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Does higher level of education of the labor force cause growth? Evidence from Bulgaria

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Abstract This study tries to give new evidence on the relationship between human capital and output per capita in the former centrally-planned economies. Educational attainment of the labor force is used as a proxy for the human capital stock in Bulgaria. The empirical models are based on the extended Cobb–Douglas production function with labor, human capital as well as physical capital. In addition, the reduced form specifications include export and foreign direct investments. The econometric outcome suggests that an increase of the share of people with upper secondary education in the labor force is not related to the rate of long-run growth. Moreover, it is inversely related to the shortrun changes in real output. On the contrary, a positive impact is derived for tertiary education. In general, the study does not fully support the hypothesis that the higher average educational level of the population fosters growth. Export, physical capital and foreign direct investments turn out to be the driving forces of Bulgaria's growth. A partial correlation analysis implies that the quality of human capital measured by foreign language proficiency could explain the insignificant effect of secondary education.

Keywords Human capital · Educational attainment · Growth · Foreign language proficiency

1 Introduction

Since the late 80s, the studies on growth have been focusing on the role of human capital specifically education as its main source of accumulation. Despite the growing empirical literature on this issue a number of questions still remain without a definite answer. This paper addresses two of them: (1) Does the increase of the

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human capital stock lead to higher output per capita; (2) Which is more important for growth: the quantity or the quality of human capital?

For almost a decade—between the introduction of the Currency Board (July, 1997) and the last economic crisis (January, 2009)—the Bulgarian economy has been experiencing one of the highest rates of growth in Central and Eastern Europe. Annual real GDP changed from 4.0 % (1998) to 6.7 % (2004) with an average rate of 5.5 %. The purpose of this study is to estimate the contribution of human capital to the long-run trend of economic development. Utilizing the production function approach, I evaluate the link between educational attainment of the labor force and the rate of real GDP changes. The paper also compares the effect of education with that of other growth factors. Last but not least, I try to distinguish between the role of the quantity and the quality of human capital for growth.

The investigated time period is almost 12 years (2000:1—2012:2); the latest data available are for the second quarter of 2012. Due to the limited range of reliable time series data for the former centrally-planned countries, most studies apply cross-sectional analyses. However, their main drawback is the impossibility to explain the country-specific patterns of the long-term economic development and its determinants. Therefore, my paper analyses the growth process in one economy employing time series data. Krueger and Lindhal (1998) point out that a period longer than 5 years is enough for a reliable relationship between human capital and growth to be derived. To overcome the limitation of the data, I use cyclically-adjusted quarterly figures from Eurostat,[1] Bulgarian National Bank[2] and National Statistical Institute.[3]

The basic empirical specification is based on the extended Cobb-Douglas production function with three inputs: labor, physical capital and human capital. The model includes additional growth determinants such export and FDI. Educational attainment of the labor force aged 25–64 years measures the human capital stock. Such an approach solves the problem of endogeneity because the educational level of the population in a given period could reflect the growth trend in the past only. The quantity of human capital is measured by the share of people in the labor force having completed at least upper secondary education. I use foreign language knowledge as a measure of the quality of human resources. This is an adequate measure at least for two reasons: (1). It facilitates the adoption of advanced production technologies and models of management, international trade and FDI especially in small open economies like Bulgaria and (2). Previous studies (Hall and Jones 1999) derive a positive link between the share of people whose mother tongue is one of the most popular European languages and output per capita. The indicators involved in the analysis are the average number of foreign languages learnt per pupil at secondary school as well as the share of people who speak English.

The paper has four sections. Section 2 presents in brief the theoretical models as well as the main empirical findings. A descriptive comparative analysis of human

[1] Quarterly time series for educational attainment of the labor force have been available since the year 2000 at http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsq_agaed&lang=en.

[2] For FDI inflows see the link: http://www.bnb.bg/Statistics/StExternalSector/StDirectInvestments/StDIBulgaria/index.htm.

[3] For GDP, export and business investments see: http://www.nsi.bg/ORPDOCS/GDP_1.2.3.xls.

capital in Bulgaria and the EU member states specifically the post-communist countries form Central and Eastern Europe (CEE) is given in Sect. 3.[4] Section 4 discusses both the methodology and the econometric outcome while the last part summarizes the results of the present study.

2 A review of literature

Two main strands of *theoretical models* investigating the sources of growth could be distinguished in the literature: endogenous growth models and neoclassical models (Solow 1956; Swan 1956). In the models of endogenous growth human capital is a key determinant of the long-lasting growth trend.[5] Romer (1986) focuses on the role of human capital (or "knowledge") for the development of new capital goods and productivity improvements. The rationale behind the devotion of resources to the development of knowledge is the existence of a patent system. Both the limitless process of generation of knowledge and the presence of externalities determine the increasing returns to human capital, which are crucial for growth in the long run.

In the model of Lucas (1988), individuals allocate their time between production and schooling. The assumption that human capital involves constant returns to the existing stock of human capital produces a positive growth rate of output per capita. In both models the growth trend depends on the initial stock of human capital. Nelson and Phelps (1966) propose an alternative explanation. The existence of qualified labor resources enhances the capacity of the country for innovation as well as for adoption and implementation of new and better products, new methods of production as well as new technologies from abroad.

Vandenbussche et al. (2006) point out that only skilled human capital rather than the overall stock of it determines the growth-enhancing effect in advanced economies. As well, the closer the country to the technology frontier i.e. the stock of global technological knowledge available to innovators in all sectors in all economies the stronger the impact of qualified labor force.

