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The Cost of Low Educational Achievement in the European Union

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Abstract: This report uses estimates of the effect of educational achievement – as measured by international student achievement tests – on economic growth to simulate the impact of improved educational achievement for individual EU countries and the EU as a whole. The projections suggest that the present values of educational reforms vary by country, depending on current economic performance and current educational achievement. Under plausible assumptions, the aggregate gains for the European Union add up to astounding amounts on the three considered reform scenarios: €32 trillion for an average increase of ¼ standard deviations; €87 trillion for bringing each nation up to the level of Finland, the top-performing country; and €21 trillion for reaching the official EU benchmark of less than 15% low-achievers in basic skills by 2020. Some of the recent accession countries tend to gain very substantially from educational reform. The results suggest that maintaining a focus on educational outcomes, rather than just attainment, can yield immense long-run economic effects in the EU. Implications for education policies are discussed.

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Eric A. Hanushek and Ludger Woessmann

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1. Introduction

In its Europe 2020 strategy, the new 10-year successor of the Lisbon strategy, the European Council (2010) has set out a "framework for the Union to mobilise all of its instruments and policies" to advance "jobs and smart, sustainable and inclusive growth." Education looms high in this strategy, as one of the "five EU headline targets … which will constitute shared objectives guiding the action of Member States and the Union". Recent economic research provides guidance both on the relevance of the EU goals and on the future gains that could be had from improving educational achievement. This report utilizes this research to quantify the cost, in terms of foregone future GDP, that the European Union and its Member States incur because of low educational achievement.

The European Union has consistently recognized the importance of educating its citizens, often framed in terms of developing a human capital policy. A prime motivation behind this focus is ensuring that all citizens within the EU have the skills needed to compete in a modern, integrated society. But the implications of education go beyond the impact on individual ability to compete. Current macroeconomic research about the growth of nations strongly indicates that the future health of an economy depends on the cognitive skills of its workers.

This new research has also identified the relevant aspects of human capital. Convenience and data availability most commonly dictated that both research and policy discussions focused on school attainment, i.e., years of schooling. But the recent work has highlighted what people know – their cognitive skills. Particularly in international comparisons and analyses, direct measures of cognitive skills through international tests like TIMSS and PISA prove to be far superior to years of schooling. A corollary of this is that goals about completion levels – including Education for All and goals for secondary-school and tertiary-education completion – do not ensure that high levels of human capital are developed, because attainment does not guarantee development of cognitive skills. This raises concerns about the chosen preference of Europe 2020 benchmarks for early-school leaving and tertiary attainment over benchmarks for basic skills and learning outcomes.

Our analysis provides a quantitative look at the implication of improved cognitive skills on each of the EU countries and on the EU as a whole. Specifically, we develop a measure of cognitive skills of each country based upon international assessments in math and science. We then use available estimates of the impact of these cognitive skills on economic growth to simulate how future GDPs would evolve under various school reform plans that improved the cognitive skills of the country. The analysis is entirely focused on long-term growth, because growth is what affects the future well-being of countries.[1] It uses past history of growth over the period 1960-2000 to provide indication of what future development might be like and specifically of what might be expected from school reform.

These estimates follow the simulations for OECD countries found in Hanushek and Woessmann (2010a). There is overlap between that analysis and the analysis here, but a key feature of this analysis is expansion to the eight non-OECD EU countries for which no previous analysis exists: Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania, and Slovenia. This also allows us to provide projection estimates for the EU as a whole. In addition, we will simulate the effects of an additional school reform plan that is based on the official benchmark of EU policy contained in its current education and training framework (ET 2020).

At any point in time, attention to economic policies that deal with current demand conditions and with business cycles always seems to take priority. Perhaps this has never been as true as in 2009 and 2010, when the most obvious focus of attention has been the worldwide recession. Without minimising the need to deal with current unemployment conditions, the message of this report is that considering issues of longer-run economic growth, which are closely intertwined with people's human capital, may be more important for the welfare of nations.

2. Cognitive Skills: A Key Determinant of Economic Growth

This analysis builds on a large and expanding body of research that considers the growth of economies. Economists have considered the process of economic growth for much of the last 100 years, but most studies remained as theory with little empirical work. Over the past two decades, economists linked analysis much more closely to empirical observations and in the process rediscovered the importance of growth. The analysis here particularly concentrates on the role of human capital. Human capital has been a central focus of much of the recent growth modelling, and it is a standard element of any empirical work.[2] Its importance from a policy perspective is clear and unquestionable.

[1] Although it has clear limitations, e.g., in the areas of underreporting of household activity, the shadow economy, leisure, and environmental damages, or as a measure of general well-being and happiness (e.g., Stiglitz, Sen, and Fitoussi (2009)), GDP is still the best available measure of socio-economic welfare for practical purposes.

[2] For a detailed discussion, see Hanushek and Woessmann (2008, 2009).

The recent literature stresses the importance of accurately measuring human capital. In particular, there is now compelling evidence that consistent measures of cognitive skills are closely related to economic growth. We briefly review the development of models of growth based on cognitive skills and then move to the implications of these.

2.1 What Research Has Found out about the Effect of Education on Economic Growth

The macroeconomic literature focusing on cross-country differences in economic growth has overwhelmingly employed measures related to school attainment, or years of schooling, to test the predictions of growth models. Initial analyses employed school enrolment ratios (e.g., Barro (1991); Mankiw, Romer, and Weil (1992); Levine and Renelt (1992)) as proxies for the human capital of an economy. An important extension by Barro and Lee (1993, 2010) was the development of internationally comparable data on average years of schooling for a large sample of countries and years, based on a combination of census and survey data.

The vast literature of cross-country growth regressions has tended to find a significant positive association between quantitative measures of schooling and economic growth.[3] To give an idea of the robustness of this association, an extensive empirical analysis by Sala-i-Martin, Doppelhofer, and Miller (2004) of 67 explanatory variables in growth regressions on a sample of 88 countries found that primary schooling was the most robust influence factor (after an East Asian dummy) on growth in GDP per capita in 1960-1996. More recent research that improved on data quality issues in measuring years of schooling also tends to find positive growth effects of years of schooling (de la Fuente and Doménech (2006); Cohen and Soto (2007); Barro and Lee (2010)).

However, average years of schooling is a particularly incomplete and potentially misleading measure of education for comparing the impacts of human capital on the economies of different countries. It implicitly assumes that a year of schooling delivers the same increase in knowledge and skills regardless of the education system. For example, a year of schooling in Kyrgyzstan (the country with the lowest performance in the PISA 2006 science assessment) is assumed to create the same increase in productive human capital as a year of schooling in Finland (the country with the highest performance in the PISA 2006 science assessment).[4] Additionally, this measure assumes that formal schooling is the primary

[3] For extensive reviews of the literature, see, e.g., Topel (1999); Temple (2001); Krueger and Lindahl (2001); Sianesi and Van Reenen (2003).

[4] Note that there are also problems within individual countries if school quality changes over time. For the sample of countries participating in the International Adult Literacy Survey (IALS), there is evidence of considerable change in quality within countries; see Hanushek and Zhang (2009).

(sole) source of education and that variations in non-school factors have a negligible effect on education outcomes. This neglect of cross-country differences in the quality of education and in the strength of family, health, and other influences is probably the major drawback of such a quantitative measure of schooling.

Over the past ten years, empirical growth research demonstrates that consideration of cognitive skills dramatically alters the assessment of the role of education and knowledge in the process of economic development. Using data from international student achievement tests, Hanushek and Kimko (2000) demonstrate a statistically and economically significant positive effect of cognitive skills on economic growth in 1960-1990. Their estimates suggest that one country-level standard deviation higher test performance would yield around one percentage point higher annual growth rates. The country-level standard deviation is equivalent to 47 test-score points in PISA 2000 mathematics, which is roughly the average difference between Sweden and Japan (the best performer in 2000) or between the average Greek student and the OECD average score. One percentage point difference in growth is itself a very large value, because the average annual growth of OECD countries has been roughly 1.5 percent.

Their estimate stems from a statistical model that relates annual growth rates of real GDP per capita to the measure of cognitive skills, years of schooling, the initial level of income, and a wide variety of other variables that might affect growth including in different specifications the population growth rates, political measures, openness of the economies, and the like. The general concern is that things other than human capital are the real causes of some or all of the observed growth and that ignoring them in the statistical analysis artificially inflates the importance of cognitive skills. One solution to this is inclusion of the other factors in the statistical model. For extensive discussion of other approaches to the causality concern see Hanushek and Woessmann (2009).

The relationship between cognitive skills and economic growth has now been demonstrated in a range of studies. As reviewed in Hanushek and Woessmann (2008, 2011), a number of recent studies employ measures of cognitive skills that draw upon the international testing of TIMSS and PISA (along with earlier versions of these) in order to assess the human capital differences across countries. The uniform result of the empirical analyses is that the international achievement measures provide an accurate measure of the skills of the labour force in different countries and that these skills are closely tied to economic outcomes.[5]

2.2 Channels through which Education Can Impact Growth

Theoretical models of economic growth have emphasised different mechanisms through which education may affect economic growth. As a general summary, three theoretical model frameworks have been applied to the modelling of economic growth.

The most straightforward modelling follows a standard characterisation of an aggregate production function where the output of the macro economy is a direct function of the capital and labour in the economy. Augmented neoclassical growth theories, developed by Mankiw, Romer, and Weil (1992), extend this analysis to incorporate education, stressing the role of education as a factor of production. Education can be accumulated, increasing the human capital of the labour force and thus the steady-state level of aggregate income. The human capital component of growth comes through accumulation of more education that implies the economy moves from one steady-state level to another. Once at the new level, education exerts no further influence on growth. This view of the role of human capital is fairly limited, because there are natural constraints on the amount of schooling in which a society will invest.

A very different view comes from the "endogenous growth" literature that has developed over the past two decades. In this work, a variety of researchers (importantly, Lucas (1988), Romer (1990), and Aghion and Howitt (1998)) stress the role of education in increasing the innovative capacity of the economy through developing new ideas and new technologies. These are called endogenous growth models because (in contrast to the neoclassical model) technological change is determined by economic forces within the model. Under these models, a given level of education can lead to a continuing stream of new ideas, thus making it possible for education to affect growth even when no new education is added to the economy.

A final view of education in production and growth centres on the diffusion of technologies. If new technologies increase firm productivity, countries can grow by adopting these new technologies more broadly. Theories of technological diffusion such as Nelson and

[5] Note that this does not mean that individuals learn nothing after age 15, but rather that what they have learned in school is a good predictor for the accumulation of further skills in life and the capacity to deploy these skills effectively.

Phelps (1966), Welch (1970), and Benhabib and Spiegel (2005) stress that education may facilitate the transmission of knowledge needed to implement new technologies.

All approaches have in common that they see education as having a positive effect on growth. The latter two stress its impact on long-run growth trajectories. Still, in empirical implementations, it is hard to discriminate among these different channels through which education affects economic growth. The cognitive-skills view of human capital that has emerged in the literature appears well aligned with the latter two approaches of theoretical modelling.

2.3 Estimating the Effect of Cognitive Skills on Economic Growth

The analytical approach to measuring human capital that underlies our analysis here is to combine data from international tests given over the past 45 years in order to develop a single comparable measure of skills for each country that can be used to index skills of individuals in the labour force.[6] While the PISA tests are now well-known, the history of testing is less understood. Between 1964 and 2003, twelve different international tests of mathematics, science, or reading were administered to a voluntarily participating group of countries (see Hanushek and Woessmann (2011) for details). These include 36 different possible scores for year-age-test combinations (e.g., science for students of grade 8 in 1972 as part of the First International Science Study or mathematics of 15-year-olds in 2000 as a part of the Programme on International Student Assessment). Only the United States participated in all possible tests.

Hanushek and Woessmann (2009) aggregate all of the available test information for each country into a single measure of cognitive skills. In order to do this, U.S. scores on the international tests are benchmarked to the pattern of scores for U.S. students on their own National Assessment of Educational Progress. The variance of the international scores is adjusted to variations in scores across a set of OECD countries with stable schooling system.[7] These two transformations of the tests allow calibrating all of the international results to a common scale. The available tests for each country are then averaged to produce the composite measure of cognitive skills for the analysis of economic growth.

