used tertiary education[3], more precisely enrolment in tertiary education and public expenditure per pupil in tertiary education (as a % of GDP

[3] There are two stages of tertiary education in ISCED 1997; the first contains tertiary programmes with academic orientation or occupation (ISCED 5) and the second contains tertiary studies that lead to a advanced research qualification – doctorate (ISCED 6). For more details see [27].

per capita). GDP at constant prices were collected from The United Nations database [25], population and education proxies from UNESCO database [26]. We converted all series into logs.

To examine the above mentioned relationship we perform cointegration test followed by error correction model (ECM)[4]. Similar to Asteriou and Agiomirgianakis [2], who examined the relationship in Greek economy. If variables are cointegrated, it indicates there is a long-run relationship or equilibrium. The ECM corrects for disequilibrium in short-run Gujarati [12]. If two or more series are integrated of order 1, i.e. I(1) and a linear combination of them is integrated of order 0, i.e. I(0), then the series are said to be cointegrated. I(1) means the series is non-stationary in level (has a unit root) but after first differencing, I(0) series is stationary in level [1].

To find out whether time series have unit root, i.e. are non-stationary we used augmented Dickey-Fuller test (ADF test), which estimates the following regression [12]:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_t \tag{2}$$

where ε_t is a white noise error term and where $\Delta Y_t = Y_t - Y_{t-1}$, etc. The null hypothesis tests whether $\delta = 0$.

Thus, we can perform cointegration test. Most specifically, we use the Johansen cointegration method (see [14, 15]). First of all we need to determine the lag order of vector autoregression through Akaike information criterion defined as [12]:

$$AIC = e^{2k/n} \frac{\sum \hat{u}_i^2}{n} = e^{2k/n} \frac{RSS}{n} \tag{3}$$

where k is the number of explanatory variables (including the intercept), n is the number of observations, RSS means the residual sum of squares and $2k/n$ the penalty factor.

The next step in Johansen`s approach is to estimate the VECM by maximum likelihood and the number of cointegrating vectors r. We applied two tests: (i) the trace test [10]:

$$\lambda_{trace}(r) = -n \sum_{i=r+1}^{m} \ln\left(1 - \hat{\lambda}_i\right) \tag{4}$$

and (ii) the maximum eigenvalue test:

$$\lambda_{\max}(r) = -n \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{5}$$

where n is the number of observations and $\hat{\lambda}$ is the i:th canonical correlation. The trace test tests the null hypothesis of at most r cointegrating vectors against the alternative more than r. The maximum eigenvalue tests the null hypothesis of r cointegrating vectors against the alternative of $r+1$. Tests reject the null hypothesis if $\lambda_{trace}(r)$ or $\lambda_{max}(r)$ are larger than their critical values or significance level.

As the next step the error[5] should be estimated from the cointegration equations (6) and test for unit root. The error need to be I(0) to confirm the long-run relationship.

$$e = Y_t - \alpha - \beta X_t \tag{6}$$

where e is error, α, β are long-run coefficients.

Finally, the ECM should be estimated [16].

$$\Delta Y_t = \varphi + \lambda_{e_{t-1}} + \omega_0 \Delta X_t + \varepsilon_t \tag{7}$$

where current changes in Y are a function of current changes in X and the degree to which the series are outside of their equilibrium in the previous period. The symbol e denotes the error from equation (6) and it can be

[4] Often also used – vector error correction model (VECM).
[5] Sometimes also called error correction term (ECT).

thought of as an equilibrium error. The model is out of equilibrium, if it is non-zero. The absolute value of λ shows us the correction to equilibrium in next period. Briefly, consider the case $\Delta X_t = 0$, $e_{t-1} < 0$ it indicates the dependent variable is below the equilibrium state, therefore λe_{t-1} should be positive and causes increasing Y in next period.

3 Empirical results

In this section we present and discuss the results from cointegration and ECM in the case of Austria and then compare and evaluate the development of used time series of Austria and the Czech Republic.

3.1 Austria

The ADF test of all time series implies that they are integrated of order one, I(1) at 5 % significance level. Akaike information criterion (AIC) indicates the optimal lag length of one period, i.e. one year[6]. Performing trace test and maximum eigenwalue test to estimate the VECM we yield one cointegration equation by trace test. Results of cointegration rank are shown in Table 1. The null and alternative hypotheses were established: H_0: r = 0 against H_1: r > 0. We reject the null hypothesis at 5 % significance level, therefore the number of cointegrating equations is not equal to zero. In next round we established: H_0: r = 1 against H_1: r > 1. We accepted null hypothesis, thus the number of cointegrating equation equals to one.