An important feature of the endogenous growth theory is that although the individual firm faces diminishing returns, the returns to capital at the aggregate level could be constant or even increasing. This rising marginal productivity in the economy driven by human capital is essential for the growth process. The long-term rate of growth per capita is determined within the model.

The followers of the neoclassical theory introduce human capital in the Solow-Swan model (Mankiw et al. 1992). Both physical and human capital may accumulate over time. However, investments in human capital lead only to transitional growth; no long-run growth of per capita GDP is observed because of the decreasing marginal returns to both types of capital and a lack of externalities.

[4] I use the acronym NMS-9 to denote the New member states of the EU coming from Central and Eastern Europe besides Bulgaria. The group includes Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

[5] See (McCallum 1996), Aghion and Howitt (2009) for a review of endogenous growth literature.

The neoclassical framework is more successful in explanation of the international differences in income than the growth path.

Two main conclusions emerge from the *empirical literature*. First, most studies find that human capital fosters growth (e.g. Barro 1991; Murthy and Chien 1997; Bils and Klenow 2000; Rogers 2008). Benhabib and Spiegel (1994) distinguish between the level effect and the growth effect of education. They emphasize that the level of the human capital stock is directly related to innovations and productivity, while the rate of human capital accumulation does not accelerate growth. De la Fuente and Domenech (2006) apply eight alternative data series on the average years of schooling. The regression coefficient is within the range 0.249/0.348 and is statistically significant.

Hanushek and Woessman (2007) point out that this is not the quantity but the quality of human capital that stimulates aggregate production. It is found that a unit increase (one standard deviation) of the quality of human capital boosts the yearly growth rate by over 1.4 % points. This is about five times larger than the abovementioned coefficient, which measures the effect of its quantity.

The second conclusion is that primary and secondary education has a greater impact on growth than higher education (McMahon 1998; Pereira and Aubyn 2008). Some authors claim that the role of higher education depends positively on the level of economic development (Petrakis and Stamatakis 2002) or the technological advance (Vandenbussche et al. 2006). Griliches (1997) suggests that the puzzling result about the non-significant effect of higher education could be explained by the tendency for more educated people to work in sectors where GDP is under-measured such as services, construction, government sector. In general, the research outcomes are “vulnerable” to both the selected proxy for education and the methodology of the study.

3 Human capital in Bulgaria and the EU-27

This section focuses on some facts about human capital in Bulgaria in comparison with that in the NMS from CEE. The descriptive analysis concerns three proxies: educational attainment of the active population aged 25–64 years measures the stock of human capital; spending on education gives an estimate of how much money is invested in human capital, while foreign language skills can be used to describe the labor-force quality. Figure 1 compares educational attainment in 2000 with that in 2008. About two-thirds (64.6 %) of the EU-27’s labor force had completed at least an upper secondary level in the beginning of the century; their share rose to 71.4 % in 2008.[6] In general, the quantity of human capital is higher in the former centrally planned economies. The greatest values were observed in the Czech Republic (90.9 %), Lithuania (90.6 %) and Slovakia (89.9 %). The figures show that in most CEE countries the quantity of human capital in the overall labor force is very close to its upper limit. This implies that the focus should be directed toward the quality of education.

[6] Throughout the paper, it is accepted that human capital is measured by the population having completed at least upper secondary education.

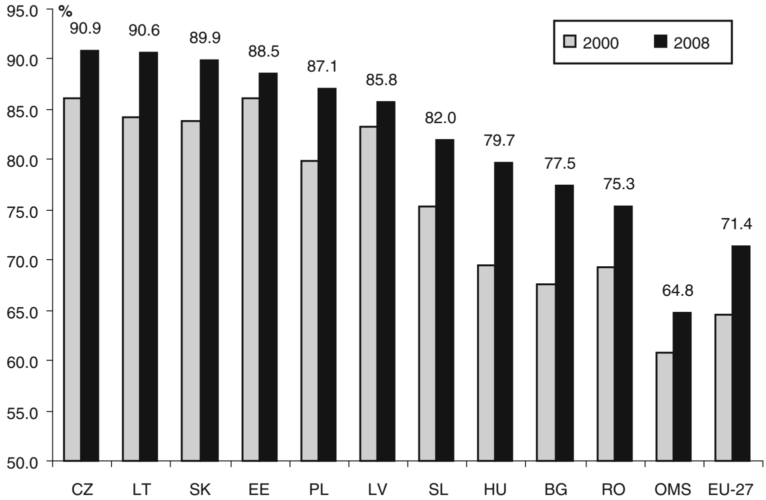

Fig. 1 Educational attainment of the labor force: 2000 vs. 2008. *Source* Eurostat

Bulgaria has the second lowest completion rate (78 %) after Romania due to the larger share of people with secondary education. On the other hand, Bulgaria and Hungary registered the highest expansion (10 %) of the most qualified labor resources over the investigated period. The relatively low quantity of human capital in Bulgaria is confirmed also by the Barro-Lee calculations. Their last update[7] shows that the average years of total schooling for the population aged 25 years and more in 2005 was 9.677 years whereas the corresponding figure for the NMS-9 was 11.142.

In 2008, the estimated overall expenditure per pupil at secondary school amounted to 2290.7€ (56 % of the NMS-9 average), while the value for tertiary education was 4763.3 € (94 %). These figures imply that government[8] invests primarily in higher education. The ratio of annual expenditure per pupil to GDP per capita measures more precisely the priority being given to education in an economy.[9] Bulgaria stands among post-communist member states with the largest ratio for tertiary education (48.8); it is one and a half times higher than that for the other CEE countries (Fig. 2). The graph clearly underlines the structural discrepancies in the sector: the insufficient support for secondary education contrasts with the large volume of spending on higher educational institutions. However, this may cause inefficiency and lower returns to the most qualified human capital (Psacharopoulos 1985).

