Human Capital and Growth in OECD Countries Revisited

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Abstract: Based on the "determinants of growth" literature, but drawing on recent developments and using the latest datasets and modern techniques, this paper aims at assessing the importance of human capital for the growth of OECD countries over a prolonged period of time. Special emphasis is placed on factors affecting total factor productivity in a globalized environment, while the specific econometric techniques allow us to account for institutional and other differences between countries. The main conclusion is that human capital is a key driver of growth for the specific group of countries. This result is robust to the choice of estimation methods, while the statistical properties of variables are properly taken into account. Greece is used as a case study in evaluating an economic policy mix in order to accelerate the real convergence process after tackling the consequences of the current crisis.

Keywords: *human capital, growth, R&D, technology transfer*

1. INTRODUCTION

This paper aims at identifying the determinants of GDP per capita in OECD countries in a comprehensive framework with special emphasis on human capital and knowledge in general (with an enhanced role for R&D capital). Apart from "traditional" variables, new elements are introduced in the analysis. The latter mostly pertain to specific aspects of the increasingly globalised environment, such as the ability of countries to take advantage of technology transfer channels depending, among others, on the degree of their outward orientation. Following another strand of the literature, a variable aimed at capturing the degree of market inefficiencies and / or distortions is also introduced.

Greece is used as a case study in order to identify specific growth drivers and quantify their impact on GDP per capita at a very critical juncture when the success of an economic policy mix based on frontloaded fiscal consolidation crucially depends on its ability also to ensure the growth prospects of the economy.

The structure of the paper is as follows: in section 2, links with the existing literature are established, while in section 3 the model to be estimated is described. In the section that follows details are provided on data sources and definitions, with empirical results presented in section 5, including a reference to the Greek economy as far as policy implications are concerned. Section 6 concludes.

2. LINKS TO THE EXISTING LITERATURE

Following article [1] which rekindled the interest in endogenous growth, there were numerous contributions building on the already existing basis. Only indicatively, we should mention the reviews on the issue [2 -8]. Regarding the empirics of growth, initially many researchers attempted to test the theoretical models, often facing the objections by others (such as [9]) who questioned whether the basic conclusions of these theoretical models (e.g., scale effects) are compatible with hard data and the stylized facts of growth[1]. Another strand of the empirical literature was based on ad-hoc ("atheoretical") empirical models incorporating the variables economic theory would suggest. Among the most notable examples, we find articles [11-12], followed by a vast literature of articles in the spirit of growth regressions –see, among others, [2] and empirical research by international organizations such as the O.E.C.D., the European Commission, the I.M.F. and the World Bank[2]. The econometric methods used and the conclusions of these articles are usually very interesting, although not directly related to theoretical developments. [16-17] provide a very useful review of the relevant literature.

3. THE MODEL

The starting point of our analysis is the seminal work of [18], which for many years served as a benchmark for assessing the value of empirical approaches to neoclassical growth theories incorporating human capital. [19] provided an insightful criticism of the aforementioned paper and proceeded to compile empirical estimates with newer data and methods. Regarding the paper at hand, we opted to add variables suggested by several distinct contributions to the literature and then estimate the resulting model with the latest data available. More specifically we add:

a) a variable aimed at capturing distortions imposed by the participation of the public sector in economic activity[3]. These distortions pertain, among others, to market inefficiencies, weaknesses of the regulatory framework, increases in administrative burden, red-tape and the lower productivity of public enterprises. Ideally, we would also add a variable directly measuring product market regulation, but the relevant time series provided by the OECD is not long enough.

b) a variable to capture the effect of R&D, not the country level but at a more global sense (more specifically, we opt to investigate the effect of R&D undertaken by all OECD countries together). The implicit assumption here is that knowledge "produced" in one advanced country or the other is available at no cost (or, at least, at negligible cost) to other advanced countries through technology transfer and diffusion channels. The degree to which each country can exploit these channels depends, *inter alia*, on its outward orientation (see below on openness). The other important assumption is that it is not the *flow* of R&D expenditure that is relevant in this context, but the *stock* (as first analyzed by [11]). The construction of this variable is explained in the following section. The rate of growth of Total Factor Productivity (TFP) for advanced countries was additionally tried to capture aspects of the innovation / knowledge accumulation process not necessarily incorporated in R&D.

c) openness, which measures the ability of countries to best utilize the access in greater markets and the resulting economies of scale. Openness can, also, approximate the ability of exploiting the channels of technology transfer and diffusion, which consist a close substitute of primary involvement in R&D.

d) hours worked, in the sense used by [15], i.e., in an attempt to further capture the effect of the labour input utilization "intensity".

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1 For example, see [10].

2 Indicatively we should mention [13-15].

3 Only indicatively, see [20] and [2] for the theoretical underpinnings of this idea and [21] for an empirical estimate.

4. DATA SOURCES AND DEFINITIONS

The main source of the data used in our empirical estimates is the Penn World Tables database (Mark 7.0, June 2011, [22]). These data are largely considered the most reliable for international comparisons and have been widely used in the empirical literature. The variables used from this database are the following:

rgdpch: per capita GDP (chain series)
ci: investment share in GDP
pop: population
openc: Imports + Exports / GDP
cg: government share in GDP

The population variable is used to construct *n* for each country (the rate of change of the population). The variable (*n+g+d*) is constructed by adding 0.03 to the rate of change of the population in order to take account of depreciation and productivity growth. This method of constructing (*n+g+d*) is often used in the literature (see, for example, [19]).