H_0	Trace statistic	5 % critical value	Probability 5 %
r = 0	35.2486	35.1928	0.0493
r = 1	19.0088	20.2614	0.0736

Table 1 Unrestricted cointegration rank trace test

Based on trace test, the long-run cointegration vector for our variables is given by following equation:

$$GDPPC_t = 0.903793 ENRTER_t + 0.581762 EXPTER_t - 3.083162 + e_t \quad (8)$$

and test error for unit root. ADF implies error is integrated of order 0, I(0), hence time series are cointegrated and long-run relationship confirmed[7]. Therefore we find a positive long-run relationship between economic growth and human capital and this conclusion is consistent with economic theory. Increasing enrolment in tertiary education (ENRTER) about 1 % will cause increasing GDP per capita (GDPPC) about 0.9 % and increasing about 1 % the public expenditure per pupil in tertiary education (EXPTER) will cause increasing GDP per capita almost 0.6 %. This conclusion confirms the hypothesis established in introduction.

ECM is given by equation (9):

$$\Delta GDPPC_t = 0.0444 e_{t-1} + 0.1864 \Delta GDPPC_{t-1} + 0.1691 \Delta ENRTER_{t-1} + 0.0678 \Delta EXPTER_{t-1} + \varepsilon_t \quad (9)$$

thus, GDP per capita is lower in short-run than in long-run. About 4.4 % of deviation from equilibrium is corrected next period by changes in GDP per capita.

3.2 Comparison with the Czech Republic

In this subsection we present the results of comparison of selected indicators in the Czech Republic and Austria. For the comparison we employ annual data during the period 1998 – 2008, respectively 1999 – 2008 in case of public expenditure[8]. Unfortunately, these data did not allow us to use the same method of evaluation as in the case of Austria. And so we compare the growth rates of economic growth and human capital. Development of these indicators is captured in Figure 1, Figure 2 and Figure 3. Based on these data, we can not confirm the relationship between human capital and economic growth in the Czech Republic unequivocally. A negative value of growth rate of enrolment in Austria was caused by the introduction of tuition fee in 2001.

[6] The same lag length chose [2].
[7] We conducted all needed tests but results are not presented for economy of space.
[8] We used this reduced time series because of former data for Czech Republic were not available.

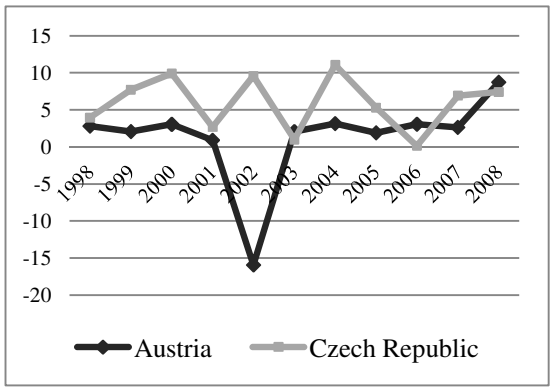

Figure 1 Growth rate of enrolment in total tertiary education (in %)

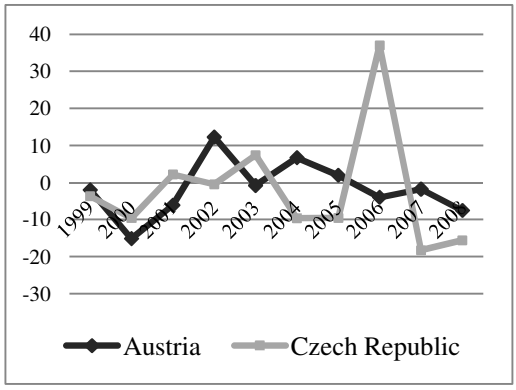

Figure 2 Growth rate of public expenditure on tertiary education per pupil as a % of GDP per capita (in %)

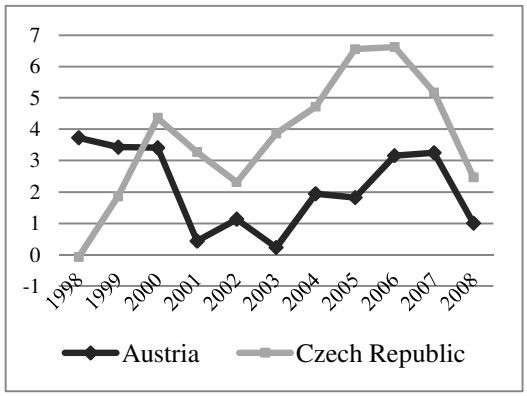

Figure 3 Growth rate of GDP per capita (in %)

4 Conclusion

The aim of this paper was to investigate the relationship between human capital and economic growth. We performed cointegration followed by error correction model. We employed annual data of Austrian economy (1971 – 2008) – GDP per capita for economic growth, enrolment in tertiary education and public expenditure in tertiary education as proxies for human capital. We found out, positive long-run relationship exists among these variables. Therefore, our hypothesis was confirmed. Moreover, according to our assumption, there is a positive relationship between human capital and national competitiveness. In the case of comparison with the Czech Republic we used the reduced time series (1998 – 2008) and based on these data, we can not confirm the relationship between human capital and economic growth in the Czech Republic unequivocally.