[6] The clear empirical objective is obtaining a measure of the skills of the workforce. The testing information for students is used to proxy the skills of workers. This construction causes no problems if the relative performance of individuals in different countries has remained constant, but it could introduce problems if that is not true.

[7] The details are described in Hanushek and Woessmann (2009).

The extended empirical analysis underlying our analysis here relates long-term growth to cognitive skills and other aspects of national economies, relying upon an international data set for up to 50 countries (Hanushek and Woessmann (2009)). These countries have participated in one or more of the international testing occasions between 1964 and 2003 and have aggregate economic data for the period 1960-2000.[8] The underlying statistical model relates average annual growth rates in real GDP per capita over the 1960-2000 period to GDP per capita in 1960, various measures of human capital (including the cognitive skills measure), and other factors that might influence growth. The inclusion of initial GDP per capita simply reflects the fact that it is easier to grow when one is farther from the technology frontier, because one just must imitate others rather than invent new things. Real GDP is called on a purchasing power parity basis. The empirical approach is consistent with the type of growth model based on the generation of ideas and new technologies – which seems consistent with the perspective and measurement of cognitive skills.

The estimates are easiest to see in Figure 1 which displays the relationship between our measure of cognitive skills and economic growth rates.[9] Two things are apparent from this. First, there is a strong positive relationship such that countries with higher measured cognitive skills grow faster. Second, the countries are all relatively close to the line, indicating that we explain most of the variation in growth rates across countries.

<< Figure 1 about here >>

The underlying statistical estimates (which are more fully described in Appendix A) indicate a powerful effect of cognitive skills on growth. An improvement of one-half standard deviation in mathematics and science performance at the individual level implies, by historical experience, an increase in annual growth rates of GDP per capita of 0.87 percent. While more detail is provided about these improvements below, suffice it to say that Finland was approximately one-half standard deviation above the OECD average over the 2000-2006 period. This historical impact suggests a very powerful response to improvements in educational quality.

Hanushek and Woessmann (2009) perform a set of analyses that provide some assurance that the estimated effect indeed reflects a causal impact of educational achievement on

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[8] International economic data come from the Penn World Table (Heston, Summers, and Aten (2002)). Communist countries during this period are not included.

[9] This figure plots the effect of cognitive skills on growth after allowing for difference in initial income (GDP per capita in 1960) and school attainment.

economic growth. Conditioning on additional measures – apart from the initial level of per-capita GDP – that might be conceived to be related to growth, such as economic institutions, geographical location, political stability, capital stock, and population growth, does not change the result of a significant impact of cognitive skills. Furthermore, additional resources in the school system, which might become affordable with increased growth, are not systematically related to improved test scores (see also Hanushek and Woessmann (2010b) and Section 4.1 below). To rule out simple reverse causation, Hanushek and Woessmann (2009) separate the timing of the analysis by estimating the effect of scores on tests conducted until the early 1980s on economic growth in 1980-2000, finding an even larger effect. Three direct tests of causality devised to rule out certain alternative explanations based on unobserved country-specific cultures and institutions confirm the results. The first one considers the earnings of immigrants to the U.S. and finds that the international test scores for their home country significantly explain U.S. earnings but only for those educated in their home country and not for those educated in the U.S. A second analysis takes out level considerations and shows that changes in test scores over time are systematically related to changes in growth rates over time. A third causality analysis uses institutional features of school systems as instrumental variables for test performance, thereby employing only that part of the variation in test outcomes emanating from such country differences as use of central exams, decentralized decision making, and the share of privately operated schools. These results support a causal interpretation and also suggest that schooling can be a policy instrument contributing to economic outcomes.

2.4 How to Simulate the Long-run Benefits of Policy Reforms

The empirical analysis of growth provides an indication of the long-run impact on growth rates of a labour force with varying skills as measured by mathematics and science scores. This long-run relationship does not, however, describe the path of benefits from any programme of changing the skills of the population. A variety of policies could improve the cognitive skills of the population – including health programmes, schooling programmes, the introduction of new teaching technologies, and the like.

We begin by showing the economic impact of policies that would raise cognitive skills. For these simulations, it does not really matter how skills are improved, but we motivate these calculations by thinking in terms of schooling changes. Schools are the locus of most governmental policies today. Moreover, when we turn potential policies, we rely exclusively on programmes involving schools.

It is important to understand the dynamics of economic impacts of such programmes. Three elements of the dynamics are particularly important for consideration: First, programmes to improve cognitive skills through schools take time to implement and to have their impact on students. It is simply not possible to change learning over night. Second, the impact of improved skills will not be realised until the students with greater skills move into the labour force. Third, the economy will respond over time as new technologies are developed and implemented, making use of the new higher skills.

In order to capture these elements, a simple simulation model is developed. These simulations follow the development in Hanushek and Woessmann (2010a) but extend those results to cover the European Union instead of remaining just in the OECD and to simulate a particular EU benchmark programme. The details of the simulation can be found in Hanushek and Woessmann (2010a). The underlying idea is that moving from one quality level to another of the workforce depends on the shares of workers with different skills. As such, the impact of skills on GDP at any point in time will be proportional to the average skill levels of workers in the economy. The expected work life is assumed to be 40 years, which implies that each new cohort of workers is 2.5 percent of the workforce. Thus, even after an educational reform is fully implemented, it takes 40 years until the full labour force is at the new skill level.

In order to consider the impacts of improvement on EU countries, the simulations rely on the estimates of growth relationships derived from the 23 OECD countries with complete data. As indicated above, these estimates suggest that a 50 point higher average PISA score (i.e., one-half standard deviation higher) would be associated with 0.87 percent higher annual growth. (Note, however, that using the estimation results from the larger 50 country sample would yield only minor differences in the results).

The simulations are conducted for all of the EU countries. There are eight non-OECD EU countries (for which no previous analysis of growth exists): Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania, and Slovenia. These countries could not be included in the previous growth analysis because we were generally missing both historic economic information and test information. We do have current information on both economic status and test scores. The testing information for the expansion of countries is all very recent, however. Just two of the expansion countries participated in international testing before 2006: Bulgaria in 2002 and Latvia in 2000 and 2003. We therefore generally rely on the 2006 PISA scores as the measure of cognitive skills for the simulations in this report (see Appendix B for details). Note, however, that Cyprus and Malta are special cases, because they did not participate in PISA, and, as described in Appendix C, we use TIMSS data to estimate their achievement scores.

We make the simple assumption that the future growth of newly-added EU members follows the established pattern of the OECD. This of course may be a strong assumption, especially for the former Communist block countries, where the prior economic systems distorted the economies from the OECD model. Nonetheless, these countries have had about two decades to make the economic transition, providing reason to believe that their future evolution will look more like OECD countries than like their own past.

The simulations assume that each country can simultaneously grow faster. In other words, the higher levels of human capital in each country allow it to innovate, to improve its production, and to import new technologies without detracting from the growth prospects for other countries.[10] Further, the estimates ignore any other aspects of interactions such as migration of skilled labour across borders. (Of course, one way that a country could improve its human capital would be by arranging for its youth to obtain schooling in another country with better schools – as long as the more educated youth return to their home country to work).

The simulation does not adopt any specific reform package but instead focuses just on the ultimate change in achievement. For the purposes here, reforms are generally assumed to take 20 years to complete, and the path of increased achievement during the reform period is taken as linear. For example, an average improvement of 25 points on PISA is assumed to reflect a gain of 1.25 points per year. This might be realistic, for example, when the reform relies upon a process of upgrading the skills of teachers – either by training for existing teachers or by changing the workforce through replacement of existing teachers. This linear path dictates the quality of new cohorts of workers at each point in time.

The dynamic nature of reform on the economy implies that the benefits to the economy from any improvement continue to evolve after the reform is completed. This characteristic is an outgrowth of the growth models that are estimated, where improvements in technology and productivity are related to the level of skills of the workforce.[11]

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[10] Rather than being negative, the spillovers of one country's human capital investments on other countries could also be positive. For example, if one country pushes out the world technological frontier by improving its human capital, other countries can gain from this by imitation and reach a higher productivity level. No attempt is made to consider how technological change occurs and the impact on wages and earnings. Obviously, different patterns of productivity improvements will play out differently in the labour market as seen in the United States over time (Goldin and Katz (2008)).

[11] Note, however, that simulations based on a neoclassical growth framework, where skill improvements affect only the steady-state level of income but not its long-run growth rate, yield results that are only mildly

It is possible to summarise these changes in different ways, and it is important to understand the meaning of each. Perhaps the simplest way to see the impact of any improvement in cognitive skills is to trace out the increased GDP per capita that would be expected at any point in the future. The prior estimates of the effect on economic growth of differences in cognitive skills yield a path of relative gains in GDP per capita. Thus, for example, it is possible to say what percentage increase in GDP per capita would be expected in 2050, given a specific change in skills started today. These changes are relative to the GDP in 2050, since the prior work indicates the marginal changes in growth rates that would be expected from higher skills.

An alternative approach is to summarise the economic value of the entire dynamic path of improvement in GDP per capita. Doing this is more difficult than the previous evaluation because the results will be dependent on a variety of additional factors. The value of improvement in economic outcomes from added growth depends, of course, on the path of economies that would be obtained without educational improvement. The analysis here takes the annual growth of OECD economies in the absence of education reform to be 1.5 percent.[12]

The length of the time period over which gains are calculated is somewhat arbitrary and depends in part on the use of the analysis for any policy decisions. The benchmark here considers all economic returns that arise during the lifetime of a child that is born at the beginning of the reform in 2010. According to the most recent data (that refer to 2006), a simple average of male and female life expectancy at birth over all OECD countries is 79 years (Organisation for Economic Co-operation and Development (2009b)).[13] Therefore, the calculations will take a time horizon until 2090, considering all future returns that accrue until then, but neglecting any returns that accrue after 2090.

Finally, because economic benefits accrue at varying times into the future, it is important to recognise that more immediate benefits are both more valuable and more certain than those far in the future. In order to incorporate this, the entire stream is converted into a present discounted value. In simplest terms, the present discounted value is the current dollar amount

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smaller than those reported here (Hanushek and Woessmann (2010b)). While a neoclassical interpretation would also be consistent with our empirical growth model which allows for conditional convergence including the initial GDP level, quantitatively the difference between an endogenous and neoclassical model framework matters less than academic discussions suggest.

[12] This is simply the average annual growth rate of potential GDP per worker of the OECD area over the past two decades: 1.5 percent in 1987-1996 and 1.4 percent in 1997-2006 (Organisation for Economic Co-operation and Development (2009a)).

[13] Note that these life expectancy numbers are based on age-specific mortality rates prevalent in 2006, and as such do not include the effect of any future decline in age-specific mortality rates. Life expectancy at birth has increased by an average of more than 10 years since 1960.

that would be equivalent to the future stream of returns calculated from the growth model. If we had that amount of funds and invested it today, it would be possible to reproduce the future stream of economic benefits from the principal amount and the investment returns. Thus, this calculation of present discount value allows a relevant comparison for any other current policy actions. In doing so, the discount rate at which to adjust future benefits becomes an important parameter. We follow a usual standard used in the literature of a discount rate of 3 percent.[14]

For all countries, we begin with gross domestic product at current market prices for 2010. These initial GDP estimates rely upon European Commission projections of 2010 GDP, using purchasing power standard (PPS) calculations to standardize across countries to billion Euros (see Appendix A).

3. Results on the Cost of Low Educational Achievement

The implications of improving cognitive skills of countries are best seen by looking at a series of scenarios that are actively discussed. These scenarios may be viewed as more or less plausible by decision makers in individual countries. Nonetheless, the range of scenarios helps to quantify the goals and options for EU countries. The first two scenarios replicate scenarios simulated for the OECD in Hanushek and Woessmann (2010a),[15] and the third scenario simulates a specific policy benchmark of the European Commission.

A number of assumptions go into these calculations. First, they assume that skills play the same role in the future as they have in the past, so that the evidence of past results provides a direct way to project the future. Second, while the statistical analysis did not look at how economies adjust to improved skills, the calculations assume that the experience of other countries with greater cognitive skills provide the relevant insight into how the new skills will be absorbed into the economy.

