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Balanced Growth

Finding Strategies for Sustainable Development

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Beyond balanced growth: The effect of human capital on economic growth reconsidered

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Abstract:

Human capital plays a central role in theoretical models of endogenous growth. Nevertheless, the existing empirical evidence on human capital's effect on economic growth is mixed. Part of this weak evidence might be the result of overly restrictive specifications of the estimated empirical growth models. A more flexible estimation framework's results reveal that human capital does indeed have a strong positive effect on economic growth, but this effect differs substantially across countries. In particular, the evidence suggests that human capital has a stronger effect in countries in which the population faces favorable living conditions in terms of life expectancy and geographic characteristics, while the effects do not differ substantially between countries that differ with regard to their political institutions' quality.

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1 Introduction

Knowledge and the ability to invent and innovate are considered the key determinants of economic development. This productive resource, which is embodied in people, is often referred to as *human capital.* This terminology reflects that human capital must be acquired through a process of formal or informal education. Since human capital is particularly important for economies with few other resources, education policy receives particular attention. In virtually all countries of the world, education-related matters are currently high on policy makers' agenda. Simultaneously, an increasing body of academic literature examines the determinants of education outcomes and the most effective ways to use the resources invested in the education sector.

Nevertheless, empirical estimates of human capital's growth effect have delivered mixed results. This lack of consensus among economists about human capital's empirical effect on growth appears surprising in the light of human capital's central role not only in the public debate, but also in many models of endogenous growth.[1]

A closer look reveals that most estimates have been obtained with empirical models that make restrictive assumptions about the specification of the empirical growth framework that they use for estimation. On the one hand, existing empirical studies are either based on estimation frameworks that restrict attention to the dynamics along the balanced growth path (such as studies in the tradition of Mankiw, Romer, and Weil, 1992) [2], or are based on those that adopt a growth accounting framework (for instance, studies along the lines of Benhabib and Spiegel, 1994), which assumes identical technology across countries. On the other hand, existing empirical studies have concentrated exclusively on one of various channels through which human capital is thought to affect growth. Human capital can either be seen as a factor of production, similar to physical capital or raw labor, or as the prerequisite for adopting new technologies or for innovation. In the former, human capital growth affects the output growth potential, while in the latter, the size of the existing human capital stock determines the output growth potential.

The ongoing research on human capital's empirical growth effects has recently addressed these shortcomings. Owen et al. (2009) investigated whether the assumption of a balanced growth path for all countries is appropriate in specifications of empirical growth models. Using a more flexible estimation framework that allows for different growth processes for distinct groups of countries, these authors' results suggest different growth regimes across the world. However, their results also suggest that the level of human capital might have a negative growth effect in some countries. Sunde and Vischer (2011) investigated a different source of misspecifi-

1 In endogenous growth models, long-term economic growth is explained by the variables within the model. This is in contrast to exogenous growth models, where long-term growth is explained by factors, such as technological progress, that are determined outside the models.

2 In macroeconomics, a balanced growth path refers to a situation in which major aggregates have the same growth rate over time. In the neoclassical Solow model, for example, the considered aggregates are output and the capital stock (Temple, 2008).

cation, due to the restriction to only one channel through which human capital might affect growth. They show that if both channels are empirically relevant, then estimates that restrict attention to only one channel lead to serious misspecification and thus deliver biased estimates of human capital's growth effect. Sunde and Vischer's empirical results from replications of existing studies with an appropriately extended specification reveal human capital's quantitatively and statistically significant positive growth effect through both channels.

However, it is still unclear whether human capital matters for growth in the same way across countries when both channels – the production factor and the prerequisite to innovate – are taken into account. An investigation of this question requires the combination of a flexible estimation framework, such as the one used by Owen et al. (2009), with an extended growth specification that accounts for both human capital channels, as suggested by Sunde and Vischer (2011).

The remainder of this chapter presents the results from such an analysis. Section 2 contains a description of the data and the empirical approach. Section 3 describes the results. The findings suggest that human capital is particularly important in a group of countries where human capital has a positive effect on growth through both of the channels discussed in the literature. This group of countries appears to be more developed, with better geographic features and a higher life expectancy. Human capital's growth effect is substantially smaller and statistically insignificant in the other group of countries. This finding has far-reaching implications, which are discussed in the concluding section (Section 4).