The third indicator focuses on the quality of human capital. Figure 3a displays the share of people who speak English—the most popular foreign language in

[7] See http://www.barrolee.com.

[8] More than 70% of students learn in public educational institutions.

[9] Between 2000 and 2008 education spending accounted for 4.2% of GDP in Bulgaria and 4.8% in the NMS-9 on average. The values reflect the government's size which was 38.8 and 40.5% respectively.

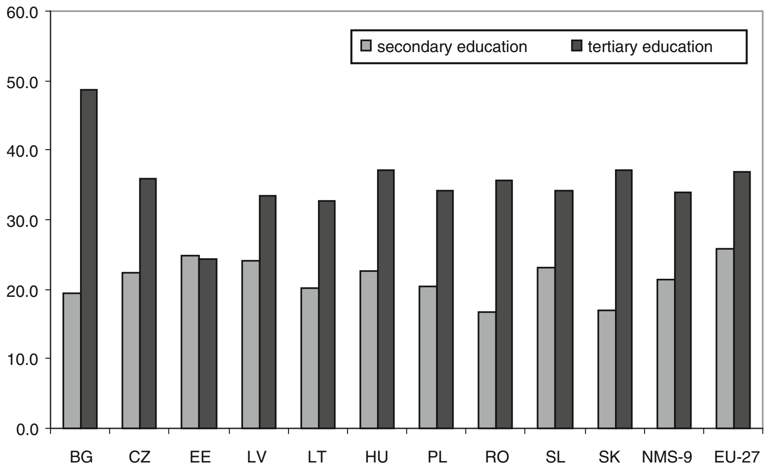

Fig. 2 Public and private expenses on education to GDP per capita (2000–2008). *Source* Eurostat

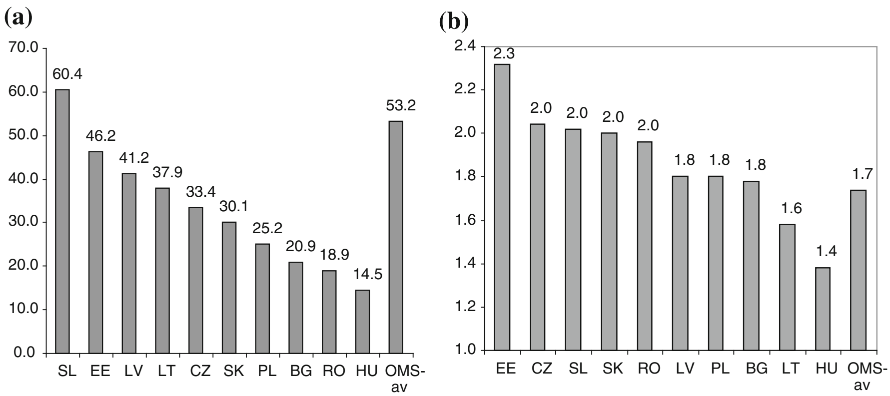

Fig. 3 Knowledge of foreign languages. **a** Popularity of English as a foreign language (2007). Share of people between 25 and 64 years who know English. UK and Ireland are excluded from calculations. Missing values for Luxembourg and Netherlands. **b** Average number of foreign languages learnt per pupil at secondary school (2004–2008)

Europe. The top positions are for Slovenia (60 %) and the Baltic States. Bulgaria is among the last three countries (20.9 %). The second Fig. 3b plots the average number of foreign languages learnt per pupil at upper secondary school between 2004 and 2008. Leaders are Luxembourg (3.0) in the EU-27 and Estonia (2.3) in the NMS. Although recently the foreign language learning has been enhanced, Bulgaria remains in the second half in the NMS-group. English, German and Russian are the three most popular languages among pupils.

The descriptive analysis presented above gives evidence that Bulgaria has a relatively lower stock of human capital in comparison with the NMS and stays closer to the EU-average. On the other hand, the government invests heavily in tertiary education at the expense of secondary schools. The purpose of the following section is to examine the long-run link between the level of human capital and output per capita.

4 Methodology and empirical results

The study utilizes the extended Cobb-Douglas production function to establish a long-run relationship between the educational level of the active population and aggregate output. The models tested here are derived from a production function with three inputs—labor, physical capital and human capital. In case of constant returns to scale, it has the following general form:

$$Y = A * K^{\alpha} * H^{\beta} * L^{(1-\alpha-\beta)} \tag{1}$$

Y is output, K denotes the stock of physical capital, H is the stock of human capital and L is the supply of labor; α and β measure the output elasticity with respect to physical and human capital, respectively. Dividing by L, the equation becomes:

$$\frac{Y}{L} = A * \left(\frac{K}{L}\right)^{\alpha} * \left(\frac{H}{L}\right)^{\beta} \tag{2}$$

Thus, the production function in a logarithmic form is:

$$\ln y = \ln A + \alpha * \ln k + \beta * \ln h \tag{3}$$

where y, k and h are quantities per unit of labor. The parameters α and β measure the elasticity of output with respect to production inputs. In case of developing economies export is added as an additional determinant in the production function. The economic reasoning is the existence of scale effects and externalities associated with export production and sales (Balassa 1978; Tyler 1981). It is appropriate to add export in the case of transition economies as well.[10] The reduced form specification includes also a variable for foreign direct investments.