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[14] This is a standard value of the social discount rate used in long-term projections on the sustainability of pension systems and public finance (e.g., Börsch-Supan (2000); Hagist, Klusen, Plate, and Raffelhüschen (2005); for a similar derivation, see also Moore et al. (2004)). By contrast, the influential Stern Review report that estimates the cost of climate change uses a discount rate of only 1.4 percent, thereby giving a much higher value to future costs and benefits (Stern (2007)). If this practice were followed here, the discounted values of the considered education reforms would be substantially bigger than reported here. Hanushek and Woessmann (2010b) present projections based on several alternative model parameters, time horizons, and discount rates.

[15] The third scenario reported in Hanushek and Woessmann (2010a), of bringing all students to a minimum competency level of 400 PISA points, is reported for the EU in Appendix D, as it is close in spirit to the EU benchmark scenario reported here as Scenario III.

3.1 Scenario I: Increase Average Performance by 25 PISA Points

One straightforward goal, already shown to be achievable by several EU countries, is to improve performance on PISA by 25 points, or ¼ standard deviation. The country with the largest performance increase in PISA between 2000 and 2006 was Poland, with an increase of 29 points in the reading assessment. This type of improvement would, for example, move Austria, Denmark, or Ireland half of the distance toward Finland on the 2006 PISA tests. Alternatively, such an improvement would put the Netherlands close to the level of Finland, or would close half of the gap between Malta and the average OECD country.

While this is a relatively modest reform scenario, it has a dramatic impact on all of the EU countries. A policy like this is uniform across countries, so the relative improvement is the same for all countries. While there are no impacts initially until higher-achieving students start becoming more significant in the labour market, GDP will be more than 3 percent higher than what would be expected without improvements in human capital as early as 2042. The impact rises to a 5.5 percent improvement in 2050 and 14.2 percent in 2070. By the end of expected life in 2090 for the person born in 2010, GDP per capita would be expected to be about 25 percent above the "education as usual" level. These dynamic improvements in the economy yield on-going gains to society, and the appropriate summary of the impact of educational improvements accumulates the value of these annual gains.

After all people in the labour force have obtained the new and improved education (in 2070), annual growth will be 0.43 percentage points higher. This implies that each country that achieves the average improvement of ¼ standard deviation of achievement will have a cumulative impact on the economy through 2090 that is equal to 268 percent of current year GDP. The discounted values of all of the future increases through 2090 for each EU country imply that the gain for the full set of EU nations totals €32 trillion in present value (see Table 1). Of this, €4 trillion would go to the smaller accession nations that joined the EU after the base set of 15 nations.

<< Table 1 about here >>

Table 1 also shows the gains to each of the EU economies from this kind of improvement. The absolute magnitude of the gains depends directly on the size of the economy in 2010. Thus, as displayed in Figure 2, Germany shows the largest gain – with a present value of over €6 trillion – and France and the United Kingdom realize gains of over €4.5 trillion. But relative to the size of its economy, the over €100 billion gain by Lithuania is a dramatic change.

<< Figure 2 about here >>

3.2 Scenario II: Bring Each Country to Finland Average Level

Perhaps the most ambitious reform would be to bring all EU students up to the average level of Finnish students (556 points on PISA 2006). This is obviously a large move, perhaps unrealistic, for some of the lower performing countries such as Bulgaria, Cyprus, and Romania that would have to move their average performance by more than 125 points on PISA. Nonetheless, Finland shows clearly what is possible with a well-functioning educational system (including both schools and other institutions).

Under this scenario, the ultimate percentage gain to GDP differs across countries depending upon how far they are behind Finland and thus how far they have to move. (Note also that Finland would not change under this scenario). Table 2 provides data on each of the EU countries in terms of the GDP gains. The table provides both the magnitude of the change (in terms of absolute and percentage levels of GDP). It also indicates the change in long-run growth rates predicted to accrue to each economy once its entire workforce has reached the higher level of cognitive skills. On average, annual growth rates across the EU would be about one percent higher, reflecting the fact that the average gap with Finland is slightly more than one-half standard deviation on the PISA tests. Across the whole EU, the present value of this educational reform would amount to €87 trillion, or more than 7 times the current GDP of the EU.

<< Table 2 about here >>

Figures 3a and 3b provide two different ways to look at the country-specific gains. The first figure shows the absolute gains, with Italy being at the top due to the combination of the size of its economy and the amount of improvement called for to equal Finland. But, if one looks at the gains compared to the size of the economy, one sees that the largest gains accrue to Romania, Bulgaria, and Cyprus – the countries farthest away from Finland in terms of cognitive skills. Romania would, for example, see long-term gains that were 20 times its current GDP.

<< Figures 3a and 3b about here >>

3.3 Scenario III: Achieve the EU Benchmark 2020 of Low Achievers in Basic Skills

The third scenario comes from the quality goal set out by the European Union in its Lisbon and post-Lisbon objectives in education and training: "By 2020 the percentage of low-achieving 15-year-olds in reading, mathematics and science literacy in the European Union should be less than 15%." (See Commission of the European Communities (2009), p. 85) To quantify these, the Commission takes the relevant literacy levels to coincide with PISA Level 1 or lower, which in PISA 2006 means mathematics at 420.1 and science at 409.5.[16] While the previous simulations could be thought of as displaying the results of shifting the entire achievement distribution, this scenario considers the implications of a "compensatory" improvement that brings up the bottom of the distribution.[17]

One substantial element of this goal is that it is set for 2020. This would imply a 10-year reform plan that in turn means that the economic benefits are both larger and seen earlier than from the same policy change enacted as a 20-year reform. Although the EU policy benchmark is defined as a benchmark for the European Union as a whole, rather than for each Member State individually, for practical purposes we model the simulation so that each Member State reaches the benchmark within its respective country, thereby contributing to a Union-wide fulfilment.[18]

The changes under this reform policy are more modest than those under the full compensatory scheme reported in Appendix D. Specifically, the 15-percent leeway implies that a number of EU countries currently do better than this goal.

The impact on long-run growth is an increase in annual growth rates of 0.23 percent and an aggregate gain in present value terms of €21 trillion (see Table 3). While smaller in total

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[16] We do not use reading tests, but the literacy level there would coincide with 407.5.

[17] In order to understand the implications of changing just one portion of the achievement distribution, an alternative estimation of the underlying economic growth models is employed. Specifically, instead of relying on just average cognitive skills in the growth models, the proportion of the population with scores less than 400 and the proportion with scores over 600 are included in the growth models. (See Hanushek and Woessmann (2009) for a discussion of this estimation). We use the estimates of the impact of reaching 400 points as the basis of this work, assuming that the results will not be that different than using the slightly higher Level 1 cut-offs, given that both are just defined in terms of changes in the shares of students reaching the level.

[18] In reality, rather than aiming to reach the benchmark within each Member State, Member States are currently setting their own targets of how they will contribute to the European benchmark. This way, the most advanced countries would also contribute to the achievement of the benchmark, lightening the strain on the least advanced countries. The ambiguity of such a procedure makes it hard to model the practical implementation of the scenario (and also makes it hard for the Member States to take political ownership of this benchmark in the political process). Scenario I above depicts a reform where all Member States contribute an equal improvement to the total scenario.

impact than the previous reform programmes, the average gain compared to GDP would be 177 percent of current GDP. And, as a plan aimed at the lower end of the cognitive skill distribution, the new EU countries – who on average have lower achievement than the EU-15 set – show disproportionate gains under this.

<< Table 3 about here >>

The range of outcomes is depicted in Figure 4a that ranks countries by the benefits in terms of absolute increases in GDP and Figure 4b that puts this in terms of percentages of current GDP. Note that gains relative to current GDP are even more skewed in this scenario with modest changes for a large portion of the EU states and very large changes for a few. Less than half of the EU states gets gains in present value terms that exceed their current GDP.

<< Figures 4a and 4b about here >>

3.4 Implications for the Member States in Eastern Europe

It is particularly interesting to look at the Member States that joined the EU after 2003, the "Eastern Enlargements" group: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia (plus Cyprus and Malta as special cases). Because of their Communist background, we know relatively little about the long-term economic past of most of the Eastern European countries. Since several of them are not members of the OECD, there also were no projections previously available for this group. The projections for the Eastern European countries are particularly illuminating as they are missing the long-run past experience of the education-economy link in a free economy that are available for the OECD countries. By building on the observed nexus in OECD countries and combining it with current information on educational achievement levels in the Eastern European countries, we learn about the future growth potential of educational reforms in these countries.

The prior discussions have noted the fact that a group of these countries has done very poorly on the PISA tests and therefore could be expected to make huge gains from improving their schools. Bulgaria, Cyprus, Malta, and Romania are at the bottom of the EU in terms of performance on educational achievement tests. Consequently, they have the potential to profit most from bringing their levels of educational achievement to levels more standard for other EU countries.

But there is another group of enlargement countries that has done very well. Estonia and Slovenia have the second lowest proportion of students below 400 points of all of the EU countries. Indeed, half of the enlargement countries do better by this measure than the average of the pre-enlargement group of 15 countries. Thus, the story on cognitive skills and deficits in learning is not a simple one of pre- and post-enlargement.

4. Policies to Improve Educational Achievement

The previous discussion has stressed the importance of cognitive skills for economic growth. The evidence indicates a strong impact of skills that can give rise to immense long-term benefits. Yet simply knowing that skill differences are important does not provide a guide to policies that might promote more skills. Indeed, a wide variety of policies have been implemented within various countries without much evidence of success in either achievement or economic terms. We believe that the disappointing results of the past generally reflect pursuing policies for which there is little empirical support.[19]

Substantial research has gone into understanding why achievement differs across students and across countries. While controversies have existed about the interpretation of various individual pieces of evidence, considerable agreement now exists about what kinds of approaches are unreliable avenues for change. There is perhaps less agreement on the precise approaches that might be followed, but even here there is a growing consensus about the general sets of policies that have shown promise based on more credible research approaches.

The work on achievement determinants is generally labelled "education production functions." The extensive work has taken a variety of perspectives and approaches. The general objective is to sort out the causal impacts of school factors (things that can potentially be manipulated through policy) from other influences on achievement including family background, peers, neighbourhood influences, and the like (which are less readily amenable to policy change). In this section, we discuss available evidence on the potential for different aspects of school policy – in particular, those focused on school resource, teacher quality, and institutional structures – to improve educational achievement significantly.[20]

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[19] The exposition in this section draws directly from Hanushek and Woessmann (2010b).

[20] See Woessmann (2008) for a discussion of education policy options over the whole lifecycle, with a particular focus on Europe.

4.1 Evidence on School Resources

The most extensive generally available evidence relates to the effects of resources. Many policies undertaken involve substantial flows of resources – direct spending, changes in teacher salaries, reductions in class size, and the like – made within the context of current school organization. The empirical evidence clearly documents the difficulties with such policies. Simply providing more resources gives, according to the available evidence, little assurance that student performance will improve significantly. The underlying analyses of resources include studies within individual countries and across different countries and have been extensively reviewed elsewhere (see Hanushek (2003); Woessmann (2007a); Hanushek and Woessmann (2011)).

The easiest way to see the situation is a simple picture of outcomes across countries. Figure 5 presents the international association between spending levels and math performance in the 2006 cycle of PISA conducted by the OECD. Ignoring Mexico and Turkey where cumulative expenditure per student (over the age range of 6 to 15 years) is less than $20,000, there is no association between educational spending and educational outcomes across OECD countries (see the black regression line in Figure 5).[21] On average, countries with high educational expenditure perform at the same level as countries with low educational expenditure. Even when numerous family-background and school features are considered in cross-country student-level microeconometric regressions, these results hold.[22]

<< Figure 5 about here >>

For policy deliberations, information on the impact of resources from within individual countries is perhaps more appropriate than cross-country information. Researchers have studied the determinants of student achievement for more than 40 years. The work was begun in the United States in the "Coleman Report" (Coleman et al. (1966)), which introduced the idea of using statistical analysis to relate various inputs of schools to student outcomes. This work also underscored the importance of including non-school factors by demonstrating that family differences were very important in explaining variations in achievement across

[21] With the two outliers, there is a weak positive association as long as other effects are ignored. Taken literally, the grey regression line that includes Mexico and Turkey depicts an association where a doubling of expenditure in these two countries is associated with one tenth of a standard deviation in test scores.

