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The Economic Benefit of Educational Reform in the European Union

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Abstract

We use estimates of the effect of educational achievement—measured by international student achievement tests—on economic growth to simulate the impact of improved achievement for individual EU countries and the EU as a whole. We calculate the present value of improvements in GDP over the life expectancy of a child born today (i.e. until 2090), using a discount rate of 3%. Under plausible assumptions, the present values of the gains from educational reforms for the EU aggregate add up to astounding amounts on the three considered reform scenarios: €35 trillion (288% of current GDP) for an average increase of ¼ standard deviations; €95 trillion (785% of current GDP) for bringing each nation up to the top-performer Finland; and €25 trillion (211% of current GDP) for reaching the official EU benchmark of <15% low-achievers in basic skills by 2020. Seen relative to the present value of GDP over the same period, these gains amount to an average increase in GDP of 4.5–16.8%. The results suggest that EU policies aimed at school attainment goals are misplaced without assurances that student achievement also improves. In fact, economic cohesion within the EU appears to be highly dependent on fostering more equality in achievement across countries. (JEL codes: I20, O40, J24, H40)

Keywords: education, growth, Europe, simulation

1 Introduction

In its Europe 2020 strategy, the 10-year successor of the Lisbon strategy, the European Council (2010) set out a 'framework for the Union to mobilize 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'. This article utilizes recent econometric research to quantify the benefit, in terms of increased future GDP, that the European Union (EU) and its Member States would reap from improved educational achievement. Our results suggest that while improving human capital in EU countries has the potential for substantial economic gain, the specific policy choices emphasized by the EU are less clearly appropriate.

The EU has consistently recognized the importance of educating its citizens, often framed in terms of developing a human capital policy.

A prime motivation 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.

Convenience and data availability most commonly dictated that both past research and policy discussions focused on school attainment, i.e. years of schooling. But the recent work emphasizes what people know—their cognitive skills—as opposed to how much time they have spent in schools. Particularly in international comparisons and analyses, direct measures of math and science skills through international tests like TIMSS and PISA prove to be far superior to years of schooling in explaining growth. 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 important concerns about the focus of Europe 2020 benchmarks on early-school leaving and tertiary attainment over benchmarks for basic skills and learning outcomes.

Our analysis uses available estimates of the impact of cognitive skills on economic growth to simulate how future GDPs would evolve under various school reform plans that improved the cognitive skills of each EU country. The analysis is entirely focused on long-term growth, because growth is what affects the future well-being of countries. 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 in Hanushek and Woessmann (2011b) and extend that analysis in important ways from an EU perspective. 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).

The importance for improved educational policies is easily seen. During the past decade, Poland has shown strong improvements in its schools (29 points, or over one-quarter standard deviation, on the PISA reading tests). If the rest of the EU could make similar gains over the next two decades, aggregate community income is projected to increase by €35 trillion (in present value terms), or 288% of current GDP, over the lifetime of a person born in 2010. Increases of this magnitude are difficult to comprehend fully, but, in comparison to projected GDP over the same period, such a gain amounts to an added 6.2%. Other policies, such as bringing all students up to basic levels of achievement, would yield similarly large gains if future growth follows past patterns.

As we have recently seen, 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 the past couple of years, when the most obvious focus of attention has been the worldwide recession. Without minimizing the need to deal with current unemployment conditions, the message of this article 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.

Achieving the gains from schooling investments is dependent on improving skills—and improving skills is not easy. The Europe 2020 strategy of the EU quite appropriately emphasizes the role of education in promoting the growth and development of member countries. But, our analysis points to the central position of developing high-level basic skills and downplays the quantitative goals emphasized by the EU. Simply attending school is not enough if the students are not learning at a high level. It is the learning and not the attendance that must have the highest priority.

2 Methodological framework

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 modeling, and it is a standard element of any empirical work.[1]

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.

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

2.1 Existing research on 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; Levine and Renelt 1992; Mankiw et al. 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.[2] To give an idea of the robustness of this association, an extensive empirical analysis by Sala-i-Martin et al. (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 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).[3] Additionally, this measure assumes that formal schooling is the primary (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.

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

[3] 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).

Over the past 10 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 in multivariate cross-country growth regressions, Hanushek and Kimko (2000) demonstrate a large positive effect of cognitive skills on economic growth in 1960–1990. The relationship between cognitive skills and economic growth has now been demonstrated in a range of studies. As reviewed in Hanushek and Woessmann (2008, 2011a), 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 labor force in different countries and that these skills are closely tied to economic outcomes.[4]

2.2 Basic empirical growth model

The basic analytical approach to measuring human capital that underlies our analysis here is to combine data from international tests given over the past 45 years to develop a single comparable measure of skills for each country that can be used to index skills of individuals in the labor force.[5] While the PISA tests are now well-known, the history of testing is less understood. Between 1964 and 2003, 12 different international tests of mathematics, science, or reading were administered to a voluntarily participating group of countries (see Hanushek and Woessmann 2011a 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 USA 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, US scores on the international tests are benchmarked to the pattern of scores for US students on their own National Assessment of Educational Progress. The variance of the international scores is adjusted

[4] Note that this does not mean that individuals learn nothing after age 15 years, 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.

[5] 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.

to variations in scores across a set of OECD countries with stable schooling system.[6] 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.

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- to 18-years old. The analysis assumes that the average scores observed for students are a good proxy of labor-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 completely true (see Hanushek and Woessmann 2009). Nonetheless, in one set of tests, scores before 1984 are linked to growth from 1980 to 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 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.[7] 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 measured on a purchasing power parity (PPP) basis. The empirical approach is consistent with a growth model based on the generation of ideas and new technologies (e.g. Romer 1990)—which seems consistent with the perspective and measurement of cognitive skills.

Within macroeconomics, however, there are alternative models of the growth process. A leading alternative to the endogenous growth models that we estimate and simulate below, is the neoclassical growth model that views human capital as one of the inputs to the aggregate production

[6] The details are described in Hanushek and Woessmann (2009).
[7] International economic data come from the Penn World Table (Heston et al. 2002). Communist countries during this period are not included.