For data on human capital, we used the Barro-Lee database (ver. 2.0, 2010, [23]), from which we extracted variable *tys* (total years of schooling) as a proxy for human capital. This variable is available at 5-year intervals, with missing observations calculated with linear interpolation.

We also extracted the variable *Hours Worked* from the OECD online statistical database *Sourceoecd* along with data on R&D expenditure for OECD Total. The latter is used in order to construct the variable R&D capital using the perpetual inventory method (with the first observation calculated as the ratio of the R&D expenditure this year divided by the average growth rate of the relevant series for the whole period[4]).

Last but not least, we used the AMECO online database of the European Commision in order to construct a variable which could serve as a proxy for the rate of change in Total Factor Productivity at the international level[5].

5. EMPIRICAL RESULTS

5.1 GENERAL RESULTS

The empirical estimation of our equation using panel data for a period of 28 years including 29 countries is presented in Table 1. The preferred econometric method was Panel Least Squares with fixed effects and White diagonal correction of standard errors and covariance for both autocorrelation and heteroscedasticity. However, our results are robust to the choice of alternative econometric methods[6]. All variables are in logarithms.

Table 1: Empirical estimates

Dependent Variable: GDP per capita
Sample: 1981 – 2008
Periods included: 28
Cross-sections included: 29

[4] Following, for example, [11].

[5] This variable averages the growth rate of Total Factor Productivity of EU-15 countries, USA, Japan and Canada.

[6] Due to space limitations, no comparative results are presented in this paper. Empirical estimates for all specifications are available upon request.

Total panel (unbalanced) observations: 659				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	14.60109	1.013482	14.40686	0.0000
Investment share in GDP	0.198979	0.022514	8.838095	0.0000
Population (variable n+g+d)	-0.149903	0.057550	-2.604756	0.0094
Human capital	0.356581	0.042244	8.440978	0.0000
Government share	-0.427132	0.038981	-10.95742	0.0000
R&D capital	0.260722	0.015163	17.19457	0.0000
Openness	0.013044	0.019960	0.653498	0.5137
Hours worked	-1.170877	0.124536	-9.401896	0.0000
R-squared	0.985249	**Mean dependent var**		10.08621
Adjusted R-squared	0.984420	**S.D. dependent var**		0.448093
S.E. of regression	0.055931	**Akaike info criterion**		-2.876324
Sum squared resid	1.948901	**Schwarz criterion**		-2.631004
Log likelihood	983.7488	**Hannan-Quinn criter.**		-2.781230
F-statistic	1188.881			0.199343
Prob(F-statistic)	0.000000			

The overall fit and explanatory power of this model are very satisfactory, as indicated by the corrected R^2 and the significance level of the F-statistic. All estimators have the expected signs and are statistically significant at the 1% significance level (with the exception of openness which is statistically significant at the 5% significance level). Real GDP per capita is positively affected by the investment share in GDP, human capital, openness and R&D capital. The opposite holds for the impact of the population variable, the government share and hours worked (the latter possibly inducing a negative productivity effect, albeit in the medium to long-run)[7]. We also tried another specification including the rate of change of TFP in order (as mentioned above) to capture innovation effects beyond those captured by R&D capital, but this variable turned out to be insignificant (at conventional levels of significance) and was eventually omitted.

5.2 STATIONARITY CONCERNS

In order to be sure that we avoid the risk of a spurious relationship (as would be the case should variables be non-stationary) we performed the tests suggested by [24] assuming a unit root for the panel series along with the tests suggested by [25 - 27], based on which the statistics ADF - Fisher Chi-square και PP - Fisher Chi-square are computed[8]. The latter tests assume that a distinct unit root exists for every panel object. Most of our test results for the variables in logarithms suggest that the hypothesis of a unit root is rejected at conventional levels of statistical significance. In cases where results between different tests are contradictory, we opt for Fisher-type tests, following [26]. The overall conclusion is that the empirical results of this section are valid and that there is no issue of a spurious relationship.

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[7] [15].

[8] Again, space limitations do not allow us to include these results in this version of the paper. Relevant tables are available upon request.

5.3 THE CASE OF GREECE

In trying to quantify the significance of our results, we calculated the effect on the dependent variable of a 10% increase in human capital. Using as benchmark the values for human capital - GDP per capita (for the latest year available) and the estimated coefficients of Table 1[9], we concluded that this increase in human capital would result in an increase of GDP per capita in the order of 2060.5 (international) dollars in 2005 prices. Although our proxy for human capital is years of schooling (an increase of which probably is not what is needed in Greece or other developed countries), we obtain a very strong indication of what human capital in general could mean for countries such as Greece, i.e., for countries in quest of growth drivers in times when the fiscal stance is heavily contractionary. Our results also indicate that, should increases in spending for education be decided, they should achieved at the expense of other expenditure items, thus not leading to an expansion of the general government: as our estimate for the size of the government is negative, an increased public spending on education should be financed only through a reallocation of resources.

6. CONCLUSION

Using insights from "traditional" determinants of growth models, which we opted to enrich with recent developments, we proceeded to estimate a model aiming at explaining differences in GDP per capita among OECD countries. Using the latest datasets available (such as PWT 7.0), we confirmed the crucial role of human capital and the positive impact of a) the outward orientation of economies b) investment in physical capital and c) R&D capital. On the other hand, a negative impact of the size of the government was detected, as expected based on previous contributions. Using Greece as a case study, we also proceeded to quantify the potential incremental contribution of investment in human capital, which could serve as a driver of growth in this very critical phase of the economic cycle.

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