[22] See Woessmann (2001, 2003); Fuchs and Woessmann (2007).

students. While this original study has been subjected to considerable criticism, it led to an extensive line of research.

The general picture about school resources in developed countries is now well known and has been reviewed in a variety of places (see Woessmann (2005a) for Europe and Hanushek (2002, 2003) for the United States). The available studies concentrate on various common inputs to schools such as teacher experience or class size. These factors are both readily available in both administrative and survey data sets and frequently identified as the focus of policy. The available econometric evidence now includes literally hundreds of separate estimates within the U.S. and other developed countries. Quite uniformly, however, there is little strong evidence that *any* of the following factors has a consistent impact on achievement: the level of teacher education, the pupil-teacher ratio, the characteristics of administration, or the facilities of the school. Specifically, aggregating results across studies, a minority of estimates are statistically different from zero (at the 5 percent level or better), and the studies do not even uniformly indicate improvements in performance with increased resources. A second line of studies focuses on financial inputs. A number of studies simply relate spending per student to achievement or capture teacher differences by teacher salaries. While these studies tend to be lower quality, they also fail to show a consistent relationship between financial resources and achievement.

These results have been controversial. A variety of debates have taken place around the correct interpretation of prior work (see, for example, Burtless (1996)). The most important line of debate has involved study quality and whether or not these works adequately control for various inputs that might complicate the interpretation of resources. For example, the statistical models may not adequately account for other inputs that affect achievement such as the quality of family inputs. The estimates might then erroneously attribute the higher achievement due to better family factors to some of the characteristics of schools.

A simplistic view of this argument – convenient as a straw man in public debates – is that 'money never matters.'[23] The research of course does not say that. Nor does it say that 'money cannot matter.' It simply underscores the fact that there has historically been a set of decisions and incentives in schools that have blunted any impacts of added funds, leading to inconsistent outcomes. That is, more spending on schools has not led reliably to substantially better results.

[23] For the historical framing of the question, see the exchange between Greenwald, Hedges, and Laine (1996) and Hanushek (1996).

One often held view is that resources may matter more in situations where students and schools have a disadvantaged background. However, there is little evidence that resource effects are consistently higher in disadvantaged situations. Empirical results are mixed at best. For example, Bressoux, Kramarz, and Prost (2009) find beneficial effects of smaller classes for low-achieving students in France, but Bénabou, Kramarz, and Prost (2009) do not find any significant effect of the French policy of education priority zones which channel additional resources to disadvantaged schools. Similarly, Leuven, Lindahl, Oosterbeek, and Webbink (2007) do not find any evidence of positive effects of programmes that targeted extra funding to schools with large proportions of disadvantaged pupils in the Netherlands. Likewise, Woessmann (2005a) finds hardly any evidence that class-size effects are more relevant for students from disadvantaged backgrounds than for well-off students in European countries. Also, much US evidence suggests that the extent to which a refocusing of additional material resources towards the disadvantaged can alter the distribution of educational outcomes is very limited at best (Betts and Roemer (2007); Hanushek (2007)), although there are studies that find that class-size reductions are more effective for disadvantaged students (Krueger (1999)). Overall, there is very little evidence suggesting that spending targeted at disadvantaged students is any more effective than spending on average.

4.2 Teacher Quality

The most current research on school inputs and achievement has also led to another set of conclusions – that teacher quality is enormously important in determining student achievement. This work has concentrated on whether some teachers consistently produce more gains in student achievement than other teachers.[24] Working with extensive panel data on individual students from different U.S. states, these studies have confirmed large differences among teachers in terms of outcomes in the classroom.

But, they have also shown that the observed differences are not closely related to commonly observed characteristics of teachers (such as amount of teacher education). Some attributes of teachers – such as having one or two years of experience – have explained part of the differences in teacher quality, but these factors are a small part of the overall variance in teacher results.[25] While convincing evidence on the effects of the quality of the initial

[24] See, for example, Hanushek (1971), Hanushek (1992), Rockoff (2004), Rivkin, Hanushek, and Kain (2005), and a number of subsequent studies reviewed in Hanushek and Rivkin (2010).

[25] There is some indication that teachers' own academic skills measured by scores on achievement tests may be an important factor (see Wayne and Youngs (2003), Eide, Goldhaber, and Brewer (2004), and Hanushek and

education that teachers received is missing, existing results on observable characteristics of teacher education are discouraging (see Chingos and Peterson (2010) and the references therein). The inability to identify specific teacher qualities makes it difficult to regulate or legislate having high-quality teachers in classrooms. It also contributes to our conclusions below that changes in the institutional structure and incentives of schools are fundamental to improving school outcomes.

4.3 Institutional Structures and Incentives in the School System

Similar to the importance of economic institutions for national economies, it is difficult to have a highly functioning education system without a supportive institutional structure. On this matter, however, there are more different opinions and perhaps a wider divergence in outcomes. Part of the reason for the divergent opinions is simply a lack of sufficient experience, analysis, and evidence.

The evidence does suggest some clear general policies that are important. Foremost among these, the performance of a system is affected by the incentives that actors face. That is, if the actors in the education process are rewarded (extrinsically or intrinsically) for producing better student achievement, and if they are penalized for not producing high achievement, achievement is likely to improve. The incentives to produce high-quality education, in turn, are created by the institutions of the education system – the rules and regulations that explicitly or implicitly set rewards and penalties for the people involved in the education process. Therefore, one might expect that institutional features have important impacts on student learning.

The unifying theme of these institutional studies is that the key to improvement appears to lie in better incentives – incentives that will lead to managerial decisions keyed to student achievement and that will promote strong schools with high-quality teachers. Here, three interrelated policies come to the forefront: promoting more competition, so that parental demand will create strong incentives to individual schools; autonomy in local decision making, so that individual schools and their leaders will take actions to promote student achievement; and, an accountability system that identifies good school performance and leads to rewards based on this.

Choice and Competition. Choice and competition in schools were proposed a half century ago by Milton Friedman (1962). The simple idea is that parents, interested in the schooling

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Rivkin (2006) for reviews), but methodologically more sophisticated work is needed before conclusive assessments can be given on this dimension.

outcomes of their children, will seek out productive schools. This demand-side pressure will result in incentives for each school to produce an effective education system. These incentives will also put pressure on schools to ensure high-quality staff in addition to a good curriculum.

In many school systems (with the Netherlands being the most obvious example), a number of privately managed schools provide alternatives for students. These schools, which also often have a religious affiliation, are part of the natural institutional framework. Unfortunately, little thorough evaluation has been done of the choice possibilities, in large part because there is no obvious comparison group (i.e., choice is instituted for an entire country and there is no example of the no-choice alternative). In a cross-country comparison, students in countries with a larger share of privately managed schools tend to perform better on average (cf. Woessmann (2007b, 2009); Woessmann, Luedemann, Schuetz, and West (2009)), and recent evidence corroborates the conclusion that this is due to a causal effect of private-sector competition (West and Woessmann (2010)).[26]

In the U.S., there are limited examples of private school choice, ranging from the publicly funded school vouchers in Milwaukee, Cleveland, and Washington, DC, to privately financed voucher alternatives.[27] The evaluations of these generally show that the choice schools do at least as well as the regular public schools, if not better (see Rouse (1998); Howell and Peterson (2002)).

In Europe, Bradley and Taylor (2002) and Levačić (2004) find similar positive effects of school competition on the performance of English schools. Sandström and Bergström (2005) and Björklund, Edin, Freriksson, and Krueger (2004) provide evidence on significant positive effects of competition from privately operated schools on the performance of public schools in Sweden. Filer and Münich (2003) show that the introduction of a voucher-type system in the Czech Republic led to the creation of private schools in areas where public schools are doing badly and that the public schools facing private competition improved their performance.

Critics of choice-based policies often argue that a greater reliance on choice and private competition can lead to greater segregation of students (e.g., Ladd (2002)). On the other hand, in particular the additional choice created by public funding for privately operated schools

[26] Note that private school management does not mean private school funding; the international evidence suggests that both private school management and *public* school funding are associated with better achievement across countries (Woessmann (2009)).

[27] The largest U.S. voucher program in the State of Florida provides vouchers for special needs students (Greene (2007)). While there is considerable satisfaction with this program, there is no evaluation available that is based on explicit outcome measures.

may particularly benefit disadvantaged students whose choices are otherwise most constrained, and thus boost equity in the school system. In fact, the cross-country patterns suggest that a larger share of privately operated schools is not only related to a higher performance level, but also to a substantially lower dependence of student achievement on socioeconomic status – as long as all schools are publicly financed (Woessmann, Luedemann, Schuetz, and West (2009)). The point is that through residential sorting, systems that do not allow choice among schools can already lead to substantial segregation. In such a setting, allowing choice among schools can even lead to reduced segregation because access to good schools is no longer tied to being able to afford to live in an expensive neighbourhood (Nechyba (2000)).

The major issue on choice and competition is still the limited experience. Teachers unions and administrator groups invariable dislike the idea of competition – because it puts pressure on them. Thus, not many examples of operational, large-scale attempts at competition have been evaluated. Nonetheless, the benefits of competition are so well documented in other spheres of activity that it is quite inconceivable that more competition would not be beneficial for schools.

Autonomy and Decentralization. Several institutional features of a school system can be grouped under the heading of autonomy or decentralization, including local decision making on different matters, fiscal decentralization, and parental involvement. Almost any system of improved incentives for schools depends upon having school personnel in individual schools and districts heavily involved in decision making. It is difficult to compile evidence on the impact of autonomy, because the degree of local decision making is most generally a decision for a country (or state) as a whole, leaving no comparison group within countries. Across countries, students tend to perform better in schools that have autonomy in personnel and day-to-day decisions (Woessmann (2003, 2007b); Woessmann, Luedemann, Schuetz, and West (2009)), in particular when there is accountability (see also the review in Hanushek and Woessmann (2011)).

The U.S. states have varying amounts of local autonomy. One systematic form of school autonomy is "charter schools," which are public schools that are allowed to perform quite autonomously. (Note that these are actually hybrids of choice schools and public-school autonomy, because they survive only if sufficient numbers of students are attracted to them and continue to attend them). These schools are relatively new, a fact that complicates evaluation since many are still in the start-up phase. The evidence on them is mixed but indicates a variety of places where charter schools outperform the regular public schools after the initial start-up phase but also suggests in part that the regulations governing them and the particular competitive public schools they face have an influence.[28] Also, given U.S. residential mobility, individual public school districts compete with each other, and more competition appears to produce better results (Hoxby (2000)).[29]

Given the available evidence, support for autonomy also strongly rests on a conceptual basis. A system with strong incentives seems likely to capitalize on local decision making.

School Accountability. Many countries around the world have been moving toward increased accountability of local schools for student performance. The United Kingdom has developed an elaborate system of "league tables" designed to give parents full information about the performance of local schools. The United States has legislated a federal law ("No Child Left Behind") that all states develop an accountability system that meets certain general guidelines. It also sets into law a series of actions required when a school fails to bring sufficient numbers of students up to proficiency in core subjects.

Evidence on the impacts of these systems has begun to accumulate. While there is some uncertainty given the newness of the overall federal accountability system (introduced in 2002), the best U.S. evidence indicates that strong state accountability systems in fact lead to better student performance (Carnoy and Loeb (2002); Hanushek and Raymond (2005); Jacob (2005); Dee and Jacob (2009)).

One institutional set-up that combines accountability with parental choice are systems that give students in schools that repeatedly do badly on the accountability test a voucher to attend private schools.[30] In Florida, the threat of becoming subject to private-school choice if failing on the test has been shown to increase school performance particularly for disadvantaged students (West and Peterson (2006); Figlio and Rouse (2006)).