To catch the long-run trend in the economic development, I use quarterly seasonally and cyclically adjusted real data sets over the period 2000:1–2012:2. The dependent variable is real GDP per unit of labor force. The formula used to calculate the stock of physical capital (K) corresponds to the perpetual-inventory method:

$$K_t = (1 - \delta) * K_{t-1} + I_t \tag{4}$$

where I_t denotes domestic business investments; the annual depreciation rate δ is set to 0.05.[11]

The human capital stock in Bulgaria is measured by people in the labor force having completed at least upper secondary education. The variable SEC includes active population with upper secondary education (ISCED 3-4). Alternatively, the variable HIGH denotes the labor force with tertiary education (ISCED 5-6). In

[10] This extended aggregate production function in a logarithmic form becomes: $\ln y = \ln A + \alpha * \ln k + \beta * \ln h + \gamma * \ln \exp$, where γ is the output elasticity with respect to export.

[11] An explanation of the method and its application for Bulgaria could be found in Ganev (2005).

addition, the variable PRIM represents the share of people with no education, primary or lower secondary education. Export (EXP) and foreign direct investments in Bulgaria are included as ancillary determinants of growth. Equity capital is used instead of total FDI inflows (the variable FDI) because the existence of negative values in the latter makes seasonal adjustment impossible. All variables are expressed as ratios to active population and in logs.

Economic time series are usually non-stationary therefore I apply the usual statistical procedures to test this hypothesis. The existence of a unit root and the order of integration are proven by the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979) as well as the Kwiatowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatowski et al. 1992). According to both of them, the variables are integrated of order 1. The results of the tests are not identical only for active population with tertiary education (the variable HIGH). The ADF test with a constant and trend can not support the null hypothesis for a unit root at the 5 % level of significance ($p = 0.017$). However, the more powerful ADF-GLS test (Elliot et al. 1996) does not reject non-stationarity. The calculated τ-statistics of -1.66759 in case of one lag included is higher than the 5 % critical value (-3.19). Also, the ADF-GLS test for the data in first differences (d HIGH) is -3.30647 which suggests that the variable HIGH also follows an I(1) process. The KPSS test supports the hypothesis that the variables are integrated of order 1.

Perron (1989) points out that the failure to allow for an existing structural break in data leads to a bias that reduces the ability of the ADF test to reject a false unit root hypothesis. Therefore, the next step in my preliminary analysis is to test for structural breaks. The method is similar to that used by Yamatoto (1996) and Hayashi (2005). The structural stability is tested by the Quandt likelihood ratio test assuming a drift and a liner trend in the time processes (see Eq. 5). The optimal time lag is selected on the basis of AIC (Akaike Information Criterion); in most cases it is one. Then, ADF-GLS and KPSS tests are performed again for the time series before and after the suggested quarter of the break.

$$y_t = \alpha + \beta t + \sum_{i=1}^{k} b_i y_{t-i} + \varepsilon_t \qquad (5)$$

Table 5 (see Appendix 1) shows the results of the QLR test, the suggested timing of the break as well as the unit root test statistics; the Chow F-test (Chow 1960) is represented on Fig. 5. Structural breaks appear in all dynamic rows except the variable EXP. Nonetheless, both the ADF-GLS test and the KPSS test confirm that the null hypothesis of a unit root can not be rejected under the assumption of structural instability in the samples used Table 1.

The long-run dependence between non-stationary economic processes is modeled by the co-integrating regression. If more than one co-integrating relations are expected, the Johansen (1988) test is preferred (to, for example, the two-step procedure suggested by Engel-Granger, 1987). The Trace test and L-max test establish the number of co-integrating vectors the system has (see Table 2). The Trace test verifies the hypothesis that the co-integration rank is equal to r against the alternative hypothesis that it is k; the L-max test hypothesizes that the rank is equal

Table 1 Results of the tests for stationarity

Variable	ADF-test[a] τ- statistics (*p* value)	KPSS—statistics[b]
ln RGDP[c]	−0.827 (0.962)	0.59197
dln RGDP	−5.505 (1.63e−005)	0.05546
ln SEC	−2.183 (0.499)	0.23761
dln SEC	−6.301 (2.044e−007)	0.10464
ln HIGH	−3.781 (0.017)	0.22935
dln HIGH	−4.704 (0.0006)	0.13280
ln PRIM	−2.408 (0.3752)	0.15701
dln PRIM	−4.676 (0.0007)	0.05203
ln K	−2.026 (0.586)	0.58697
dln K	−4.188 (0.005)	0.14179
ln EXP	−3.143 (0.096)	0.11010
dln EXP	−4.798 (0.0004)	0.03294
ln FDI	−2.217 (0.480)	0.33929
dln FDI	−7.792 (9.361e−012)	0.04372

[a] H_0: there is a unit root. A model with constant and linear trend is tested

[b] H_0: the time series is stationary. A linear trend is included in all cases

[c] Seasonally-adjusted quarterly data are used over the period 2000:1–2012:2 (N = 50). All variables are per unit of active population and expressed in a logarithmic form

Table 2 Johansen test for co-integration

Rank	Eigenvalue	Trace test	*p* value	Lmax test	*p* value
0	0.7063	198.39	0.000	60.03	0.000
1	0.6939	138.36	0.001	58.06	0.002
2	0.5452	80.36	0.174	38.61	0.043
3	0.2808	41.75	0.786	16.15	0.895
4	0.2577	25.59	0.759	14.61	0.678
5	0.1545	10.99	0.871	8.22	0.798
6	0.0549	2.77	0.890	2.77	0.892

Variables included in the model are RGDP, SEC, HIGH, PRIM, KSTOCK, EXP, FDI inflows. All variable are per unit of active population and expressed in logs. Restrictive trend is selected. The time period is 2000:1–2012:2

to r against the alternative that it is r + 1. The model comprises real output, the capital stock, export, the educational indices of primary, secondary and tertiary education and the FDI inflows. Restricted trend and unrestricted constant are included.