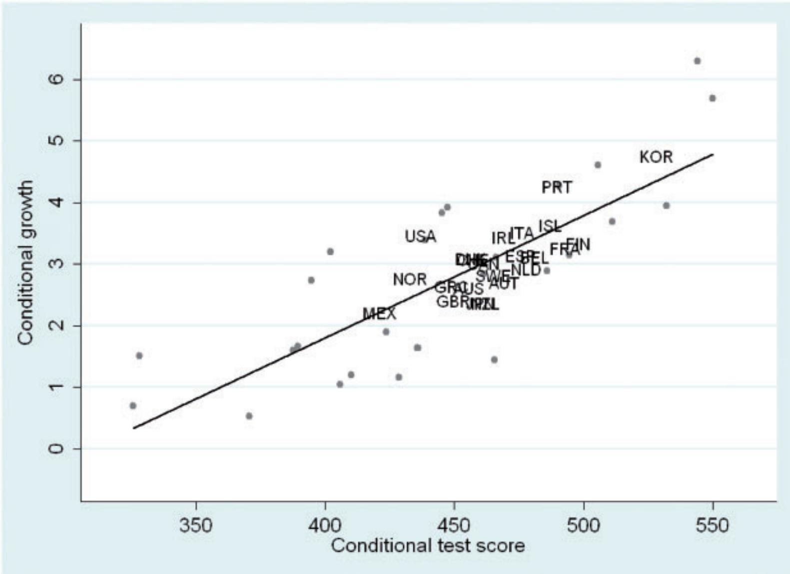

Figure 1 Educational achievement and economic growth. *Notes*: Added-variable plot of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960–2000 on the initial level of real GDP per capita in 1960, average test scores on international student achievement tests, and average years of schooling in 1960 (mean of the unconditional variables added to each axis). OECD countries labeled by acronyms, non-OECD countries by dots. Own depiction based on the database derived in Hanushek and Woessmann (2009).

process, as opposed to the determinant of the underlying rate of technological progress (Mankiw et al. 1992).[8] In this alternative, differences in cognitive skills would not affect the long-run growth rate but instead would relate directly just to the steady-state level of income that an economy would achieve in the long run. In our analysis below, we can easily provide the neoclassical alternative, which we view as a lower bound on the future GDP impacts of an improvement in cognitive skills.

The basic estimates are easiest to see in Figure 1 that displays the relationship between our measure of cognitive skills and economic growth

[8] Nonneman and Vanhoudt (1996) extend the analysis of Mankiw et al. (1992) to include investment in R&D (see also Keller and Poutvaara 2005). In our perspective, where cognitive skills affect the ability to generate new technologies, such R&D investments may constitute one channel of the overall growth effect of cognitive skills.

rates and that highlights the OECD countries that are central to the analysis here.[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.

The underlying statistical estimates 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. Here, the basic estimation employs a sample of 24 OECD countries for which appropriate economic data are available for the period of 1960–2000, although estimates for the expanded sample of 50 countries are very similar. The basic model estimated for the 24 OECD countries is:

$$\underset{(3.0)}{G = -4.27} - \underset{(8.6)}{0.30}\ \text{GDP/capita}_{1960} + \underset{(5.8)}{1.86}\, C + \underset{(0.8)}{0.046}\, S \rightarrow R^2 = 0.85$$

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.[10]

The empirical growth model indicates a powerful effect of cognitive skills on growth. The estimated coefficient on cognitive skills implies that an improvement of one-half standard deviation in mathematics and science performance (i.e. 50 points on the PISA scale) at the individual level would by historical experience yield an increase in annual growth rates of GDP per capita of 0.93 percentage points. 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.

In such estimation, it is obviously difficult to be certain that the relationship is causal in the sense that increasing achievement would yield

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.

10 The sources of data and the calculation of cognitive skills are described in detail in Hanushek and Woessmann (2009). 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 modeling framework, see Hanushek and Woessmann (2009). For the specific model of the OECD sample, see Table 2 in Hanushek and Woessmann (2011b).

increased long run growth, but Hanushek and Woessmann (2009) perform a set of analyses that rule out the most significant threats to a causal interpretation. In the most straightforward analysis, conditioning on additional measures 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. Perhaps more surprisingly, 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 2011b). While beyond the scope of this analysis, Hanushek and Woessmann (2009) pursue a variety of tests that support a causal interpretation and also suggest that schooling can be a policy instrument contributing to economic outcomes.[11]

2.3 The simulation approach

The empirical analysis of growth provides an indication of the long-run impact on growth rates of a labor 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 program of changing the skills of the population. A variety of policies could improve the cognitive skills of the population—including health programs, schooling programs, 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.

It is important to understand the dynamics of economic impacts of such programs. Three elements of the dynamics are particularly important: First, programs to improve cognitive skills through schools take time to implement and to have their impact on students. Second, the economic

[11] To rule out simple reverse causation, they 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 further direct tests of causality were also 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 USA and finds that the international test scores for their home country significantly explain US earnings but only for those educated in their home country and not for those educated in the USA. 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.

impact of improved skills will not be realized until the students with greater skills move into the labor 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 (2010, 2011b) but extend those results to cover the EU instead of remaining just in the OECD and to simulate a particular EU benchmark program. The underlying idea is that a more skilled labor force leads to high long-run economic growth through the regular generation of new ideas and production processes. The simulations thus rely on an endogenous growth model framework where growth rates can be permanently increased by having a higher skilled population. As noted above, however, economists have also developed alternative models of growth that do not portray the long-run growth rate as a function of human capital. After our preferred endogenous growth simulations, we therefore also provide simulations based on a neoclassical growth framework but these different perspectives have limited impact on the policy bearing of our estimates.

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% of the workforce. Thus, even after an educational reform is fully implemented, it takes 40 years until the full labor 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 24 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 0.93 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 paper (see Appendix A for details). Note, however, that Cyprus and Malta are special cases, because they did not participate in PISA, and, as described in Appendix B, 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.[12] They also assume that, ultimately, all OECD countries have access to the same technology. Further, the estimates ignore any other aspects of interactions such as migration of skilled labor 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). Furthermore, the simulations assume that all countries have a stationary population with a constant age distribution, so as not to compound the effects of education reform with those of demographic change.[13]

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.

12 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 labor market as seen in the USA over time (Goldin and Katz 2008).

13 Woessmann and Piopiunik (2009) provide similar projections for Germany that also take into account projected population dynamics; considering demographic change does not alter the basic result of astoundingly large gains from education reforms.

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. 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. 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, since the prior work indicates the marginal changes in growth rates that would be expected from higher skills.

An alternative approach is to summarize the economic value of the entire dynamic path of improvement in GDP per capita. For all countries, we begin with GDP at current market prices for 2010.[14] Our analysis assumes that, in the absence of education reform, EU economies will grow at a rate of 1.5% per year.[15] It considers all economic returns that arise during the lifetime of a child that is born at the beginning of the reform in 2010, which means a time horizon until 2090 and neglecting any returns that accrue thereafter.[16]

While economic benefits accrue at varying times into the future, more immediate benefits are both more valuable and more certain than those far in the future. Due to this, the entire stream is converted into a present discounted value, which is the current dollar amount 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

[14] These initial GDP estimates rely upon European Commission projections of 2010 GDP, using purchasing power parity (PPP) calculations to standardize across countries to billion Euros (see Appendix A).

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

[16] 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). 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 greater than 10 years since 1960.

and the investment returns. We follow precedents in the literature to use a discount rate of 3 percent for our projections.[17]

3 Results on the benefits of improved educational achievement

The implications of improving cognitive skills of countries are best seen by looking at a series of scenarios that represent plausible goals for decision makers in individual countries. The first two scenarios represent a modest and a more ambitious overall goal,[18] 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.