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References

[1] Arlt, J.: Kointegrace v jednorovnicových modelech. *Politická ekonomie* **45** (1997), 733-746.
[2] Asteriou, D., and Agiomirgianakis, G. M.: Human Capital and Economic Growth. Time Series Evidence from Greece. *Journal of Policy Modeling* **23** (2001), 481-489.
[3] Balcar, J.: Lidský kapitál a jeho evoluce v ekonomické teorii. *Ekonomická revue* **9**, No. 3 (2006), 86-98.
[4] Barro, R. J.: *Economic Growth in a Cross Section of Countries*. NBER Working Paper No. 3120, 1989.
[5] Barro, R. J: Human Capital and Growth. *The American Economic Review* **91**, No. 2 (2001), 12-17.
[6] Barták, M., and Vomáčková, H.: *Ekonomický rozměr lidského kapitálu*. Universita J. E. Purkyně v Ústí nad Labem, Ústí nad Labem, 2007.
[7] Bassanini, A., and Scarpetta, S.: *Does Human Capital Matter for Growth in OECD Countries?: Evidence from Pooled Mean-Group Estimates*. OECD Economics Department Working Papers No. 282, 2001.
[8] Becker, G. S.: *Human Capital*. Columbia University Press, New York, 1964.
[9] Bils, M., and Klenow, P. J.: *Does Schooling Cause Growth or the Other Way Around?* NBER Working Paper No. 6393, 1998.
[10] Cipra, T.: *Finanční ekonometrie*. Ekopress, Praha, 2008.
[11] De la Fuente, A., and Donénech, R.: *Human Capital in Growth Regression: How much Difference Does Data Quality Make?* OECD Economics Department Working Papers No. 262, 2000.
[12] Gujarati, D.: *Basic Econometrics*. The McGraw-Hill Companies, New York, 2004.
[13] Hančlová, J., Kubicová, I., Macháček, M., Melecký, A., Melecký, L., Melecký, M., Nevima, J., and Ramík, J.: *Makroekonometrické modelování české ekonomiky a vybraných ekonomik Evropské unie*. VŠB-TUO, Ostrava, 2010.
[14] Johansen, S.: Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamics and Control* **12** (1988), 231-254.
[15] Johansen, S.: Estimation and Hypothesis Testing of Cointegration Vectors in Gaussion Vector Autoregressive Models. *Econometrica* **59**, No. 6 (1991), 1551-1580.
[16] Koop, G.: *Analysis of Economic Data*. John Wiley & Sons, Chichester, 2005.
[17] Lucas, R. E.: On the Mechanics of Economic Development. *Journal of Monetary Economics* **22** (1988), 3-42.
[18] Mankiw, N. G., Romer, D., and Weil, D. N.: *A Contribution to the Empirics of Economic Growth*. NBER Working Paper No. 3541, 1990.
[19] OECD. *The Well-being of Nations: The Role of Human and Social Capital*. [Online]. [20th April 2012]. Available on: http://www.oecd.org/dataoecd/36/40/33703702.pdf.
[20] Porter, M. E.: *The Competitive Advantage of Nations: With a New Introduction*. Free Press, New York, 1998.
[21] Romer, P. M.: Endogenous Technological Change. *Journal of Political Economy* **98**, No. 5 (1990), S71-102.
[22] Schultz, T. W.: *Investment in Human Beings*. University of Chicago Press, Chicago, 1962.
[23] Schwab, K., et al.: *The Global Competitiveness Report 2010-2011*. World Economic Forum, Geneva, 2010.
[24] Söderbom, M., and Teal, F.: *Trade and Human Capital as Determinations of Growth*. CSAE Working Paper Series 2001-10, 2001.
[25] UNDATA. *United Nations Data Retrieval System*. [Online]. [9th May 2012]. Available on: http://data.un.org/Explorer.aspx
[26] UNESCO Institute for Statistics. *Predefined Tables*. [Online]. [9th May 2012]. Available on: http://stats.uis.unesco.org/unesco/ReportFolders/ReportFolders.aspx?CS_referer=&CS_ChosenLang=en
[27] UNESCO. *International Standard Classification of Education*. [Online]. [9th May 2012]. Available on: http://www.uis.unesco.org/Library/Documents/isced97-en.pdf.
[28] Verner, T.: National Competitiveness and Expenditure on Education, Research and Development. *Journal of Competitiveness* **3**, No. 2 (2011), 3-10.