Curriculum-based external exit exams are another means to introduce some form of accountability into the schooling system. They provide performance information which can hold both students and schools accountable. Students in countries with external exit exam systems tend to systematically outperform students in countries without such systems (Bishop (1997, 2006); Woessmann (2001, 2003, 2007b); Woessmann, Luedemann, Schuetz, and West (2009)). In Canada and Germany, the two national education systems where the existence of

[28] The range of estimates can be seen in Bifulco and Ladd (2006), Sass (2006), Booker, Gilpatric, Gronberg, and Jansen (2007), Hanushek, Kain, Rivkin, and Branch (2007), CREDO (2009), and Hoxby and Murarka (2009).

[29] See Rothstein (2007) and Hoxby (2007) for further discussion of this evidence.

[30] The legality of this system has been challenged in the Florida courts, so that the future of the program in Florida is in doubt.

external exams varies within the country because some regions feature them and others not, it has similarly been shown that students perform better in regions with external exams (Bishop (1997); Jürges, Schneider, and Büchel (2005); Woessmann (2010b)).

It is difficult to imagine choice or autonomy working well without a good system of student testing and accountability. Thus, the ideas about institutional structure are closely linked together. The international evidence clearly suggests that school autonomy, in particular local autonomy over teacher salaries and course content, is only effective in school systems that have external exams in place (Woessmann (2005b, 2007b); Fuchs and Woessmann (2007); Woessmann, Luedemann, Schuetz, and West (2009)). Similar evidence that accountability policies are more effective when there is greater local control has also been found across U.S. states (Loeb and Strunk (2007)).

One example of the international evidence is depicted in Figure 6, which plots relative student achievement under the four conditions resulting from the presence and absence of central exams and school autonomy over teacher salaries, after controlling for dozens of student, family, and school background factors. School autonomy over teacher salaries is negatively associated with student achievement in systems without external exams. In systems with external exams, student achievement is generally higher than in systems without external exams, reflecting the increased accountability. But what is more, the association between school autonomy and student achievement turns completely around in systems with external exams: Salary autonomy of schools is positively associated with student achievement in external-exam systems. This pattern of results has been found in different TIMSS and PISA studies, and similar cases where external exams turn a negative autonomy effect around into a positive effect have been found for other decision making areas such as school autonomy in determining course content and teacher influence on resource funding.

<< Figure 6 about here >>

Finally, given the importance of high teacher quality, a promising candidate for improvement is the specific form of accountability that aims incentives directly at teachers. While convincing evidence on the effects of performance-related teacher pay is scarce, the more rigorous studies in terms of empirical identification tend to find a positive relationship between financial teacher incentives and student outcomes (cf. the surveys in Atkinson et al. (2009) and Podgursky and Springer (2007); see also Figlio and Kenny (2007)). Thus, Atkinson et al. (2009) find that the introduction of performance-related pay had a substantial positive impact on student achievement in England. Similarly, monetary incentives for teachers based on their students' performance have been shown to improve student learning very significantly in Israel and in India (Lavy (2002, 2009); Muralidharan and Sundararaman (2009)). Likewise, the cross-country variation provides some indication that students perform better in countries that allow for teacher salaries to be adjusted based on performance in teaching (Woessmann (2010a)).

Clearly, research on how school policy can successfully advance educational achievement is an expanding field that still leaves many open questions. At the same time, our reading of the available evidence is that institutional reforms – in particular in the areas of competition, autonomy, and accountability – that create incentives for improving outcomes and focus in particular on teacher quality have substantial potential to create the kinds of learning gains that our results above show to be linked to immense long-term economic benefits.

5. Conclusions

This report quantifies the long-term economic benefits that the European Union could reap by improving educational achievement. Economic research over the past decade indicates that educational achievement, as measured by international student achievement tests, has a strong and consistent effect on the long-run economic growth of nations. We project the cost, in terms of foregone future GDP, of low educational achievement. Viewed from a different perspective, these cost estimates reveal the growth potential that the European Union could unlock by successful educational reform.

Two aspects of this analysis stand out. First, the gains from improving cognitive skills are, by past history, enormous. The present value of improved economic performance from feasible programmes is much larger than the size of EU nations' annual GDPs. In particular, the aggregate gains for the European Union range from €32 trillion for an average increase of ¼ standard deviations in student achievement (25 PISA points), to €87 trillion for bringing each nation's educational achievement up to top-performing Finland, and to €21 trillion for reaching the official EU benchmark of less than 15% low-achievers in basic skills by 2020.

Second, it is hard to get these gains. The gains come only in the future – after students have left school and become a significant proportion of the workforce. Moreover, the kinds of policies that have been pursued in the past have not been generally effective. While some nations have shown that it is possible to improve – Finland and Poland are good examples – many have simply put more resources into a system that does not respond.

Change is clearly difficult, but the rewards for change are very large. Passing up major reform policies because they are too difficult is passing up extraordinarily large economic benefits. To reap these benefits, education policy requires a clear focus on learning outcomes, rather than mere school attainment. Current educational goals need to be transformed into a "Quality Education for All" – for example, replacing the current Education for All goal of the international community that focuses much more on school attainment.

This message is as relevant for the European Union as it is for countries struggling to achieve universal primary-school attainment. In particular, in its new Europe 2020 strategy, the European Council (2010) chose to quantify its two "headline targets" in the area of education as merely quantitative measures of education levels: It adopted the targets to "reduce school drop-out rates to less than 10%" and to increase "the share of 30-34 years old having completed tertiary or equivalent education to at least 40%". While we appreciate the well-placed recognition of the leading role of education in the new European strategy for jobs and growth, existing research clearly indicates that a focus on targets of quantitative attainment rather than measured learning outcomes is strongly misplaced. As discussed above, it is the learning outcomes that matter for long-run growth, and once they are taken into account, there is no significant relation of educational attainment with growth. Therefore, a focus on attainment rather than learning outcomes is unlikely to bring the gains in job-creating growth that the Europe 2020 strategy hopes for and may even lead to considerable harm if it distracts nations' attention from active policies to improve the quality of schools.

The two Europe 2020 headline targets were drawn from a set of five benchmarks that the Council had adopted in the Strategic Framework for European Cooperation in Education and Training (ET 2020) in 2009 (see Commission of the European Communities (2009)). One of those benchmarks, to reduce the share of low-achieving 15-year-olds in reading, mathematics and science literacy in the European Union below 15%, is the basis for our Scenario III projections. While there is little evidence that advances in quantitative attainment alone would boost jobs and growth in the long run, our results show that an alternative focus on qualitative achievement could reap enormous gains in long-run economic growth and enhanced economic performance over the remainder of the century.

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Appendix A: Empirical Growth Models with Cognitive Skills

The empirical growth models that are employed here relate growth rates of GDP per capita to the initial level of GDP per capita, the years of school attainment, and the level of cognitive skills measured by mathematics and science scores on available international exams. Inclusion of initial income reflects the fact that lower income countries just have to imitate more developed countries and will find this easier than innovating with new products, technologies, or production techniques (often called conditional convergence).

The basic estimation employs a sample of 23 OECD countries for which appropriate economic data are available for the period of 1960-2000. (Hanushek and Woessmann (2008) provide estimates for an expanded sample of 50 countries that are very similar to those presented below).

Ideally, one would want the level of test performance for the workers in the economy, and not just the test performance of students who range in age from roughly 10-18 years old. The analysis assumes that the average scores observed for students are a good proxy of labour-force skills. This assumption would clearly be satisfied if the educational outcomes within countries remain roughly constant. There is some indication that this is not the case (see Hanushek and Woessmann (2009)), which would tend to introduce some error into these measures. Nonetheless, in one set of tests, scores before 1984 are linked to growth from 1980-2000, thus getting the timing closer to ideal, and the estimated effects are somewhat larger than found for the full period (Hanushek and Woessmann (2009)). In general, this kind of measurement error will tend to lead to estimates of the impact of skills that is biased downward.

The basic model estimated for the 23 OECD countries is:

$$G = -3.54 - 0.30\, GDP/capita_{1960} + 1.74\, C + 0.025\, S \qquad R^2=0.83$$
$$\quad (2.0) \quad (5.8) \qquad\qquad (4.2) \qquad (0.3)$$

where G is the average annual growth rate in GDP per capita between 1960 and 2000, $GDP/capita_{1960}$ is initial national income, C is the composite measure of cognitive skills, and S is years of schooling (measured in 1960, but qualitative results are the same when measured as average over 1960-2000). Absolute values of t-statistics are reported in parentheses below coefficients. (The sources of data and the calculation of cognitive skills are described in detail in Hanushek and Woessmann (2009)).

The estimated coefficient on cognitive skills implies that an increase of one standard deviation in performance (i.e., 100 on the PISA scale) would yield an annual growth rate that is 1.74 percentage points higher.

The estimates presume that $GDP/capita_{1960}$, C, and S are the systematic determinants of growth rates and that other factors that might explain growth are uncorrelated with these. Moreover, C is assumed to cause G, and not the other way around. For more detailed analyses supporting the modelling framework, see Hanushek and Woessmann (2009).

Appendix B: Differences to the Projections in Hanushek and Woessmann (2010a)

The methodology of the projections reported in this study follows closely the projection model used for OECD countries in Hanushek and Woessmann (2010a). Slight differences in reported results for individual countries are solely due to the following two data reasons.

First, the data on educational achievement used here refers to the PISA 2006 study, whereas the OECD study used average achievement across the three PISA cycles in 2000, 2003, and 2006. There are two reasons to focus on PISA 2006 here. One, the EU benchmark of low achievers in basic skills that we model in this study refers to the Level 1 of the PISA proficiency scale. This scale has been defined for the first time in 2006 for science, and in 2003 for mathematics, precluding the use of previous PISA cycles. Two, only two of the eight non-OECD EU countries (for which the previous analyses had not been done yet) had participated in PISA before 2006 at all (Bulgaria in 2002 and Latvia in 2000 and 2003), making a focus on PISA 2006 the obvious choice for the current analyses.

Second, the current results are calculated in Euros rather than U.S. dollars. The European Commission provides comparable data on the purchasing power standard (PPS) for all EU-27 countries, including projections for 2010. The data was extracted from the annual macro-economic database (AMECO) of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN) at http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm on 24 March 2010.

Appendix C: Deriving Educational Information for Non-PISA-Participants from TIMSS

The data on educational achievement generally refer to the average of mathematics and science achievement on the PISA 2006 test. Data on country mean achievement and student shares achieving the different PISA competency levels are derived from Organisation for Economic Co-operation and Development (2007). We use the PISA micro database to calculate the shares of students below the minimum competency level of 400 PISA points.

Two EU Member States have not yet participated in the PISA study, Cyprus and Malta. However, both of these countries participated in a similar international student achievement study, the TIMSS 2007 (see Mullis, Martin, and Foy (2008)). We derive measures of educational achievement comparable to the PISA scale for these two countries using the following method. We first re-scale the TIMSS data so that the group of nine EU countries that participated both in PISA 2006 and in TIMSS 2007 – Bulgaria, Czech Republic, Hungary, Italy, Lithuania, Romania, Slovenia, Sweden, and United Kingdom – has the same mean and standard deviation at the student level that it has on the PISA test. (A smooth normal shape of the student-level test score data in this group of countries on both tests suggests that such a re-scaling procedure is clearly warranted). From this re-scaling, we derive educational achievement data for Cyprus and Malta on the PISA scale which allows us to calculate the required means and shares of educational achievement.

Appendix D: A Scenario that Brings Everyone up to Minimum Skill Levels

A third scenario simulated for the OECD in Hanushek and Woessmann (2010a), similar in spirit to Scenario III above, is the "compensatory" improvement in education where all students are brought up to a minimal skill level – which is defined here as obtaining a score of 400 on the PISA tests (one standard deviation below the OECD average).

For these calculations, all EU countries including Finland have room for improvement. On average, 18 percent of students in the EU countries score below 400. And, as might be expected from the average scores, the required improvements are largest in Bulgaria, Cyprus, and Malta where over 30 percent of tested students are below 400 points (see Table A1).