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.

17 For example, 3% 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 et al. 2005). This order of magnitude is also suggested as a practical value for the social discount rate in cost-benefit analysis in derivations from optimal growth rate models (Moore et al. 2004). In contrast, the influential Stern Review report that estimates the cost of climate change uses a discount rate of only 1.4% (Stern 2007), thereby giving a much higher value to future costs and benefits, which in our case would lead to substantially higher discounted values of the considered education reforms than reported here. Hanushek and Woessmann (2011b) present projections based on several alternative model parameters, time horizons, and discount rates.

18 These first two replicate scenarios simulated for the OECD in Hanushek and Woessmann (2011b) but extend them to the full EU community. A third scenario reported there, of bringing all students to a minimum competency level of 400 PISA points, is reported for the EU in Appendix C, as it is close in spirit to the EU benchmark scenario reported here as Scenario III.

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 labor market, GDP will be more than 3% higher than what would be expected without improvements in human capital as early as 2041. The impact rises to a 5.9% improvement in 2050 and 15.3% 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 26% 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 labor force have obtained the new and improved education (in 2070), annual growth will be 0.47 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 288% 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 €35 trillion in present value (Table 1). Of this, €4 trillion would go to the smaller accession nations that joined the EU after the base set of 15 nations. Normalized against the discounted value of the projected future GDPs of the EU countries over the same time span (until 2090), the overall effect amounts to a 6.2% increase in discounted future GDPs.

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, Germany shows the largest gain—with a present value of over €6 trillion—and France and the UK realize gains of about €5 trillion (Figure 2). But relative to the size of its economy, the over €100 billion gain by Lithuania is a dramatic change.

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).

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	734
Belgium	888
Bulgaria	203
Cyprus	53
Czech Republic	585
Denmark	451
Estonia	56
Finland	418
France	4959
Germany	6610
Greece	761
Hungary	423
Ireland	414
Italy	4126
Latvia	71
Lithuania	117
Luxembourg	92
Malta	23
The Netherlands	1507
Poland	1592
Portugal	564
Romania	645
Slovakia	265
Slovenia	126
Spain	3278
Sweden	775
UK	5020
EU-15	30 598
EU-27	34 758

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). In this scenario, for each country the value of the reform equals 288% of its current GDP and 6.2% of the discounted value of projected GDPs in 2011–2090 without a reform. For each country, the increase in the long-run growth rate equals 0.47 percentage points. For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2011b).

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

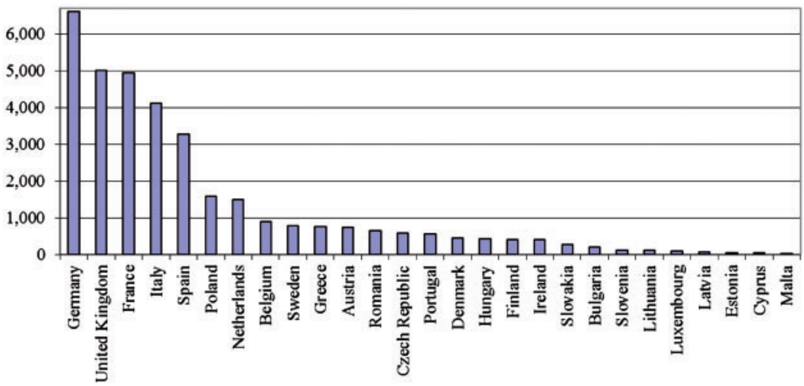

Figure 2 Present value of Scenario I (improve student performance in each country by 25 PISA points) in billion Euro (PPP). *Notes*: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP). See Table 1.

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 skill level. On average, annual EU growth rates 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 €95 trillion, or more than 7 times the current GDP of the EU and about 17 percent of the discounted future GDPs over the same time span.

Figure 3A and B 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, 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 over 20 times its current GDP.

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 EU 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 EU should be <15%’ (See Commission of the

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

	Value of reform (billion €)	Relative to current GDP (%)	Relative to discounted future GDPs (%)	Long-run growth increase (p.p.)	Increase in PISA score
Austria	1493	587	12.6	0.89	47.7
Belgium	1503	488	10.4	0.75	40.5
Bulgaria	1487	2109	45.1	2.46	132.1
Cyprus	357	1953	41.8	2.33	125.1
Czech Republic	1101	542	11.6	0.83	44.5
Denmark	999	639	13.7	0.96	51.4
Estonia	75	388	8.3	0.61	32.9
Finland	0	0	0.0	0.00	0.0
France	13 277	772	16.5	1.13	60.5
Germany	12 947	565	12.1	0.86	46.1
Greece	3292	1249	26.7	1.67	89.6
Hungary	1088	742	15.9	1.09	58.4
Ireland	908	633	13.5	0.95	50.9
Italy	17 291	1209	25.9	1.63	87.3
Latvia	219	888	19.0	1.27	68.0
Lithuania	365	898	19.2	1.28	68.7
Luxembourg	283	883	18.9	1.26	67.7
Malta	128	1612	34.5	2.03	108.8
The Netherlands	1707	327	7.0	0.52	28.1
Poland	4159	754	16.1	1.10	59.2
Portugal	2307	1179	25.2	1.60	85.6
Romania	5091	2277	48.7	2.59	139.2
Slovakia	781	850	18.2	1.22	65.6
Slovenia	235	539	11.5	0.82	44.2
Spain	10 750	946	20.2	1.34	71.6
Sweden	1780	662	14.2	0.99	53.0
UK	10 961	630	13.5	0.95	50.7
EU-15	79 498	750	16.0	1.08	55.4
EU-27	94 583	785	16.8	1.12	65.8

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP), as percentage of current GDP, and as percentage of the discounted value of projected GDPs in 2011–2090 without a reform. 'Long-run growth increase' refers to increase in annual growth rate (in percentage points) once the whole labor 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 Finnish average level of 556 PISA points). For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2011b).