The results give clear-cut evidence that there is at least one eigenvalue which is significantly different from zero, thus supporting the conclusion that the series are non-stationary. Both tests reject the hypothesis that the rank of the co-integrating matrix is equal to zero. They indicate the existence of at least one long-run relationship between the variables.

Because the purpose of this paper is to explore the determinants of real output, I focus on the co-integrating regression in which real GDP is a dependent variable (see Table 3). The method of OLS with heteroscedasticity corrected errors is applied to solve the equations. Models 1 and 3 include FDI, export and a human capital index—SEC or HIGH. The stock of physical capital participates in model 2, model 4 and model 5. The high R^2-value contrasts with the low DW-test statistics.

Table 3 Estimation of the long-run effect of human capital on output per capita

Dependent variable: RGDP

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	3.194 (0.000)	2.102 (0.002)	3.276 (0.000)	1.286 (0.004)	1.975 (0.025)
SEC	0.341 (0.099)	−0.058 (0.811)			
HIGH			0.600 (0.003)	0.406 (0.021)	
PRIM					0.004 (0.960)
KSTOCK		0.431 (0.000)		0.353 (0.000)	0.406 (0.000)
EXP	0.448 (0.000)	0.192 (0.000)	0.353 (0.000)	0.202 (0.000)	0.212 (0.000)
FDI	0.013 (0.007)	0.044 (0.000)	0.027 (0.000)	0.043 (0.000)	0.041 (0.000)
N of obs.	50	50	50	50	50
Adj. R^2	0.967	0.948	0.927	0.948	0.964
F	487.778 (0.000)	225.080 (0.000)	209.870 (0.000)	224.212 (0.000)	332.137 (0.000)
Log-likelihood	−93.802	−99.26	−97.897	−101.44	−97.210
DW	0.487	0.635	0.670	0.902	0.597
Normality of residual: χ^2 -test	23.186 (0.000)	3.301 (0.192)	3.479 (0.176)	2.080 (0.353)	3.326 (0.190)

All variables are expressed per unit of active population in a logarithmic form. *p* values are presented in parentheses

The latter is significant at the 5 % level under the Co-integrating Regression Durbin-Watson (CRDW) test, thus denoting the adequacy of the models.

When the measure of physical capital stock is excluded, the regression coefficient for the variable SEC is positive and significant at the 10 % level. On the contrary, when the full model is considered (see model 2 in Table 3), the result clearly indicates that an increase of the share of people with upper secondary education is not associated with higher output levels. It is worth noting that this finding supports the study of Krueger and Lindhal (1998) who suggest that the lack of significant correlation between education and growth is due to the insertion of a control variable for physical capital.[12]

Tertiary education is significantly and positively related to growth (see model 3 and model 4 in Table 3). However, its long-run elasticity to output decreases by 0.2 units whereas the estimated *p* value gets larger when the variable KSTOCK is added to the regression. Model 5 in Table 3 evaluates the link between the lowest educational levels and per capita output; the coefficient is not statistically significant. The figures shown in Table 3 give evidence that FDI, export and

[12] The authors refer to the study of Benhabib and Spiegel (1994).

Table 4 Estimates of the short-run adjustment (error correction model)

Dependent variable: d RGDP			
	Model 1[a]	Model 2[b]	Model 3[c]
d SEC	−0.278 (0.000)		
d HIGH		0.195 (0.002)	
d PRIM			−0.100 (0.165)
d KSTOCK	0.169 (0.000)	0.246 (0.074)	0.145 (0.017)
d EXP	0.027 (0.004)	0.020 (0.064)	0.041 (0.040)
d FDI	0.006 (0.008)	0.004 (0.000)	0.006 (0.000)
d Z	−0.078 (0.009)	−0.110 (0.000)	−0.007 (0.000)
N of obs.	48	48	48
Adj. R^2	0.940	0.864	0.482
F	150.016 (0.000)	60.448 (0.000)	9.568 (0.000)
Log-likelihood	−120.708	−119.878	−123.816
DW	1.801	1.929	2.048

All variables are expressed per unit of active population in a logarithmic form. *p* values are in parentheses

[a] The ECM corresponds to model 2 in Table 3

[b] The ECM corresponds to model 4 in Table 3

[c] The ECM corresponds to model 5 in Table 3

business investments sustain the upward growth trend in the Bulgarian economy. The elasticity of export to output ranges from 0.192 to 0.245 with an average of 0.213. The effect of physical capital is even stronger: the slope coefficient is 0.371 on average. These values imply decreasing returns to scale.

In fact, this regression output is not unexpected. It confirms one of the major problems in Bulgaria's educational system—a lack of qualified labor resources at the middle educational level. The share of active population with upper secondary or post secondary education is about 55 %; it is the economy's backbone and should be the driving force of its development. Comparatively, highly educated people account for only 1/4th of the labor force. This means that the gaps in secondary education translate into a holdback for growth.