<< Table A1 about here >>

The overall change from bringing everybody up to the level of 400 would be an average annual growth rate that was 0.6 percent higher after the reform was accomplished and after the full labour force had received the improved education. The improvements for the EU countries from achieving universal minimum proficiency would have a present value that averaged four times current GDP. This amounts to total gains of €48.5 trillion for the EU countries. Even Finland could by these calculations get a gain worth 79 percent of its current GDP through bringing its very modest proportion of low performers (3.5 percent) up to scores of 400. The ranking order of countries by magnitude of change or percentage gains is essentially unchanged from Scenario III reported in the text.

Appendix E: Tables and Figures

Table A1: Effect on GDP of Scenario III: Bring all to minimum of 400 points on PISA

	Value of reform (billion €)	in % of current GDP	Long-run growth increase (p.p.)	Note: Share of students below minimum skills
Austria	887	349%	0.56	14.7
Belgium	1,031	335%	0.54	14.1
Bulgaria	836	1,186%	1.60	42.4
Cyprus	178	976%	1.37	36.2
Czech Republic	666	328%	0.53	13.9
Denmark	465	298%	0.48	12.7
Estonia	31	160%	0.27	7.0
Finland	114	79%	0.13	3.5
France	7,383	429%	0.67	17.8
Germany	7,657	334%	0.53	14.1
Greece	1,531	581%	0.88	23.3
Hungary	486	331%	0.53	14.0
Ireland	403	281%	0.45	12.0
Italy	8,560	598%	0.90	23.9
Latvia	86	351%	0.56	14.8
Lithuania	168	413%	0.65	17.1
Luxembourg	142	442%	0.69	18.2
Malta	66	830%	1.20	31.6
Netherlands	1,135	217%	0.36	9.4
Poland	1,858	337%	0.54	14.2
Portugal	1,093	559%	0.85	22.5
Romania	1,563	699%	1.03	27.3
Slovakia	366	398%	0.63	16.6
Slovenia	122	280%	0.45	12.0
Spain	4,865	428%	0.67	17.7
Sweden	864	322%	0.52	13.6
United Kingdom	5,934	341%	0.54	14.4
EU-15	42,065	397%	0.62	15.5
EU-27	48,491	402%	0.63	17.7

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of current GDP. "Long-run growth increase" refers to increase in annual growth rate (in percentage points) once the whole labour force has reached higher level of educational performance. "Share of students below minimum skills" refers to the share of students in each country performing below the minimum skill level of 400 PISA points. For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2010a).

Table 1: Effect on GDP of Scenario I: Increase average performance by 25 points on PISA, or by ¼ std. dev.

	Value of reform (billion €)
Austria	681
Belgium	824
Bulgaria	189
Cyprus	49
Czech Republic	543
Denmark	418
Estonia	52
Finland	387
France	4,599
Germany	6,130
Greece	705
Hungary	392
Ireland	384
Italy	3,826
Latvia	66
Lithuania	109
Luxembourg	86
Malta	21
Netherlands	1,397
Poland	1,476
Portugal	523
Romania	598
Slovakia	246
Slovenia	117
Spain	3,039
Sweden	719
United Kingdom	4,655
EU-15	28,373
EU-27	32,230

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2010a).

Table 2: Effect on GDP of Scenario II: Bring each country to Finish level of 556 points on PISA

	Value of reform (billion €)	in % of current GDP	Long-run growth increase (p.p.)	Note: Increase in PISA score
Austria	1,378	542%	0.83	47.7
Belgium	1,389	451%	0.70	40.5
Bulgaria	1,345	1,908%	2.29	132.1
Cyprus	323	1,770%	2.17	125.1
Czech Republic	1,017	501%	0.77	44.5
Denmark	921	589%	0.89	51.4
Estonia	69	359%	0.57	32.9
Finland	0	0%	0.00	0.0
France	12,221	711%	1.05	60.5
Germany	11,954	522%	0.80	46.1
Greece	3,010	1,142%	1.55	89.6
Hungary	1,002	683%	1.01	58.4
Ireland	837	584%	0.88	50.9
Italy	15,819	1,106%	1.52	87.3
Latvia	201	816%	1.18	68.0
Lithuania	336	826%	1.19	68.7
Luxembourg	260	812%	1.18	67.7
Malta	117	1,467%	1.89	108.8
Netherlands	1,582	303%	0.49	28.1
Poland	3,829	694%	1.03	59.2
Portugal	2,112	1,079%	1.49	85.6
Romania	4,597	2,056%	2.42	139.2
Slovakia	718	782%	1.14	65.6
Slovenia	217	497%	0.77	44.2
Spain	9,871	869%	1.24	71.6
Sweden	1,641	611%	0.92	53.0
United Kingdom	10,110	581%	0.88	50.7
EU-15	73,105	689%	1.01	55.4
EU-27	86,875	721%	1.04	65.8

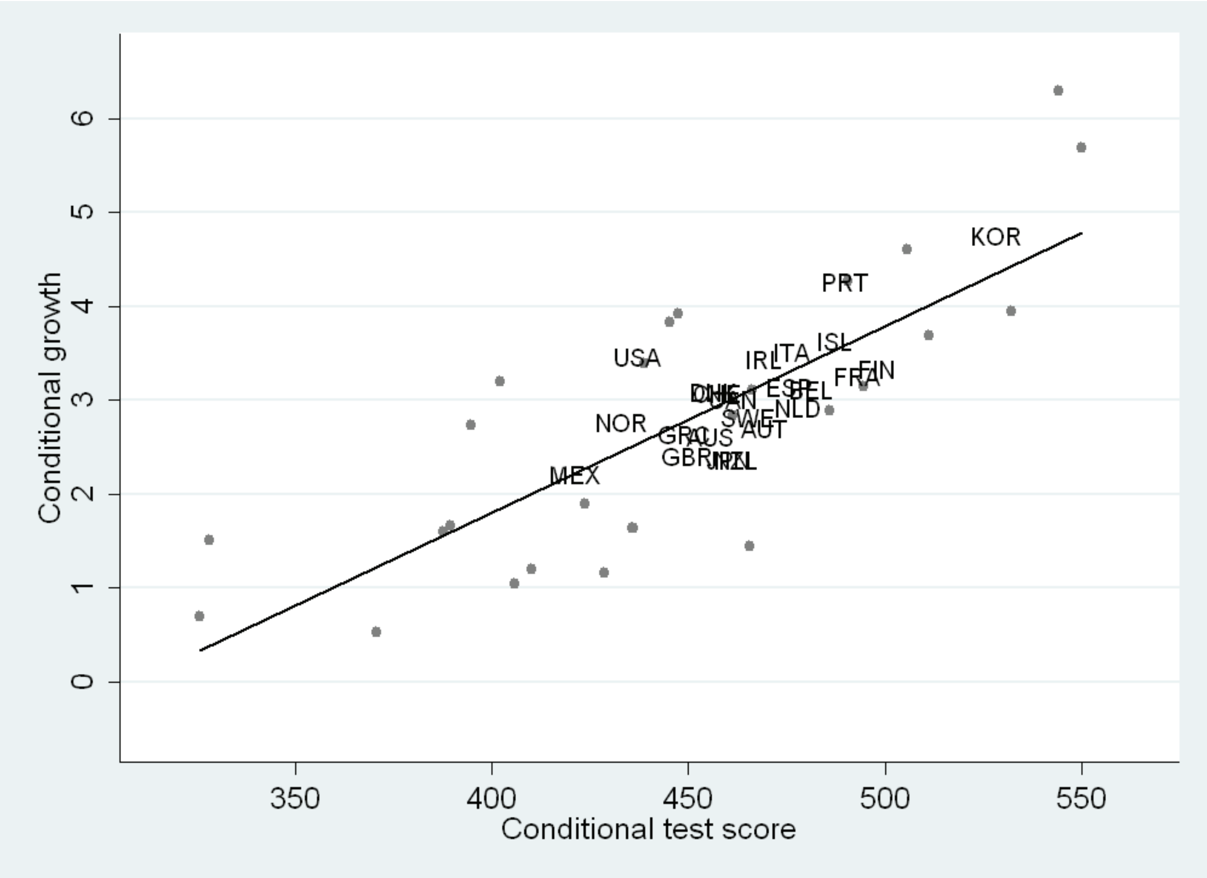
Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of current GDP. "Long-run growth increase" refers to increase in annual growth rate (in percentage points) once the whole labour force has reached higher level of educational performance. "Increase in PISA score" refers to the ultimate increase in educational performance due to the reform (of bringing each country to the Finish average level of 556 PISA points). For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2010a).

Table 3: Effect on GDP of Scenario III: Meet EU Benchmark of less than 15% below PISA Level 1 by 2020

	Value of reform (billion €)	in % of current GDP	Long-run growth increase (p.p.)	Note: Decrease in share of students below Level 1 (p.p.)
Austria	217	85%	0.12	3.2
Belgium	181	59%	0.08	2.2
Bulgaria	758	1,075%	1.25	33.0
Cyprus	151	826%	1.00	26.5
Czech Republic	128	63%	0.09	2.3
Denmark	71	46%	0.06	1.7
Estonia	0	0%	0.00	0.0
Finland	0	0%	0.00	0.0
France	3,177	185%	0.25	6.7
Germany	1,613	70%	0.10	2.6
Greece	996	378%	0.50	13.2
Hungary	123	84%	0.12	3.1
Ireland	37	26%	0.04	1.0
Italy	5,786	404%	0.53	14.0
Latvia	27	110%	0.15	4.1
Lithuania	74	183%	0.25	6.6
Luxembourg	66	206%	0.28	7.4
Malta	49	616%	0.78	20.5
Netherlands	0	0%	0.00	0.0
Poland	508	92%	0.13	3.4
Portugal	703	360%	0.48	12.6
Romania	2,571	1,150%	1.32	34.8
Slovakia	139	151%	0.21	5.5
Slovenia	15	35%	0.05	1.3
Spain	2,247	198%	0.27	7.2
Sweden	169	63%	0.09	2.3
United Kingdom	1,520	87%	0.12	3.2
EU-15	16,784	158%	0.21	5.2
EU-27	21,327	177%	0.23	8.1

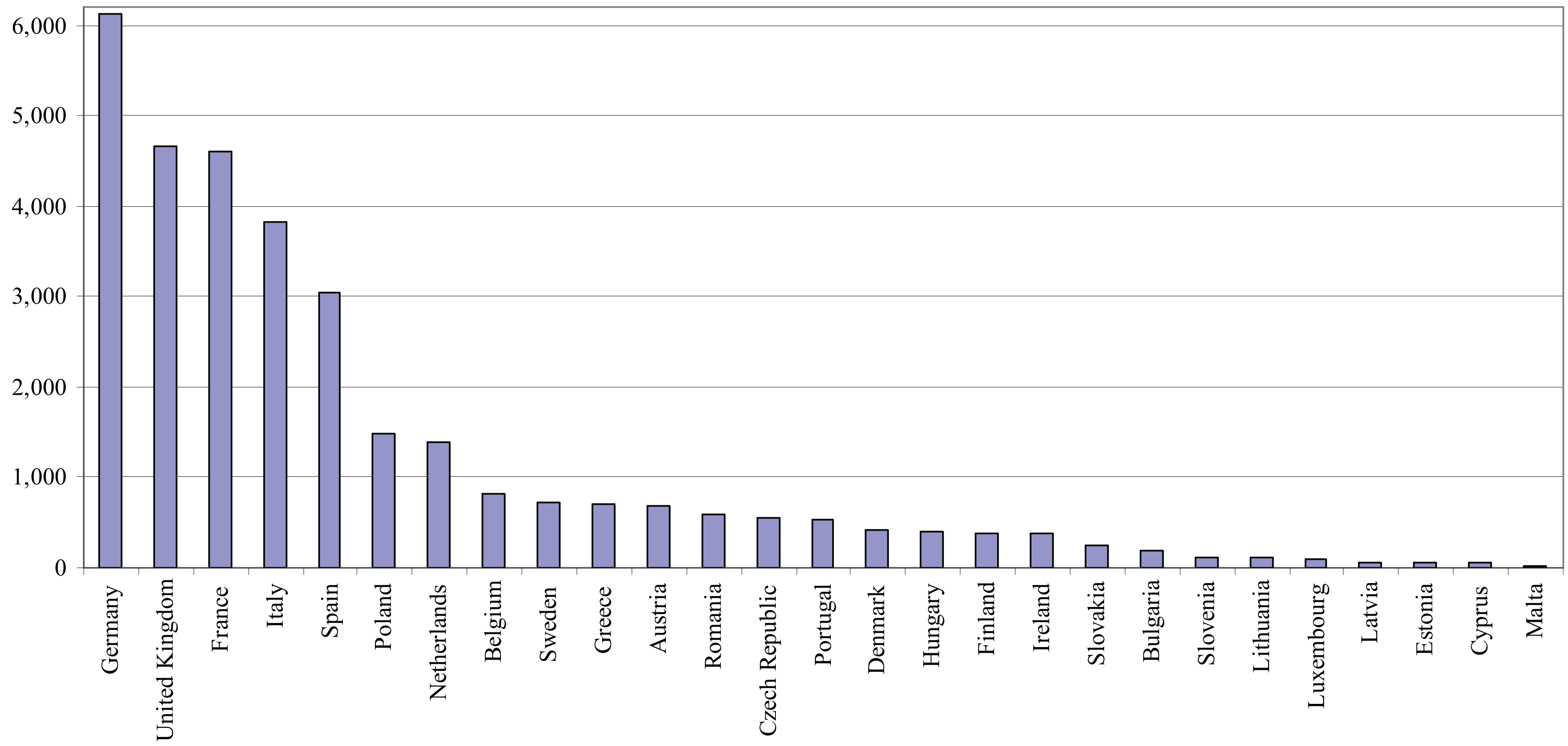
Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of current GDP. “Long-run growth increase” refers to increase in annual growth rate (in percentage points) once the whole labour force has reached higher level of educational performance. “Share of students below minimum skills” refers to the share of students in each country performing below the minimum skill level of 400 PISA points. For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2010a).