2 Empirical model and data

2.1 Data

The data for the analysis span the period 1965 to 2005 and are taken from different sources. The data on the GDP per capita and investment are from the Penn World Tables (version 6.3). The population data and the data on life expectancy at birth originate from the UN Population Division. The data on human capital correspond to the working age population's (aged 25-65) average years of schooling, as gathered by Barro and Lee (2010). The quality of political institutions is measured as an index taken from Freedom House and has been used in recent empirical studies (see, e.g., Acemoglu et al., 2008).

The estimation is conducted in long differences from 1965 to 2005, based on a sample of 94 countries for which all variables are available in the data sources. Table 1 contains the data's summary statistics.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Average annual growth in GDP per capita 1965-2005	0.0179	0.0159	-0.0148	0.0627	94
Change in log mean school years (25+) 1965-2005	0.0256	0.0147	0.0045	0.0718	94
Log mean school years (25+) in 1965	0.8176	0.9875	-1.9348	2.3245	94
Change in log capital per worker 1965-2005	0.0423	0.029	-0.0336	0.1533	94
Log GDP per capita 1965	8.1322	0.9871	6.2286	9.945	94
Log life expectancy 1965	4.0038	0.2107	3.537	4.3022	94
Absolute latitude	24.0278	16.6057	1	64	94
Freedom House Index 1965	0.6507	0.2877	0.1	1	82

2.2 Empirical model

In order to account for the possibility that countries might differ in their growth processes and, hence, in the extent to which human capital affects economic growth, the analysis follows Owen et al. (2009) and adopts a data-driven strategy. Rather than grouping countries ad hoc, for example, according to their income level at some pre-specified date, the estimation allows for different latent growth processes whose prevalence and structure are estimated from the data.

This is done by estimating the growth process by maximum likelihood, using finite mixture models. These models pre-specify the growth process as a function of the main determinants of growth in light of the theoretical predictions. In addition to human capital, these determinants include the initial income level in order to account for convergence dynamics, as well as the investment rate, which reflects the change in physical capital. But rather than assuming that the respective coefficients are the same for all countries in the sample, the finite mixture approach allows for classifying countries into a pre-specified number of groups by means of the similarity in their growth rates' conditional distributions. A distinct set of coefficients is estimated for the growth determinants in each of these groups. Furthermore, the estimation provides an estimate of a particular data point's (country observation) propensity to belong to one of these groups. The propensity of belonging to one group can be estimated as a latent variable. Alternatively, this propensity can be specified as depending on particular characteristics, for example, the life expectancy, geographic features, or institutions. The reader is referred to Owen et al. (2009) for a detailed technical description of the finite mixture approach in the context of empirical growth models.

3 Empirical results

3.1 Baseline results

The empirical results are presented in Table 2. As a benchmark, Column 1 contains the results of the empirical growth model's estimation, which constrains the coefficients to be the same across all countries in the pooled sample. Human capital has a significant positive effect on growth through the change in human capital over the observation period, as well as through the level of human capital at the beginning of the observation period in 1965. An increase of 1% in the working age population's average schooling years increases growth by 0.56%. The accumulation of physical capital also has a positive effect on growth, with an elasticity of 0.22% increase in the growth rate for a 1% increase in the capital stock. Finally, the results suggest conditional convergence, as indicated by the negative coefficient for the log GDP per capita in 1965. These results essentially replicate results presented by Sunde and Vischer (2011) and point towards human capital's positive effects through both channels, which are individually and jointly significant. Nevertheless, these results still maintain the assumption of a balanced growth path for all countries in the sample, with human and physical capital having identical effects on growth across all countries.

Columns 2 and 3 relax this assumption and present the results of a more flexible growth process estimation by applying a finite mixture model with two latent growth regimes. This specification treats the propensity to be in one of two different growth regimes as a latent variable, which is estimated jointly with the coefficients for the explanatory variables (human capital changes and levels, physical capital investments, and convergence) by maximum likelihood.