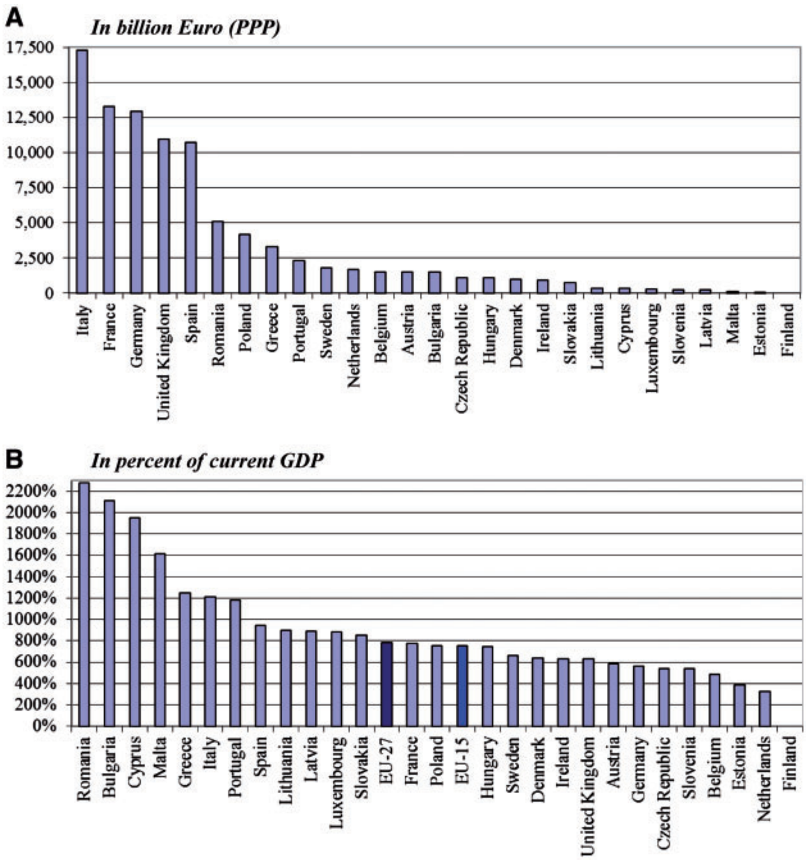

Figure 3 Present value of Scenario II (improve student performance in each country to reach Finnish PISA level). (A) In billion Euro (PPP). (B) In percent of current GDP. *Notes*: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of current GDP. See Table 2.

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.[19] While the previous simulations could be thought of as displaying the results of shifting the entire achievement distribution, this scenario

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

considers the implications of a 'compensatory' improvement that brings up the bottom of the distribution.[20]

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 EU 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 fulfillment.[21]

The changes under this reform policy are more modest than those under the full compensatory scheme reported in Appendix C. Specifically, the 15% 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 0.27% and an aggregate gain in present value terms of €25 trillion (Table 3). While smaller in total impact than the previous reform programs, the average gain compared to GDP would be more than twice the 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 scheme.

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 get gains in present value terms that exceed their current GDP.

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[20] 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.

[21] 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.

Table 3 Effect on GDP of Scenario III: meet EU Benchmark of <15% below PISA Level 1 by 2020

	Value of reform (billion €)	Relative to current GDP (%)	Relative to discounted future GDPs (%)	Long-run growth increase (p.p.)	Decrease in share of students below Level 1 (p.p.)
Austria	255	100	2.1	0.14	3.2
Belgium	212	69	1.5	0.10	2.2
Bulgaria	923	1309	28.0	1.46	33.0
Cyprus	182	997	21.3	1.17	26.5
Czech Republic	150	74	1.6	0.10	2.3
Denmark	84	54	1.1	0.08	1.7
Estonia	0	0	0.0	0.00	0.0
Finland	0	0	0.0	0.00	0.0
France	3751	218	4.7	0.30	6.7
Germany	1896	83	1.8	0.12	2.6
Greece	1185	449	9.6	0.58	13.2
Hungary	144	98	2.1	0.14	3.1
Ireland	43	30	0.6	0.04	1.0
Italy	6886	481	10.3	0.62	14.0
Latvia	32	130	2.8	0.18	4.1
Lithuania	88	216	4.6	0.29	6.6
Luxembourg	78	243	5.2	0.33	7.4
Malta	59	739	15.8	0.91	20.5
The Netherlands	0	0	0.0	0.00	0.0
Poland	598	108	2.3	0.15	3.4
Portugal	836	427	9.1	0.56	12.6
Romania	3139	1404	30.0	1.54	34.8
Slovakia	164	178	3.8	0.25	5.5
Slovenia	18	42	0.9	0.06	1.3
Spain	2654	234	5.0	0.32	7.2
Sweden	198	74	1.6	0.10	2.3
UK	1788	103	2.2	0.14	3.2
EU-15	19 866	187	4.0	0.25	5.2
EU-27	25 363	211	4.5	0.27	8.1

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP), as percentage of current GDP, and as percentage of the discounted value of projected GDPs in 2011–2090 without a reform. 'Long-run growth increase' refers to increase in annual growth rate (in percentage points) once the whole labor 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 (2011b).

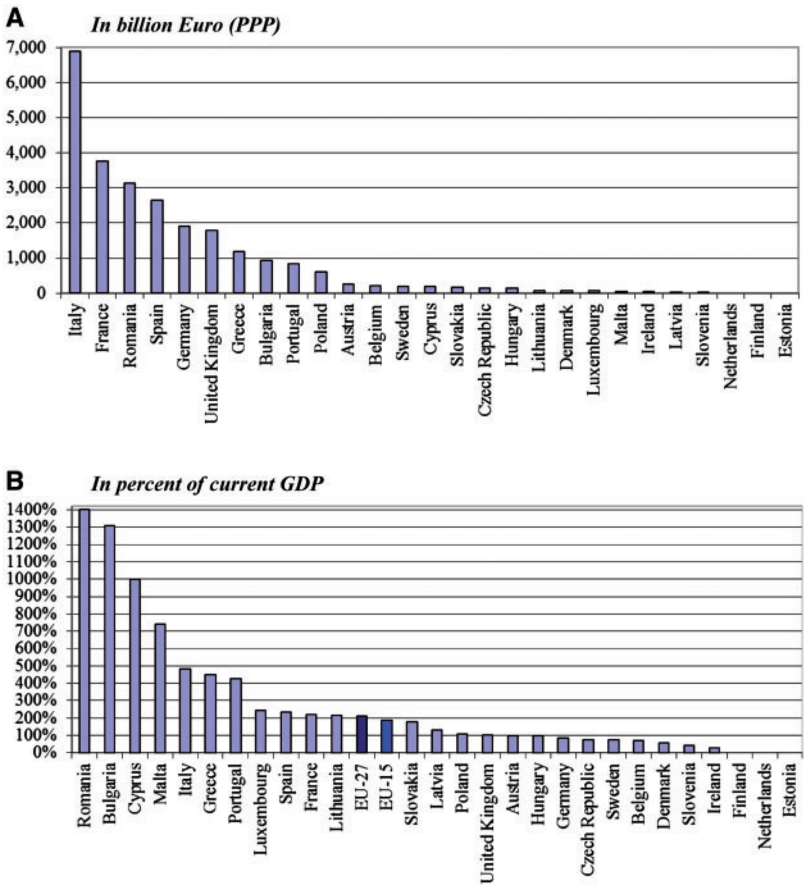

Figure 4 Present value of Scenario III (meet EU Benchmark of <15% below PISA Level 1 by 2020). (A) In billion Euro (PPP). (B) In percent of current GDP. *Notes*: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of current GDP. See Table 3.