Figure 1: Educational achievement and economic growth



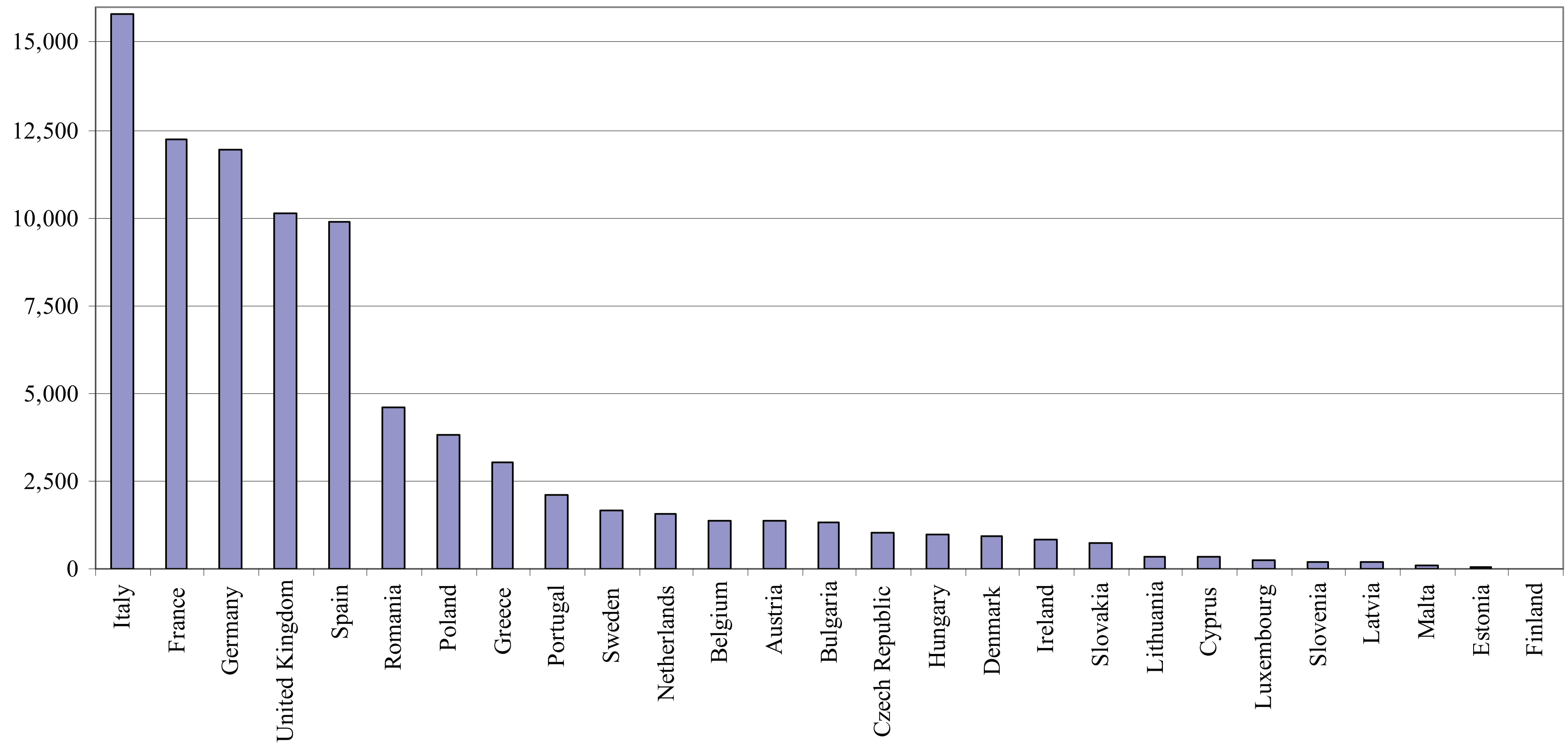
Notes: Added-variable plot of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960-2000 on the initial level of real GDP per capita in 1960, average test scores on international student achievement tests, and average years of schooling in 1960 (mean of the unconditional variables added to each axis). OECD countries labelled by acronyms, non-OECD countries by dots. Own depiction based on the database derived in Hanushek and Woessmann (2009).

Figure 2: Present value of Scenario I (improve student performance in each country by 25 PISA points) in billion Euro (PPP)



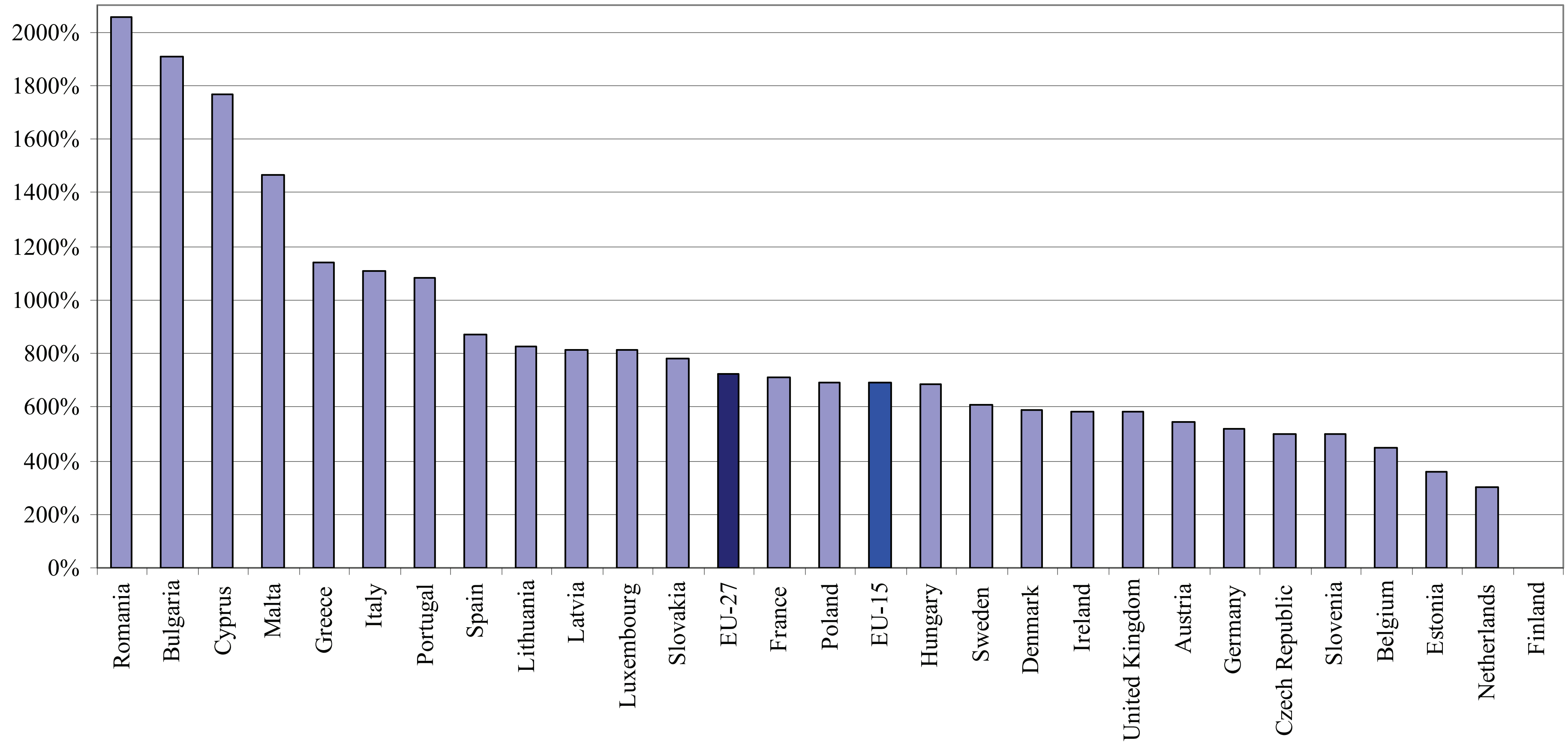
Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). See Table 1.

Figure 3a: Present value of Scenario II (improve student performance in each country to reach Finish PISA level) in billion Euro (PPP)



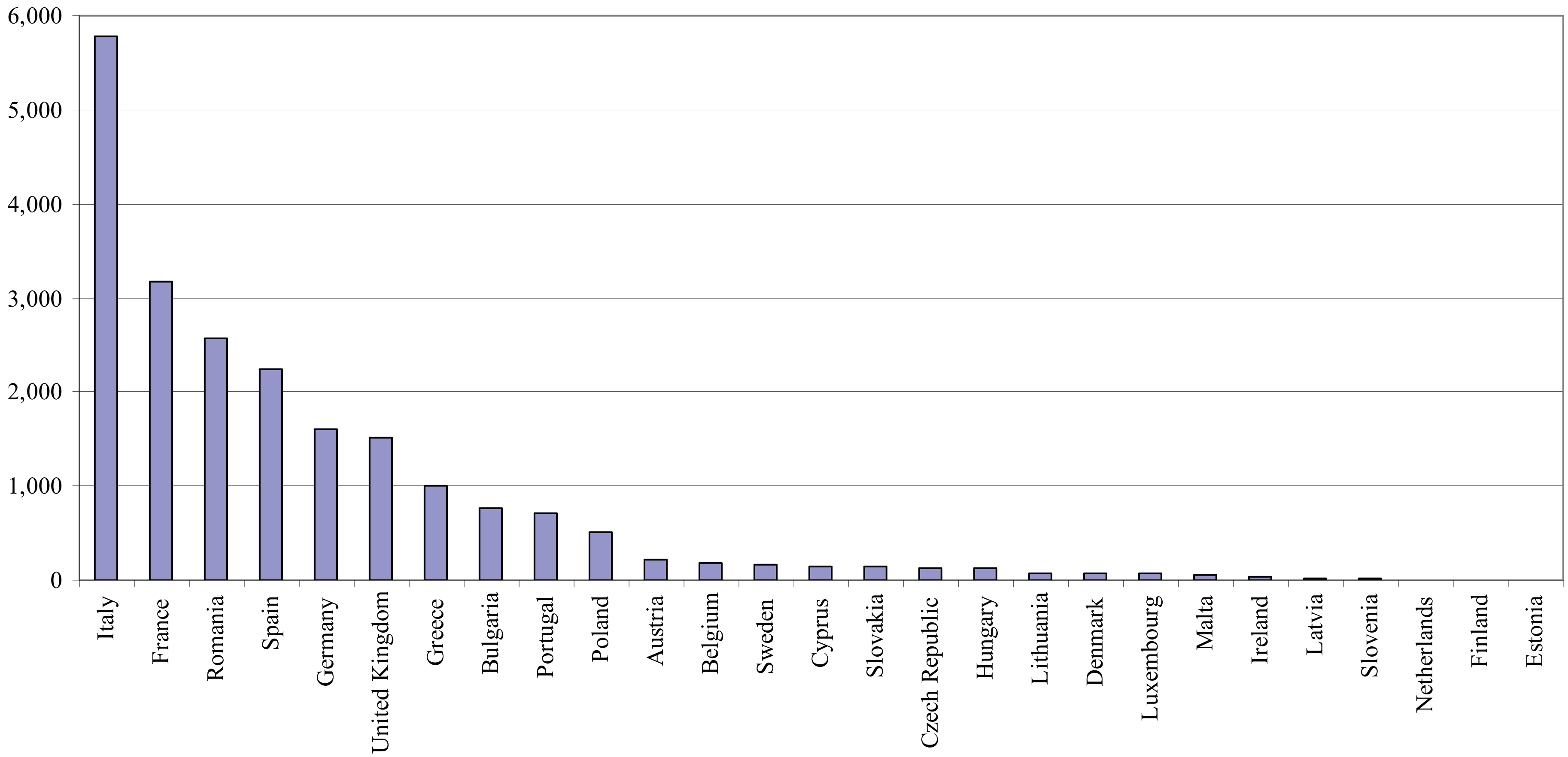
Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). See Table 2.