The estimates deliver an endogenous split of the sample countries into two distinct regimes: Regime 1 with 61 countries, and Regime 2 with 33 countries. A comparison of the estimation results across the two regimes reveals a striking disparity in the coefficient estimates. In Regime 1, investment in physical capital is the only explanatory variable with a (marginally) statistically significant positive effect on growth. Neither human capital, nor the convergence term, displays any effect. In contrast, in Regime 2, all the explanatory variables have a strong effect. Human capital affects growth through both channels by means of positive and significant coefficients that are even slightly larger than those in the pooled specification in Column 1. The accumulation of physical capital also positively affects growth with a slightly larger coefficient than in the pooled sample. Finally, the convergence term is about 1.5 times larger.

These results suggest that the growth process might follow a different path in different countries where the role of growth determinants varies across different growth regimes. However, the unconditional endogenous split into two regimes raises the question as to which factors are actually behind these different growth regimes.

Table 2: Baseline results: Standard regression models and finite mixture models

	Dependent variable: Average annual growth rate of GDP per capita 1965-2005		
	All	**Regime 1**	**Regime 2**
Change in log mean school years (25+) 1965-2005	0.5587** [0.260]	0.3277 [0.9132]	0.5846** [0.2757]
Log mean school years (25+) in 1965	0.0181*** [0.004]	0.0126 [0.0114]	0.0185** [0.0085]
Change in log capital per worker 1965-2005	0.2222*** [0.053]	0.1911* [0.0989]	0.2473*** [0.0439]
Log GDP per capita 1965	-0.007*** [0.002]	-0.001 [0.0026]	-0.010*** [0.0024]
Constant	0.0324* [0.017]	-0.0065 [0.0409]	0.0658*** [0.0166]
Regime membership:			
Constant		0.3141 [1.1917]	
Observations	94		
Countries in class		61	33
Bayesian information criterion		-521.58	

Notes: All regressions in long-difference specifications with one observation per country over the period 1965-2005. Column 1: All displays results from *ordinary least squares*. Columns 2 and 3 (*Regime* 1, *Regime* 2) display the results from the estimation of a finite mixture model. Robust standard errors are provided in brackets. ***, **, * indicate significance at the 1-, 5-, and 10-percent level, respectively.

More precise knowledge of the characteristics that lead countries to be characterized by a growth process along the lines of Regime 1 or Regime 2 would be particularly valuable for the question at hand. On the one hand, if it were known that a particular country is more likely to be characterized by Regime 2, the case for policy interventions targeting the economy's education structure would be much stronger than if the country were better characterized by Regime 1. On the other hand, if it were known that the regime propensity could be affected by policy, for example, because the propensity to exhibit a growth process as in Regime 2 would be increased if institutional quality were improved, this would indicate potentially important complementarities between policy interventions in the education sector and institutional quality.

3.2 Taking a closer look

The following analysis attempts to shed light on the country characteristics that potentially explain the classification of countries into different growth regimes. The analysis considers three potential determinants of a country's growth regime: absolute latitude, life expectancy, and the quality of the political institutions. The choice of these variables is related to an ongoing debate in the growth literature on the fundamental causes of long-term development. This debate has specifically focused on the question as to whether geographic features, which are largely exogenous, or institutions – i.e., human-made rules for the conduct of social, political, and economic interactions – are the main fundamental cause of long-run growth. Latitude is a proxy for geographic features, such as climate and agricultural conditions, the extrinsic disease environment, and related features that might affect a country's growth and development potential. Latitude has the advantage of being a readily available measure of relevant geographic features, and has therefore been frequently used in empirical work. Life expectancy is somewhere intermediate in the debate on geography vs. institutions, since life expectancy is strongly affected by the extrinsic climate and disease conditions, which relate to the geographic location. Simultaneously, however, institutional quality also strongly influences life expectancy, for example, in terms of the health system's efficiency and coverage, as well as its financing, which usually involves substantial degrees of redistribution. Finally, the quality of political institutions, as reflected by an index of political liberties, represents humanly devised institutions that are clearly endogenous and malleable in the long-run.

Table 3 presents the results of two specifications, each of which allows for two distinct growth regimes, similar to Columns 2 and 3 in Table 2. Each of these specifications includes a particular classification variable.