3.4 Alternative projections with the neoclassical growth model

The previous projections employed a specification that captures the basic ideas of endogenous growth theory, where a better-educated workforce leads to a larger stream of new ideas that produces technological progress at a higher rate. In contrast, in the neoclassical growth model, changes in test scores lead to higher steady-state levels of income but do not affect the long-run growth path. In such models, countries that improve their cognitive skills would enjoy higher growth initially as they converge to a new, higher level of income but then would see growth fall over time to their previous long-run growth rate.

We can easily simulate such models by using a slightly different empirical specification. We re-estimate our growth model with the logarithmic (rather than linear) initial value of per-capita GDP as control. The test-score coefficient hardly changes in this specification (1.72 rather than 1.86), and the coefficient on log initial income is −1.84. This estimated convergence rate of 1.8% is very close to the one expected under standard parameter assumptions in the augmented neoclassical growth model (Mankiw et al. 1992), implying that an economy moves halfway to its steady state in about 38 years. We assume that in the aggregate, the three countries with the largest shares of patents in the world—the USA, Japan, and Germany—grow at the long-run growth rate of 1.5% without reform.[22]

Table 4 shows the results of the projections based on the neoclassical model specification for each of the EU countries. In reform Scenario I, where each country increases by 25 PISA points, the value of the reform amounts to €28 trillion in present value terms. The noteworthy fact is that over the time horizon of our projections until 2090, the difference between the neoclassical and the endogenous growth model has relatively minor political meaning. This lower bound estimate places the aggregate addition to GDP at 234% of current EU GDP. This amounts to 4.4% of the present value of GDP over the 80-year period, as opposed to 6.2% under the endogenous growth simulations.

In reform Scenario II, where each country improves to the test-score level of Finland, the present value of the reform amounts to €72 trillion in the neoclassical model, compared to the previous €95 trillion in the endogenous growth model—or almost exactly six times current GDP. The present value of reform Scenario III, which cuts the percentage of low-achieving students to < 15 percent, is €22 trillion in the neoclassical projections, rather than €25 trillion in the endogenous-growth type projections. Again, the difference over our time horizon of projections is limited.

Several factors contribute to the closeness of the estimates over our time period for the impact of improvements in cognitive skills based on the two different growth models. First, our reform scenarios gradually introduce changes, due to the lags for the policy to become fully effective and for the

[22] For more details of these simulations and their interpretations, see Hanushek and Woessmann (2011b).

Table 4 Lower bound projection results with alternative 'neoclassical' model specification

	Scenario I		Scenario II		Scenario III	
	Value of reform (billion €)	Relative to discounted future GDPs (%)	Value of reform (billion €)	Relative to discounted future GDPs (%)	Value of reform (billion €)	Relative to discounted future GDPs (%)
Austria	560	4.3	1112	8.6	328	2.5
Belgium	738	4.5	1229	7.4	330	2.0
Bulgaria	198	4.7	1277	30.2	461	10.9
Cyprus	31	3.9	184	23.6	60	7.7
Czech Republic	604	4.8	1114	8.8	277	2.2
Denmark	353	4.4	760	9.4	105	1.3
Estonia	74	5.1	99	6.8	0	0.0
Finland	454	4.8	0	0.0	0	0.0
France	3820	4.3	9846	11.2	4064	4.6
Germany	5348	4.4	10 246	8.5	2649	2.2
Greece	536	4.2	2156	17.0	778	6.1
Hungary	478	4.9	1188	12.2	240	2.5
Ireland	299	4.3	639	9.1	50	0.7
Italy	2918	4.2	11 402	16.5	4680	6.8
Latvia	91	5.1	268	15.0	53	3.0
Lithuania	139	5.0	413	14.8	133	4.8
Luxembourg	40	3.5	116	10.2	42	3.7
Malta	16	4.2	83	21.4	30	7.7
The Netherlands	1261	4.5	1424	5.0	0	0.0
Poland	1807	4.9	4558	12.4	991	2.7
Portugal	472	4.5	1804	17.1	692	6.5
Romania	561	4.5	3874	31.2	1266	10.2
Slovakia	262	4.7	741	13.3	215	3.9
Slovenia	122	4.7	224	8.6	32	1.2
Spain	2474	4.3	7713	13.4	2409	4.2
Sweden	594	4.3	1324	9.7	238	1.7
UK	3950	4.4	8393	9.3	2273	2.5
EU-15	23 817	4.4	58 164	10.6	18 638	3.4
EU-27	28 201	4.4	72 187	11.3	22 394	3.5

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of the discounted value of projected GDPs in 2011–2090 without a reform. For reform parameters and additional details of the projection model, see text and Hanushek and Woessmann (2011b).

new, better-educated workers to change the average skills of the labor force. Our projections from the time after policies are fully felt involve just 20 years, a time too short to have huge differences in the implications of the alternative models. Second, the biggest impacts of the differences across the alternative models occur in the distant future, and thus the impact is lessened by discounting to obtain present values and by disregarding any returns that might accrue after 2090. Third, even ignoring discounting, the estimated convergence parameters of the neoclassical growth model imply very long periods before any country returns to its balanced growth path following a perturbation because of policy.

3.5 Implications for the Member States in Eastern Europe

It is particularly interesting to look at the projection results for 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). Due to 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 these countries 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 Priorities and policies of the EU

The new Europe 2020 strategy of the EU quite appropriately emphasizes the role of education in promoting the growth and development of member countries. As our analysis indicates, the central feature of long-term economic progress is the human capital of a country. But, our analysis also points to the central position of developing high-level basic skills. Simply attending school is not enough if the students are not learning at a high level.

The EU has policy advice and goals for education and training across the entire lifecycle of individuals—beginning with preschool opportunities and going through adult ages with lifelong learning. Again, it is appropriate to consider what might be done at all ages, but that of course does not imply that setting priorities in policies should be ignored. Specifically, as we discussed above, the evidence points strongly to an emphasis on the development of strong basic skills, which in turn points to the key role of primary and secondary education.

In its 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 significantly misaligned with the evidence. 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 EU <15%, is the basis for our Scenario III projections. Our results show that, as opposed the headline targets, 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.

The emphasis on quality that underlies our measures of cognitive skills does introduce a more difficult set of policy issues for EU countries. In many ways, goals framed in terms of school attainment and quantity of schooling are both easier to monitor and easier to attain. Leaving aside the monitoring issues, deciding on the policies that will lead to accomplishment of the qualitative goals presents significant problems.[23]

The issues are in fact highlighted by the EU long-term strategic goals in education and training of 'improving the quality and efficiency of education and training'.[24] The introduction of the importance of efficiency of spending on education—an obvious reality as most EU nations face significant fiscal pressures—indicates immediately that spending priorities across different parts of the lifecycle are necessary. On this, there is a substantial body of literature, as summarized by Cunha et al. (2006), that demonstrates the importance of early learning. In simplest terms, early learning is complementary to later learning, so that, say, what is learned in tertiary education depends on the quality of primary and secondary education. This complementarity also appears to explain why the amount of tertiary education is not related to economic growth across the OECD once the level of earlier learning is accounted for (Hanushek and Woessmann 2011b). Evaluations of investments in job training generally find low returns to such training, and, while not directly considering the complementarity with earlier learning, can be interpreted in a similar vein (Heckman LaLonde and Smith 1999).