The short-run adjustment is given in Table 4. Following Engel and Granger (1987), the error correction model (ECM) in (Eq. 6) regresses real output on its potential factors in a lagged differenced form ($X_{i,t-1}$) and the lagged error term (z_{t-1}):

$$\Delta RGDP_t = \sum_{i=1}^{n} \beta_i \Delta X_{i,t-1} + \beta_{n+1} z_{t-1} + \varepsilon_t. \tag{6}$$

The error term z_t is derived from a co-integrating model of the form:

$$RGDPt = \alpha_0 + \left(\sum_{i=1}^{n} \alpha_i X_{i,t} \right) + z_t \tag{7}$$

The models passed a series of diagnostic checks such as ARCH, collinearity, and omitted variables such as other lags of independent variables. The variables HIGH and SEC enter significantly although with different signs. An increase in the share of active population with upper secondary education affects short-run growth negatively. This unfavorable tendency is neutralized by the positive role of FDI, export and business investments. About 8 % of the difference between the actual and the long-run value of RGDP is corrected each quarter.

On the contrary, the short-run increase of the labor force with tertiary education exhibits a statistically significant positive effect on output and about 0.2 of the discrepancy between the actual and the equilibrium value of real GDP is eliminated. Regarding the other variables, only the slope coefficient for foreign direct investments is significant at the 5 % level. As expected, primary education has no effect on the short-run economic activity.

The general conclusion emerging from this econometric exercise is that the study does not explicitly prove that the higher average educational attainment determines the positive trend of output per capita observed in Bulgaria after the year 2000. Although the models including tertiary education favor the theoretical hypothesis that education facilitates growth, the result for upper secondary education unequivocally points out that it is not related to the long-run economic development. My estimates show that the aggregate production function with physical capital, foreign direct investments and export best describes economy. The paper substantiates the study of Ganev (2005) that educational attainment (years of schooling) does not increase total factor productivity in transition economies[13]. In addition, Stattev (2009) proves that export is a major determinant of growth in the Bulgarian economy.

A reasonable explanation of the non-significant role of secondary education is that the quality of human capital is a crucial factor for growth especially in countries where the average educational level is comparatively high. In order to test that hypothesis, I carry out a simple experiment which aims to compare the impact of the quantity of human capital on aggregate activity with the effect of its quality measured by foreign language proficiency of active population. Comparable data for the EU member states are available since the year 2004. [14]So, the average number of foreign languages learnt per pupil at upper secondary school in 2004 is my proxy for the quality of human capital[15] (Fig. 4a). Four years later (between 2008 and 2010), pupils at the secondary school in 2004 were 20–24 years old. Therefore, I measure the stock of human capital by the average number of active persons with upper secondary education aged 20–24 years over the period 2008–2010[16] (Fig. 4b). The dependent variable is the average real GDP per person of labor force between 2008 and 2010. Real GDP per capita in 2000 is a control variable in both cases.

The correlation analysis (Fig. 4a) shows a statistically significant positive relationship between language qualification and output: one additional foreign

[13] The sample includes seven countries from Eastern Europe between 1991 and 2000.

[14] Source: Eurostat.

[15] This is the first year for which a database for the EU exists.

[16] For the purposes of the descriptive analysis, I switch from the 25–64 age-group to people between 20 and 24 years old because pupils at upper secondary school in 2004 (between 16 and 19 years of age) formed the 20–24 age-group between 2008 and 2010.

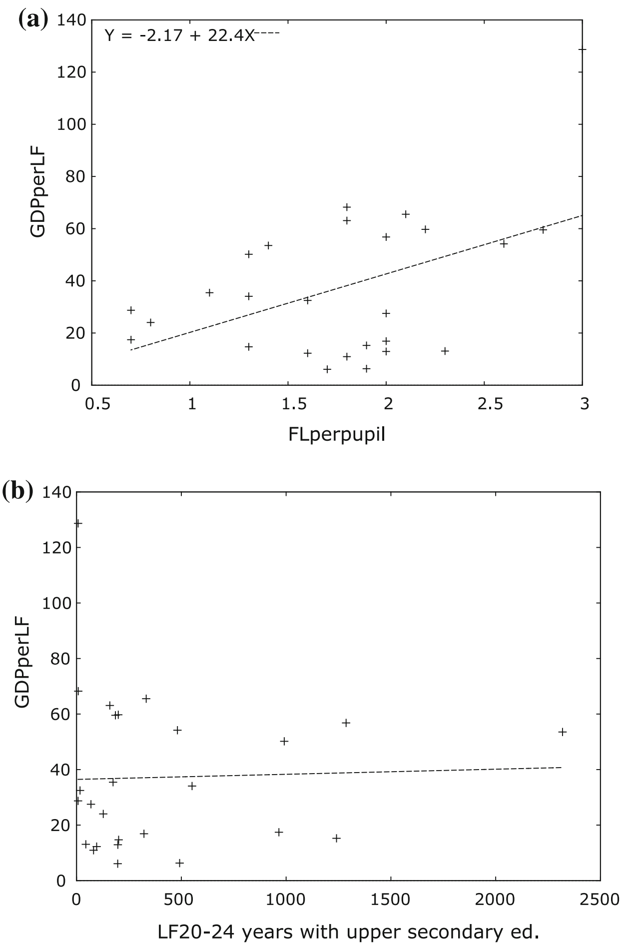

Fig. 4 Impact of quality vs. quantity of human capital on output per capita. United Kingdom and Ireland are excluded from calculations; missing values for Austria. Data for Island and Turkey are added. **a** Number of foreign languages learnt at school vs. output. **b** Stock of human capital vs. output

language is expected to increase output by 22 units. On the contrary, the association on the next plot (Fig. 4b) is close to zero and statistically insignificant.