Columns 1 and 2 present the results of the estimation of a finite mixture model, which stipulates two distinct growth regimes, with a country's absolute latitude as the main determinant of its propensity to be characterized by a particular regime. This estimation reveals an estimated regime split with 69 countries in Regime 1 and 25 countries in Regime 2. Countries with a lower latitude (located closer to the equator) are more likely to be characterized by the Regime 1 growth process and countries with a larger latitude by the Regime 2 growth process. Given that a larger latitude is typically associated with a higher level of economic development, this implies that Regime 1 essentially represents less developed countries, whereas Regime 2 represents more developed countries. This specification's fit is better than that of the specification with a constant as the latent regime membership, as estimated in Table 2 and as reflected by the Bayesian information criterion's lower value of -542.27 compared to -521.58.

Table 3: Finite mixture models with regime determinants: Latitude and life expectancy

	Dependent variable: Average annual growth rate of GDP per capita 1965-2005			
	Regime 1	**Regime 2**	**Regime 1**	**Regime 2**
Change in log mean school years (25+) 1965-2005	0.3482 [0.3312]	0.7734*** [0.1830]	0.1674 [0.403]	1.0131*** [0.372]
Log mean school years (25+) in 1965	0.0148** [0.0059]	0.0225*** [0.0019]	0.0047 [0.008]	0.0240*** [0.006]
Change in log capital per worker 1965-2005	0.1896*** [0.0553]	0.0663 [0.0935]	0.1181** [0.053]	0.2166*** [0.060]
Log GDP per capita 1965	-0.0051** [0.0026]	-0.016*** [0.0031]	-0.0067 [0.006]	-0.009*** [0.002]
Constant	0.0287 [0.0194]	0.1209*** [0.0335]	0.0444 [0.036]	0.0419** [0.019]
Regime membership:				
Absolute latitude	-0.1478** [0.0620]			
Log life expectancy 1965			-16.9*** [6.233]	
Observations				
Countries in class	69	25	34	60
Bayesian information criterion	-542.27		-538.52	

Notes: All regressions in long-difference specifications with one observation per country over the period 1965-2005. Columns 1 and 2 (*Regime* 1, *Regime* 2) display the results from a finite mixture model with absolute latitude as the regime classification variable. Columns 3 and 4 (*Regime* 1, *Regime* 2) display the results from a finite mixture model with log life expectancy in 1965 as the regime classification variable. Robust standard errors are provided in brackets. ***, **, * indicate significance at the 1-, 5-, and 10-percent level, respectively.

In terms of growth determinants, the results show that changes in human capital have no growth effect in Regime 1, whereas the initial stock of human capital has a positive but comparably small growth effect. In contrast, in Regime 2, the change in human capital and its initial level have large and statistically positive growth effects. In contrast, physical capital accumulation exhibits a significant effect in Regime 1 countries, whereas it exhibits no growth effect in Regime 2. The conditional convergence process appears to be stronger in Regime 2 countries. Finally, the larger constant indicates that baseline growth is more rapid in Regime 2 countries.

In total, these results suggest that human capital is important for growth, but that the degree to which human capital matters for growth differs across countries. Furthermore, the potential to adopt and operate technologies – as reflected by the initial stock of human capital's effect – as well as the increase in the available pool of human capital, affects growth much stronger in Regime 2. Most importantly, however, the growth processes seem to differ strongly across countries.

Columns 3 and 4 present results of the estimation of a model with life expectancy as a determinant of regime classification. This estimation delivers an estimated regime classification of 34 countries into Regime 1 and 60 countries into Regime 2, with countries with a high life expectancy more likely to be classified as Regime 2. Since countries with higher life expectancy are considered more developed, this again implies that the classification reflects a split into less developed countries (Regime 1) and more developed countries (Regime 2). Compared to the results obtained with latitude as the regime classification variable, life expectancy leads to a substantially different classification of countries. Nevertheless, the goodness of fit is comparable, or slightly worse, with a Bayesian information criterion value of -538.52.

In terms of the determinants of growth, the estimates again display substantial differences in the coefficients between the two regimes. Human capital appears not to have any effect on growth in Regime 1, neither in terms of the change in human capital, nor in terms of the initial stock. In contrast, human capital has a strong positive effect on growth in the countries classified as Regime 2 countries. Both effects are substantially larger in size than in the benchmark estimates obtained with the pooled sample reported in Column 1 of Table 2. Physical capital accumulation has a comparable positive growth effect in both regimes. The conditional convergence process and the constant growth rate are only significant in Regime 2. In short, these results corroborate the previous findings of substantial heterogeneity in the growth process across countries. More importantly, the results suggest that human capital is an important determinant of growth through both channels, but only for countries that appear to be more developed in the sense of exhibiting a higher life expectancy at the beginning of the observation period in 1965.