This logic does not, of course, say that no spending should go toward tertiary education or lifelong learning. It just indicates that concentrating on basic skills should receive a priority in terms of overall allocation of resources and the efficiency of their use. One interpretation of the past evidence on the (lack of) success in later education is that it is simply very difficult and costly to make up for basic skills past the normal period of primary and secondary schooling.

One related area of policy, beginning with the Copenhagen Declaration of 2002 (Council of the European Union 2002) and continuing through the Bruges Communiqué (European Commission 2010), is a systematic emphasis on the development of vocational education and training across the EU. The motivation is clear, particularly in current times where nations are plagued with high unemployment: If workers have

23 On monitoring of the achievement goals, the PISA testing of the OECD provides reliable information every 3 years with the caveat that a few EU members have not participated in PISA. The EU has conducted annual reporting on progress (e.g. Commission of the European Communities 2011), but most significant education policies involve longer cycles, and the 3-year reporting of PISA results is not a huge problem.

24 See the 'Strategic Framework for Education and Training' at http://ec.europa.eu/education/lifelong-learning-policy/doc28_en.htm [accessed 14 November 2011].

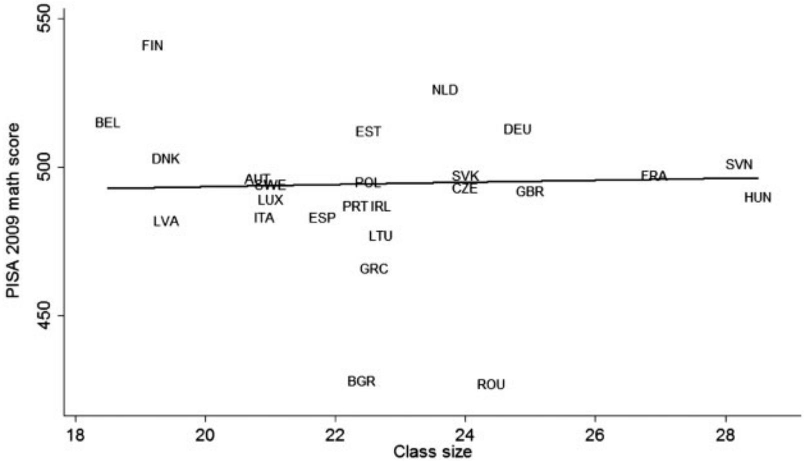

Figure 5 Class size and math achievement of EU countries in PISA 2009. *Notes*: Own depiction based on data from PISA 2009. Line reflects regression line of best fit (without three outliers).

more job-related skills, they will be better able to find employment. Two aspects of this policy thrust are related to our work here. First, the previous analysis suggests that any vocational training programs should not skimp on the development of basic skills. Second, if higher economic growth is achieved such as described above, there may be an adverse impact from having an expanded development of vocational education. Specifically, developing the firm-specific skills that makes workers more immediately attractive in the labor force may make them less adaptable when technology changes—as is generally the case with economic growth. Hanushek Woessmann and Zhang (2011) find that employment later in the lifecycle falls for vocationally trained workers—particularly in the countries with the greatest use of firm training programs.[25] Both concerns suggest caution in the expansion of vocational education and training.

When we return to policies relevant for basic skills, we nonetheless face the same efficiency issues. There is ample evidence that resources alone bear little relationship to student outcomes.[26] For a graphic illustration of

25 On the production side of the same issue, Krueger and Kumar (2004) suggest that firms—facing high re-training costs for workers—might make choices of technologies that lower overall economic growth for countries.

26 For an international comparative context, see Hanushek and Woessmann (2011a). For the evidence in both developed and developing countries, see Hanushek (2003), Woessmann (2003), and Glewwe et al. (2011).

this, we need only to compare PISA performance with average class size across countries as in Figure 5. The fact that there is a perfectly flat line—indicating that the PISA score is unrelated to differences in class sizes within the relevant range—is consistent with a large body of existing research.

These findings lead to a simple conclusion that how money is spent is much more important than how much is spent. But there is considerable uncertainty about *any* policy that is uniformly successful. In looking across very different schooling systems, Mourshed et al. (2010) find considerable local variation in how schools get better, and these variations are related to how developed the country and its education system are.

Our previous investigation indicates that a key ingredient is the institutional structure that conditions the incentives that exist for local schools. For example, having a good examination and accountability system appears important, as does more parental choice of schools (Hanushek and Woessmann 2011b).

Yet, the analysis of institutions also shows that country-specific variations are important. For example, in advanced countries with well-developed economic and educational institutions, allowing more local autonomy in decision making generally leads to achievement gains (Hanushek et al. 2011). But at lower levels of economic development and educational performance—of the level of several EU countries—local decision-making authority appears to detract from achievement.

From evaluations of local programs in various countries, it becomes clear that few if any programs have uniformly strong impacts on achievement. In other words, local capacity and local context seem to affect how well any particular program works. If this characterizes the policy situation more generally, the answer appears to lie in developing a 'system of continuous improvement'. Instead of looking for universal programs, decision makers—at the country level or at the local authority level—would always introduce new programs in ways that permitted evaluation of their effectiveness. Those programs that raised achievement would be retained, while those that did not would be modified or dropped. In that way, schools would move toward higher achievement through the development of local programs that were successful.

5 Conclusions

This article quantifies the long-term economic benefits that the EU 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

Table 5 Summary of projection results

	Scenario I	Scenario II	Scenario III
'Endogenous-growth' specification			
Value of reform (billion €)	34 758	94 583	25 363
Relative to discounted future GDPs (%)	6.2	16.8	4.5
'Neoclassical' specification			
Value of reform (billion €)	28 201	72 187	22 394
Relative to discounted future GDPs (%)	4.4	11.3	3.5

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP) and as percentage of the discounted value of projected GDPs in 2011–2090 without a reform. For reform parameters and additional details of the projection models, see text and Hanushek and Woessmann (2011b).

the long-run economic growth of nations. We project the growth potential that the EU could unlock by successful educational reform.