A similar pattern is observed when the share of people who speak English is related to GDP per unit of active population (the data refer to 2007); again real GDP per capita (2000 = 100) is a control variable (see Appendix 2, plot *a*). The second graph (Appendix 2, plot *b)* demonstrates that the link between the average educational level of human capital and GDP per capita is best described by a quadratic equation. Moreover, the quadratic term in the estimated regression model takes a negative sign. That means that the first derivative i.e. the rate of growth per a person is inversely related to the change in the share of people having completed at least upper secondary education. The correlation analyses imply that: (1) knowledge of the most popular foreign languages measures adequately the quality of human capita and (2) it explains a large part of the variation in output per capita[17] across Europe.

An alternative explanation for the econometric result might be that when human capital is above a given threshold level, it is not significantly related to economic activity because the existence of diminishing returns. Given the quality of education, a similar statistically insignificant effect should be expected for all post-communist member states due to the high levels of human capital. However, this explanation is not consistent with the endogenous growth theory and the existence of externalities of human capital in those models.

The importance of quality for the effect of human capital on growth fits the concept of "proximity to technological frontier" mentioned in Sect. 2. The technological level of the Bulgarian economy has been continuously increasing for the last two decades. As the country approaches the technological frontier, it needs skilled labor capable of innovation rather than imitation of technologies. The impossibility to perform that task reduces the growth-enhancing capacity of education.

5 Conclusion

This study tries to illuminate the impact of educational attainment on the long-run dynamics of output per capita in the Bulgarian economy. The share of people in the labor force having completed upper secondary education enters insignificantly the co-integrating regression. Moreover, its short-run accumulation is related negatively to real output per capita. When tertiary education is considered, the result is positive and statistically significant both in the short- and the long-run. In general, the study does not fully support the hypothesis that the higher average educational level fosters growth taking into consideration the fact that the share of active population having completed upper secondary education is twice as large as the share of people with tertiary education. Moreover, the upward trend of real output is attributed mainly to FDI, physical capital and export.

Looking for a plausible explanation of the econometric outcome, I explore the role of the quality of human capital measured by foreign language skills of the population. The cross-country correlation analysis implies that the spread of English explains a larger part of the variation in output per capita across member states in comparison with the human capital quantity. Thus, this paper calls on more attention to the quality of human capital when policies for growth in Europe are designed[18].

[17] The correlation coefficient between real GDP per an active person and real GDP per capita is near 1.

[18] In 2011, the European Commission released a new set of benchmark values for education in the EU member states (European Commission 2011). They concern rather the quantity of human capital than its quality.

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Appendix 1

See Table 5 and Fig. 5.

Table 5 Test for structural break and unit root tests

Variable	QLR-test[a]		ADF-GLS[b]		KPSS[c]	
	Max F-value	Structural break	Before the break	After the break	Before the break	After the break
ln RGDP	25.791[(1)]	2009:4	−1.571[(1)]	−1.932[(1)]	0.350[(1)]	0.103
ln SEC	11.175[(1)]	2006:1	−2.571[(1)]	−1.640[(1)]	0.101	0.170[(1)]
ln HIGH	4.772[(1)]	2002:1	NA[d]	−2.349[(1)]	NA	0.251[(1)]
ln PRIM	6.417[(1)]	2006:1	−2.052[(1)]	−1.683[(1)]	0.232[(1)]	0.200[(1)]
ln KSTOCK	7.812[(1)]	2008:2	−1.925[(1)]	−1.082[(1)]	0.296[(1)]	0.234[(1)]
ln EXP	1.756	–				
ln FDI	4.412[(2)]	2003:2	−1.738[(1)]	−1.555[(1)]	0.102	0.296[(1)]

[a] Quandt likelihood ratio test for structural break at an unknown point. H_0: No structural break in data. The maximum Chow *F* test statistics is presented

[b] H_0: The time series is non-stationary. *P* values are given in parentheses. Models include constant and trend and one lag

[c] H_0: The time series is stationary

[d] The results of the tests are not presented due to the insufficient number of observations (only 8) before the suggested break