Figure 3b: Present value of Scenario II (improve student performance in each country to reach Finish PISA level) in percent of current GDP



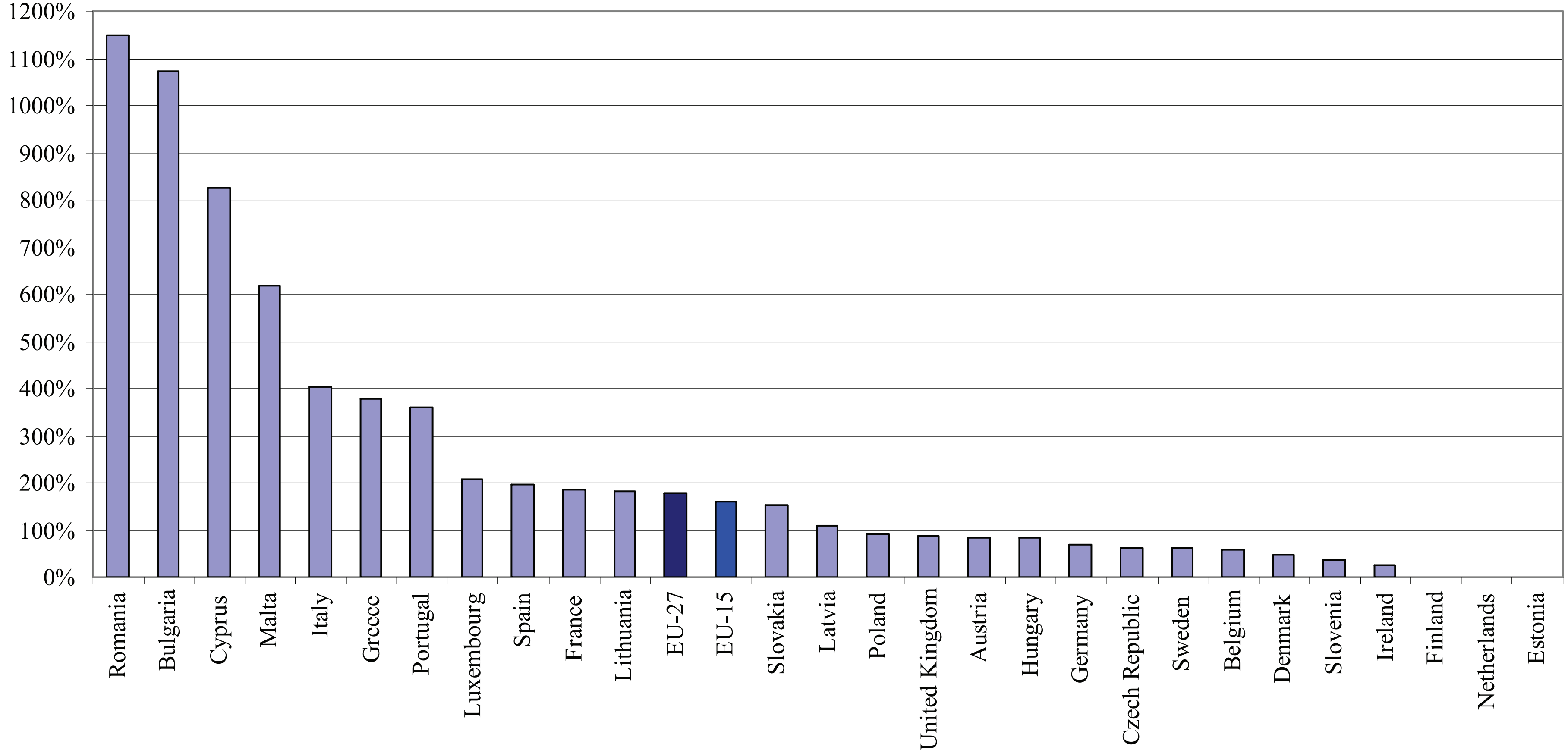
Notes: Discounted value of future increases in GDP until 2090, expressed as percentage of current GDP. See Table 2.

Figure 4a: Present value of Scenario III (meet EU Benchmark of less than 15% below PISA Level 1 by 2020) in billion Euro (PPP)



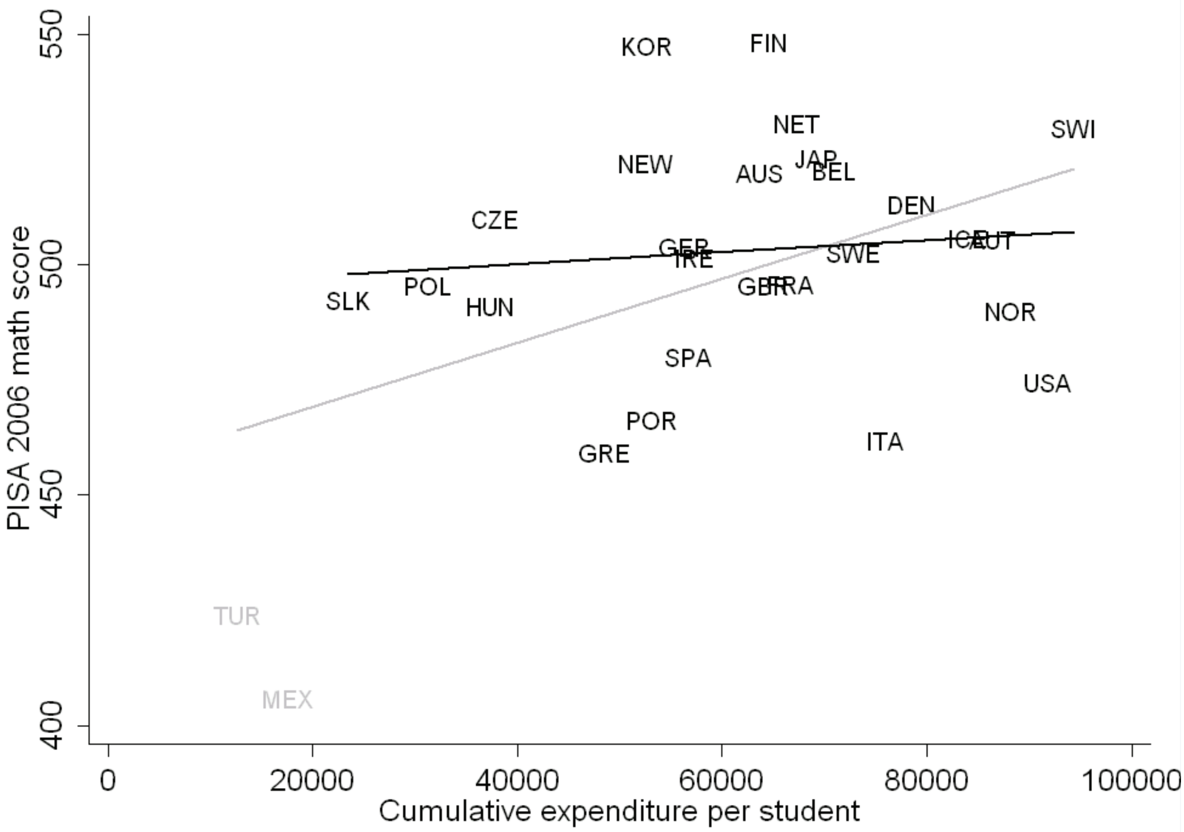
Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). See Table 3.

Figure 4b: Present value of Scenario III (meet EU Benchmark of less than 15% below PISA Level 1 by 2020) in percent of current GDP



Notes: Discounted value of future increases in GDP until 2090, expressed as percentage of current GDP. See Table 3.

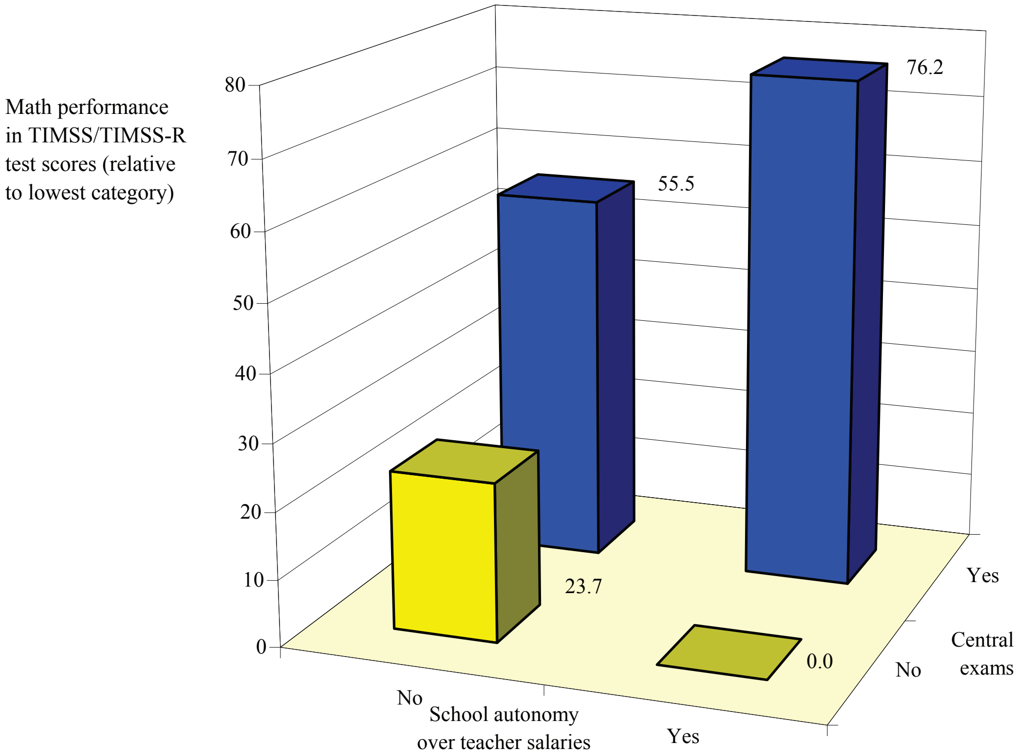
Figure 5: Expenditure per student and student achievement across countries



Notes: Association between average math achievement in PISA 2006 and cumulative expenditure on educational institutions per student between age 6 and 15, in US dollars, converted by purchasing power parities. Grey line: regression line for full sample. Black line: regression line for countries with expenditure above $20,000.

Source: Hanushek and Woessmann (2010b).

Figure 6: Accountability, autonomy, and student achievement across countries



Notes: Performance difference between the four categories relative to the lowest category which is set equal to zero. Based on a cross-country student-level multiple regression using the combined TIMSS and TIMSS-Repeat micro databases that extensively controls for family background, school inputs, and other institutional features.

Source: Woessmann (2005b).

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