Three aspects of this analysis stand out. First, the gains from improving cognitive skills are, by past history, enormous. As summarized in Table 5, the present value of improved economic performance from feasible programs is much larger than the size of EU nations' annual GDPs. In particular, the aggregate gains in our preferred endogenous growth formulation for the EU range from €35 trillion (288% of current GDP) for an average increase of ¼ standard deviations in student achievement (25 PISA points), to €95 trillion (785% of current GDP) for bringing each nation's educational achievement up to top-performing Finland, and to €25 trillion (211% of current GDP) for reaching the official EU benchmark of < 15% low-achievers in basic skills by 2020. The second row of the table shows these gains relative to future GDP (without reform). The modest increase of 25 PISA points yields an increase of 6.2% over the no-reform GDP. Moreover, as the bottom half of Table 5 shows, the magnitude of these gains is not an artifact of the way the growth models are formulated. In the lower bound estimates from the neoclassical model, the aggregate gains across the scenarios are still estimated to be at least €22 trillion (3.5% of accumulated future GDP) and an enormous €72 trillion (11.3% of accumulated future GDP) from all countries coming up to Finland in cognitive skills.

Second, disparities in incomes across the EU are significantly related to the human capital and cognitive skills of the different countries. An implication of this is that policies to improve the achievement of students in lower performing countries could work to reduce existing income differentials. But, the opposite is also true. Without reducing the differences in achievement, there is little hope of bringing about more equality in the economic well-being of EU countries and citizens.

Third, it is hard to get these gains. The kinds of policies that have been pursued in the past have not been generally effective. As noted in Commission of the European Communities (2011), from 2000 to 2009 the proportion of low performers in reading literacy aged 15 years only decreased from 21.3% to 20.0% (after having increased to 24.1% in 2006). Thus, getting everybody $<15\%$ by 2020 would require noticeably more rapid improvement than recently observed. 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. 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. (See Hanushek and Woessmann 2011b for an extensive discussion of available evidence on different policy options to improve educational achievement.) 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 show to be linked to immense long-term economic benefits. Within these broad areas, however, any specific institutions and policies within them must be developed over time to take advantage of the strengths of local schools.

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.

Significantly improving the schooling system often faces serious political obstacles. The gains come only in the future—after students have left school and become a significant proportion of the workforce—and outside of the electoral cycle for most politicians. As a result, it is often easier to focus on the short run, leaving the larger policy decisions that affect the long run until some later day. The present analysis shows vividly that such myopia is very, very costly.

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References

Barro, R. J. (1991), "Economic Growth in a Cross Section of Countries", *Quarterly Journal of Economics* **106**, 407–443.

Barro, R. J. and J.-W. Lee (1993), "International Comparisons of Educational Attainment", *Journal of Monetary Economics* **32**, 363–394.

Barro, J. Robert and J.-W. Lee (2010), "A New Data Set of Educational Attainment in the World, 1950–2010", NBER Working Paper 15902, National Bureau of Economic Research (April), Cambridge, MA.

Börsch-Supan, A. (2000), "A Model Under Siege: A Case Study of the German", *Economic Journal* **110**, F24–F45.

Cohen, D. and M. Soto (2007), "Growth and Human Capital: Good Data, Good Results", *Journal of Economic Growth* **12**, 51–76.

Commission of the European Communities (2009), *Progress Towards the Lisbon Objectives in Education and Training: Indicators and Benchmarks 2009*, Commission Staff Working Document. Commission of the European Communities, Brussels.

Commission of the European Communities (2011), *Progress Toward the Common European Objectives in Education and Training: Indicators and Benchmarks 2010/2011*, Commission of the European Communities, Brussels.

Council of the European Union (2002), "Council Resolution of 19 December 2002 on the Promotion of Enhanced European Cooperation in Vocational Education and Training", *Official Journal of the European Communities*, 2003/C 13/02.

Cunha, F., J. J. Heckman, L. Lochner and D. V. Masterov (2006), "Interpreting the Evidence on Life Cycle Skill Formation", in E. A. Hanushek and F. Welch, eds., *Handbook of the Economics of Education, Vol. 1*, Elsevier, Amsterdam, pp. 697–812.

de la Fuente, A. and R. Doménech (2006), ‘‘Human Capital in Growth Regressions: How Much Different does Data Quality Make?’’, *Journal of the European Economic Association* **4**, 1–36.

European Commission (2010), ‘‘The Bruges Communiqué on Enhanced European Cooperation in Vocational Education and Training for the Period 2011–2020’’, 7 December, Bruges.

European Council (2010), ‘‘Conclusions of the European Council, 17 June 2010’’, Document EUCO 13/10. European Council, Brussels.

Glewwe, P., E. A. Hanushek, S. D. Humpage and R. Ravina (2011), ‘‘School Resources and Educational Outcomes in Developing Countries: A Review of the Literature from 1990 to 2010’’, NBER Working Paper 17554, National Bureau of Economic Research (October), Cambridge, MA.

Goldin, C. and L. F. Katz (2008), *The Race Between Education and Technology*, Harvard University Press, Cambridge, MA.

Hagist, C., N. Klusen, A. Plate and B. Raffelhüschen (2005), ‘‘Social Health Insurance: The Major Driver of Unsustainable Fiscal Policy?’’, CESifo Working Paper 1574, CESifo, Munich.

Hanushek, E. A. (2003), ‘‘The Failure of Input-Based Schooling Policies’’, *Economic Journal* **113**, F64–F98.

Hanushek, E. A. and D. D. Kimko (2000), ‘‘Schooling, Labor Force Quality, and the Growth of Nations’’, *American Economic Review* **90**, 1184–1208.

Hanushek, E. A., S. Link and L. Woessmann (2011), ‘‘Does School Autonomy make Sense Everywhere? Panel Estimates from PISA’’, NBER Working Paper 17591, National Bureau of Eocnomic Research (November), Cambridge, MA.

Hanushek, E. A. and L. Woessmann (2008), ‘‘The Role of Cognitive Skills in Economic Development’’, *Journal of Economic Literature* **46**, 607–668.

Hanushek, E. A. and L. Woessmann (2009), ‘‘Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation’’, NBER Working Paper 14633, National Bureau of Economic Research (January), Cambridge, MA.

Hanushek, E. A. and L. Woessmann (2010), *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*, Organisation for Economic Cooperation and Development, Paris.

Hanushek, E. A. and L. Woessmann (2011a), "The Economics of International Differences in Educational Achievement", in E. A. Hanushek, S. Machin and L. Woessmann, eds., *Handbook of the Economics of Education, Vol. 3*, North Holland, Amsterdam, pp. 89–200.

Hanushek, E. A. and L. Woessmann (2011b), "How Much do Educational Outcomes Matter in OECD Countries?", *Economic Policy* **26**, 427–491.

Hanushek, E. A., L. Woessmann and L. Zhang (2011), "General Education, Vocational Education, and Labor-Market Outcomes over the Life-Cycle", NBER Working Paper 17504, National Bureau of Economic Research (October), Cambridge, MA.

Hanushek, E. A. and L. Zhang (2009), "Quality-Consistent Estimates of International Schooling and Skill Gradients", *Journal of Human Capital* **3**, 107–143.