Table 4 presents results of institutions' quality as the regime predictor variable. Owing to missing values, the sample size is reduced to 82 countries in this specification. The estimation is conducted by using a binary regime quality variable as the regime predictor, which takes the value 1 for all countries with a quality of democracy index above the median in the sample, and zero otherwise.[3] The results deliver a classification of 29 countries into Regime 1 and 53 countries into Regime 2, where countries with a better institutional quality are more likely to be classified as Regime 1. In contrast to the previous results, Regime 1 represents countries with better political institutions, which usually refers to more developed countries, whereas Regime 2 represents countries with political institutions of a lower quality.

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3 Alternative specifications using a binary variable that codes countries above and below the mean index, or directly using the respective index values for the regime classification, deliver qualitatively identical results.

However, institutional quality does not appear to be a strong predictor of regime membership, as is indicated by the Freedom House indicator's insignificant effect. With a Bayesian information criterion value of -465.81, this model's fit is even worse than that of a model with an unspecified latent regime membership propensity, as reflected in Columns 2 and 3 in Table 2.

4 Conclusion

The estimation results of finite mixture models with different regime classification determinants all deliver a broadly coherent picture. Human capital has a strong effect on growth through both channels, as a production factor and as a prerequisite for the adoption of new and more efficient technologies. The results thereby corroborate Sunde and Vischer's (2011) recent findings. These findings suggest that specifications accounting for only one of these channels might deliver biased estimates of human capital's growth effect. The results also show that these effects are not homogeneous across countries. Rather, it appears that human capital is particularly important for growth in countries with a comparably high level of development, which is proxied by better geographic conditions in terms of absolute latitude or higher life expectancy. According to these findings, and in line with the conclusions by Owen et al. (2009), a balanced growth path does not appear to be an appropriate characterization of growth from a comparative development perspective. The empirical results do not, however, provide a definite answer with regard to the question as to whether geography or institutions is the fundamental determinant of growth. Rather, the results are consistent with both geography and institutions playing some role in shaping the growth process. Nevertheless, the results also indicate that the heterogeneity in the growth process, particularly in terms of human capital's growth effect, is more pronounced in subsamples that differ in terms of geographic latitude or life expectancy than in terms of institutional quality.

The findings also provide a new aspect to the debate on poverty traps and conditional convergence. From a more applied, policy-oriented perspective, the results suggest that, concerning education policies, developed countries might have a higher return in terms of growth than underdeveloped countries. This implies that improvements in institutional quality might produce a double dividend: they might have additional indirect effects by making other production factors, such as human capital, more effective with regard to fostering economic growth.

Table 4: Finite mixture models with regime determinants: Political institutions

	Dependent variable: Average annual growth rate of GDP per capita 1965-2005	
	Regime 1	**Regime 2**
Change in log mean school years (25+) 1965-2005	-0.2082 [0.2172]	0.5211 [0.4379]
Log mean school years (25+) in 1965	0.0133*** [0.0047]	0.0165** [0.0069]
Change in log capital per worker 1965-2005	0.1437*** [0.0366]	0.3002*** [0.0575]
Log GDP per capita 1965	-0.008*** [0.0014]	-0.007*** [0.0025]
Constant	0.0648*** [0.0111]	0.0393* [0.0221]
Regime membership:		
Freedom House 1965	2.1679 [2.1508]	
Observations		
Countries in class	29	53
Bayesian information criterion	-465.81	

Notes: All regressions in long-difference specifications with one observation per country over the period 1965-2005. Columns 1 and 2 (*Regime* 1, *Regime* 2) display the results from a finite mixture model with a binary indicator taking the value 0/1 for countries with a Freedom House index 1965 below/above the median as the regime classification variable. Robust standard errors are provided in brackets. ***, **, * indicate significance at the 1-, 5-, and 10-percent level, respectively.

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