[(1),(2)] Significant at 5 % or 10 % level

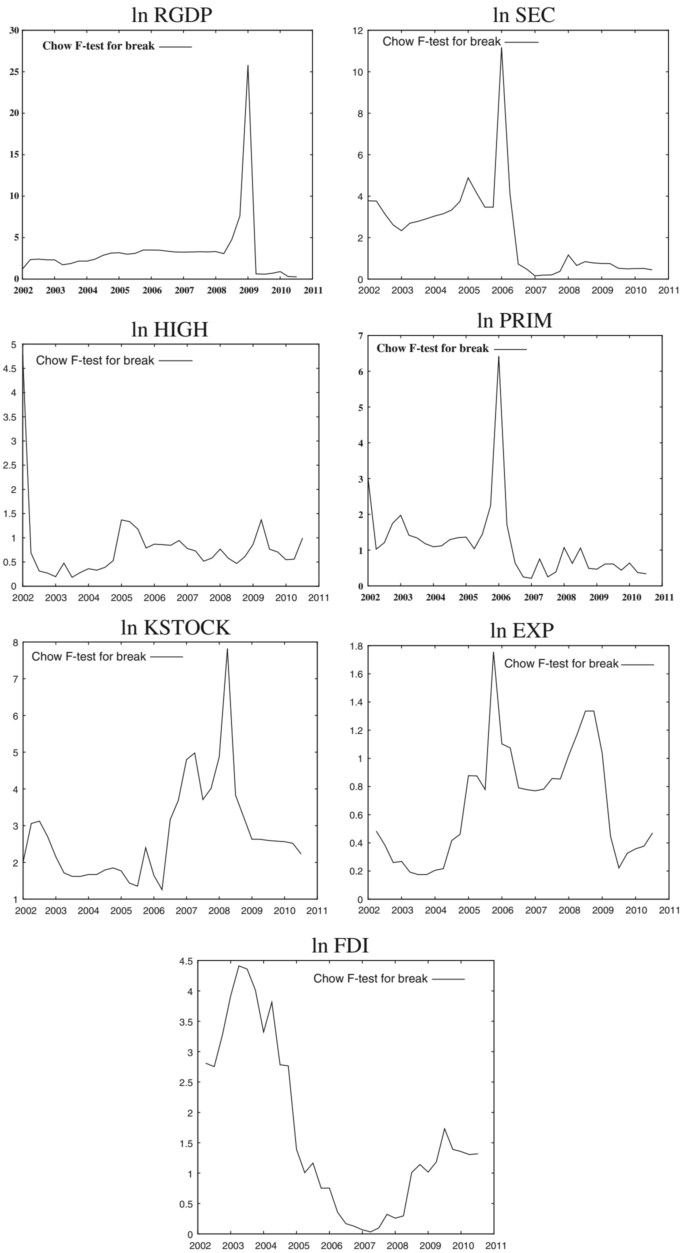

Fig. 5 QLR test: Chow F test statistics

Appendix 2

See Fig. 6.

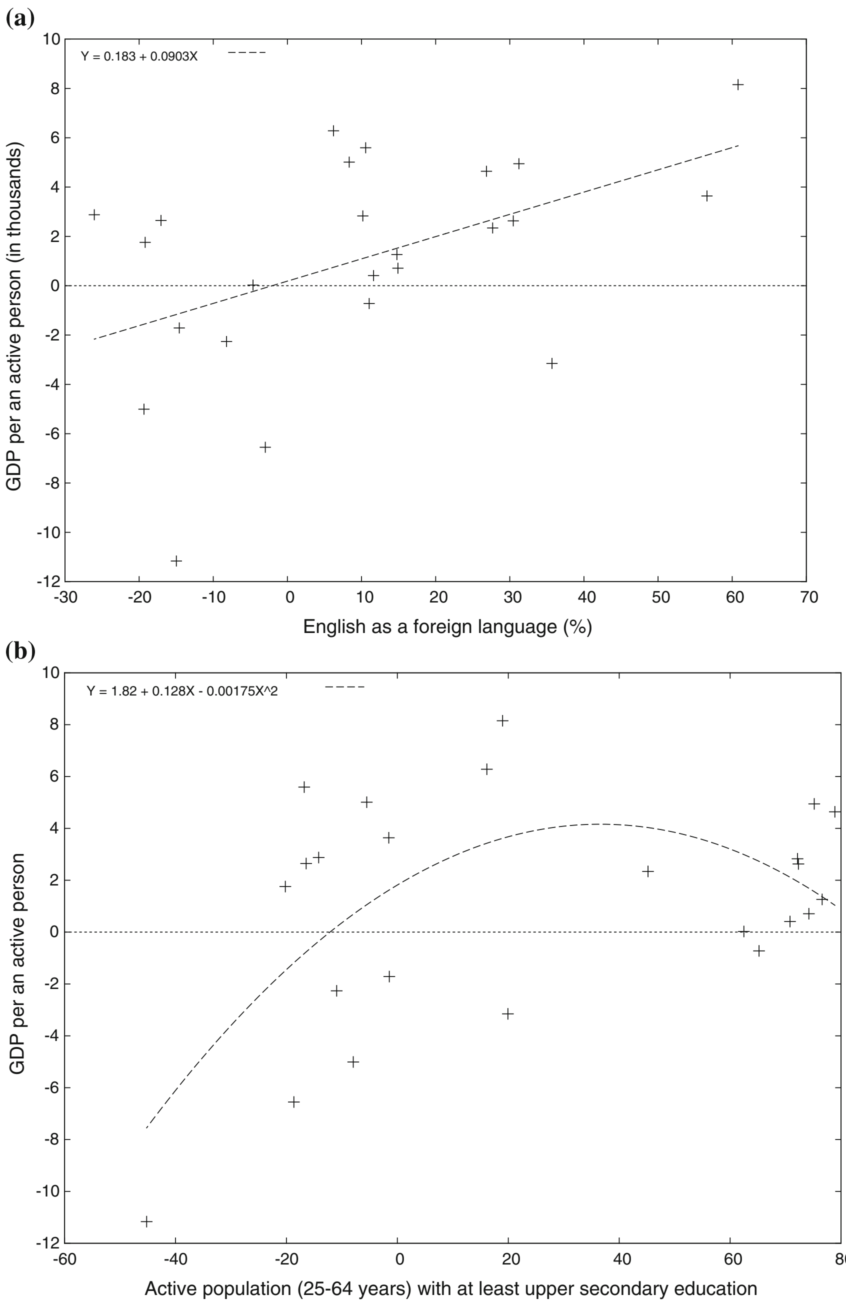

Fig. 6 Quality vs. quantity of human capital: additional evidence. **a** Partial correlation between GDP per a unit of labor force and the share of people who know English language. Data refer to 2007. Real GDP per capita in 2000 is a control variable in both cases. Ireland and UK are excluded from calculations while values for Turkey are added; missing data for Luxembourg and Netherlands. **b** Partial correlation between GDP per a unit of labor force and the share of people with at least upper secondary education (%)

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