Heckman, J. J., R. LaLonde and J. Smith (1999), "The Economics and Econometrics of Active Labor Market Programs", in O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics, Vol. 3*, North Holland, Amsterdam, pp. 1865–2097.

Heston, A., R. Summers and B. Aten (2002), *Penn World Table Version 6.1*, Center for International Comparisons at the University of Pennsylvania (CICUP), University of Pennsylvania, Philadelphia.

Keller, K. R. I. and P. Poutvaara (2005), "Growth in OECD Countries and Elsewhere: How much do Education and R&D Explain?", *Economics Bulletin* **15**, 1–11.

Krueger, A. B. and M. Lindahl (2001), "Education for Growth: Why and for Whom?", *Journal of Economic Literature* **39**, 1101–1136.

Krueger, D. and K. B. Kumar (2004), "US-Europe Differences in Technology-Driven Growth: Quantifying the Role of Education", *Journal of Monetary Economics* **51**, 161–190.

Levine, R. and D. Renelt (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions", *American Economic Review* **82**, 942–963.

Mankiw, N. G., D. Romer and D. Weil (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics* **107**, 407–437.

Moore, M. A., A. E. Boardman, A. R. Vining, D. L. Weimer and D. Greenberg (2004), "'Just give me a Number!' Practical Values for the Social Discount Rate", *Journal of Policy Analysis and Management* **23**, 689–812.

Mourshed, M., C. Chijioke and M. Barber (2010), *How the World's Most Improved School Systems Keep Getting Better*, McKinsey and Company.

Mullis, I. V. S., M. O. Martin and P. Foy (2008), *TIMSS 2007 International Mathematics Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*, TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College, Chestnut Hill, MA.

Nonneman, W. and P. Vanhoudt (1996), "A Further Augmentation of the Solow Model and the Empirics of Economic Growth for OECD Countries", *Quarterly Journal of Economics* **111**, 943–953.

Organisation for Economic Co-operation and Development (2007), *PISA 2006: Science Competencies for Tomorrow's World, Vol. 1*, Analysis, OECD, Paris.

Organisation for Economic Co-operation and Development (2009a), *OECD Economic Outlook, Volume 2009/1, No. 85*, OECD, Paris.

Organisation for Economic Co-operation and Development (2009b), *Society at a Glance 2009: OECD Social Indicators*, OECD, Paris.

Romer, P. (1990), "Endogenous Technological Change", *Journal of Political Economy* **99**, S71–S102.

Sala-i-Martin, X., G. Doppelhofer and R. I. Miller (2004), "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach", *American Economic Review* **94**, 813–835.

Sianesi, B. and J. van Reenen (2003), "The Returns to Education: Macroeconomics", *Journal of Economic Surveys* **17**, 157–200.

Stern, N. (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, UK, and New York.

Temple, J. (2001), "Growth Effects of Education and Social Capital in the OECD Countries", *OECD Economic Studies* **33**, 57–101.

Topel, R. (1999), "Labor Markets and Economic Growth", in O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics, Vol. 3*, North Holland, Amsterdam, pp. 2943–2984.

Woessmann, L. (2003), "Schooling Resources, Educational Institutions, and Student Performance: The International Evidence", *Oxford Bulletin of Economics and Statistics* **65**, 117–170.

Woessmann, L. and M. Piopiunik (2009), *Was unzureichende Bildung kostet: Eine Berechnung der Folgekosten durch entgangenes Wirtschaftswachstum*, Bertelsmann Stiftung, Gütersloh, Germany.

Appendix A

Differences to the projections in Hanushek and Woessmann (2011b)

The methodology of the projections reported in this study follows closely the projection model used for OECD countries in Hanushek and Woessmann (2011b). 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 US dollars. The European Commission provides comparable data on the purchasing power parity (PPP) for all EU-27 countries, including projections for 2010. The data were 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 B

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 et al. 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 UK—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 C

A scenario that brings everyone up to minimum skill levels

A third scenario simulated for the OECD in Hanushek and Woessmann (2011b), 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). This extension is actually a more stringent version of the EU benchmark on basic skills, although here we allow 20 years to accomplish this goal instead of the 10 years of the EU 2020 goals.

For these calculations, all EU countries including Finland have room for improvement. On average, 18% 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% of tested students are below 400 points (Appendix Table C1).

The overall change from bringing everybody up to the level of 400 would be an average annual growth rate that was 0.7% higher after the reform was accomplished and after the full labor force had received the improved education. The improvements for the EU countries from achieving universal minimum proficiency would have a present value that averaged over four times current GDP. This amounts to total gains of €58 trillion for the EU countries. Even Finland could by these calculations get a gain worth 93% of its current GDP through bringing its very modest proportion of low performers (3.5%) 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.

Table C1 Effect on GDP of bringing all to minimum of 400 points on PISA

	Value of reform (billion €)	Relative to current GDP (%)	Relative to discounted future GDPs (%)	Long-run growth increase (p.p.)	Share of students below minimum skills
Austria	1054	414	8.9	0.65	14.7
Belgium	1225	398	8.5	0.63	14.1
Bulgaria	1026	1456	31.1	1.88	42.4
Cyprus	217	1188	25.4	1.60	36.2
Czech Republic	791	390	8.3	0.62	13.9
Denmark	552	353	7.6	0.56	12.7
Estonia	36	189	4.0	0.31	7.0
Finland	135	93	2.0	0.16	3.5
France	8808	512	11.0	0.79	17.8
Germany	9099	397	8.5	0.63	14.1
Greece	1837	697	14.9	1.03	23.3
Hungary	577	394	8.4	0.62	14.0
Ireland	478	333	7.1	0.53	12.0
Italy	10 280	719	15.4	1.06	23.9
Latvia	103	417	8.9	0.66	14.8
Lithuania	200	492	10.5	0.76	17.1
Luxembourg	169	528	11.3	0.81	18.2
Malta	80	1005	21.5	1.40	31.6
The Netherlands	1343	257	5.5	0.42	9.4
Poland	2208	400	8.6	0.63	14.2
Portugal	1310	670	14.3	1.00	22.5
Romania	1884	842	18.0	1.21	27.3
Slovakia	436	475	10.2	0.74	16.6
Slovenia	145	332	7.1	0.53	12.0
Spain	5804	511	10.9	0.79	17.7
Sweden	1027	382	8.2	0.60	13.6
UK	7054	405	8.7	0.64	14.4
EU-15	50 175	473	10.1	0.73	15.5
EU-27	57 879	480	10.3	0.74	17.7

Notes: Discounted value of future increases in GDP until 2090, expressed in billion € (PPP), as percentage of current GDP, and as percentage of the discounted value of projected GDPs in 2011–2090 without a reform. 'Long-run growth increase' refers to increase in annual growth rate (in percentage points) once the whole labor 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 (2011b).