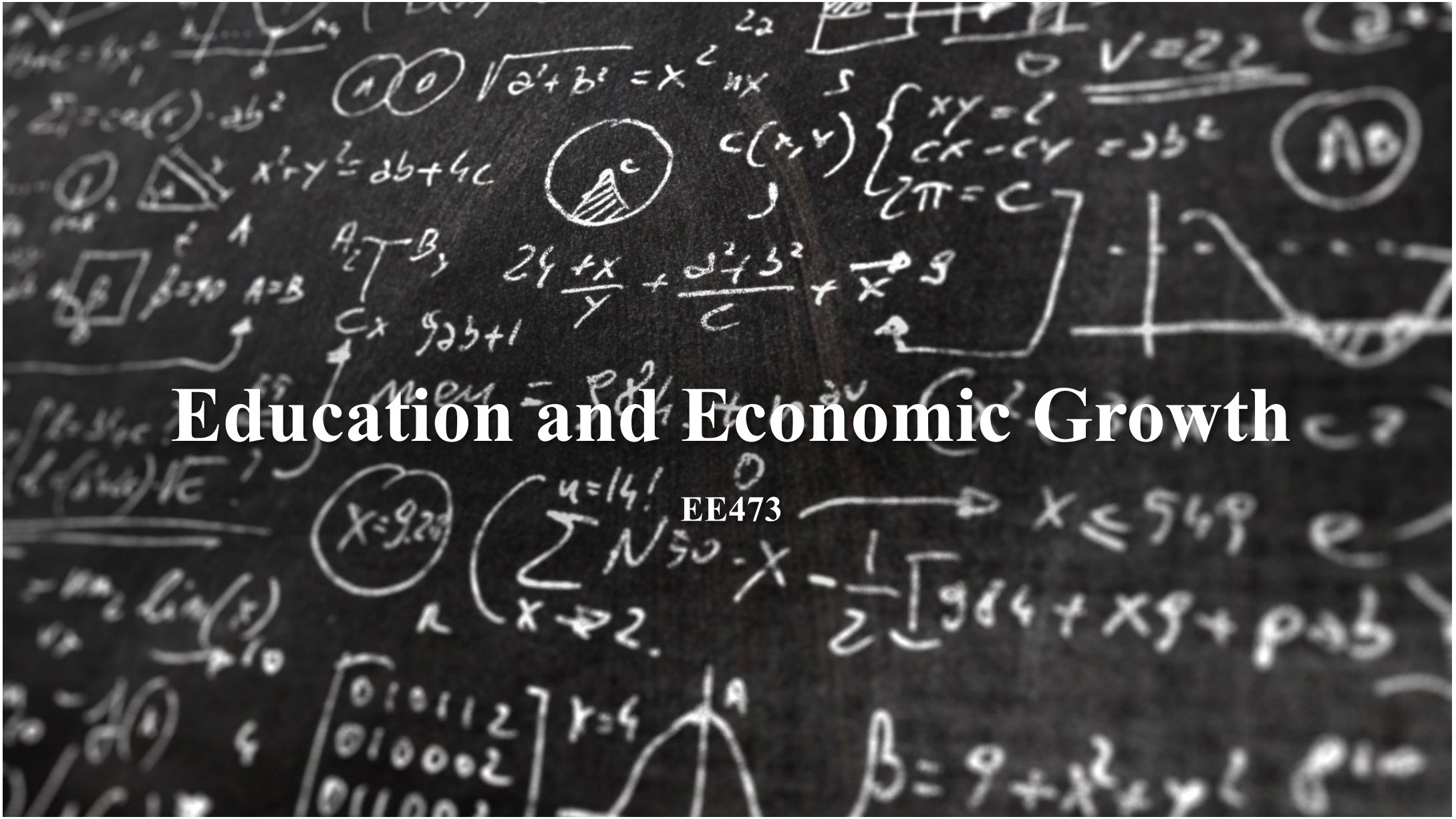

Education and Economic Growth

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The theoretical growth literature emphasizes at least three mechanisms through which education may affect economic growth :

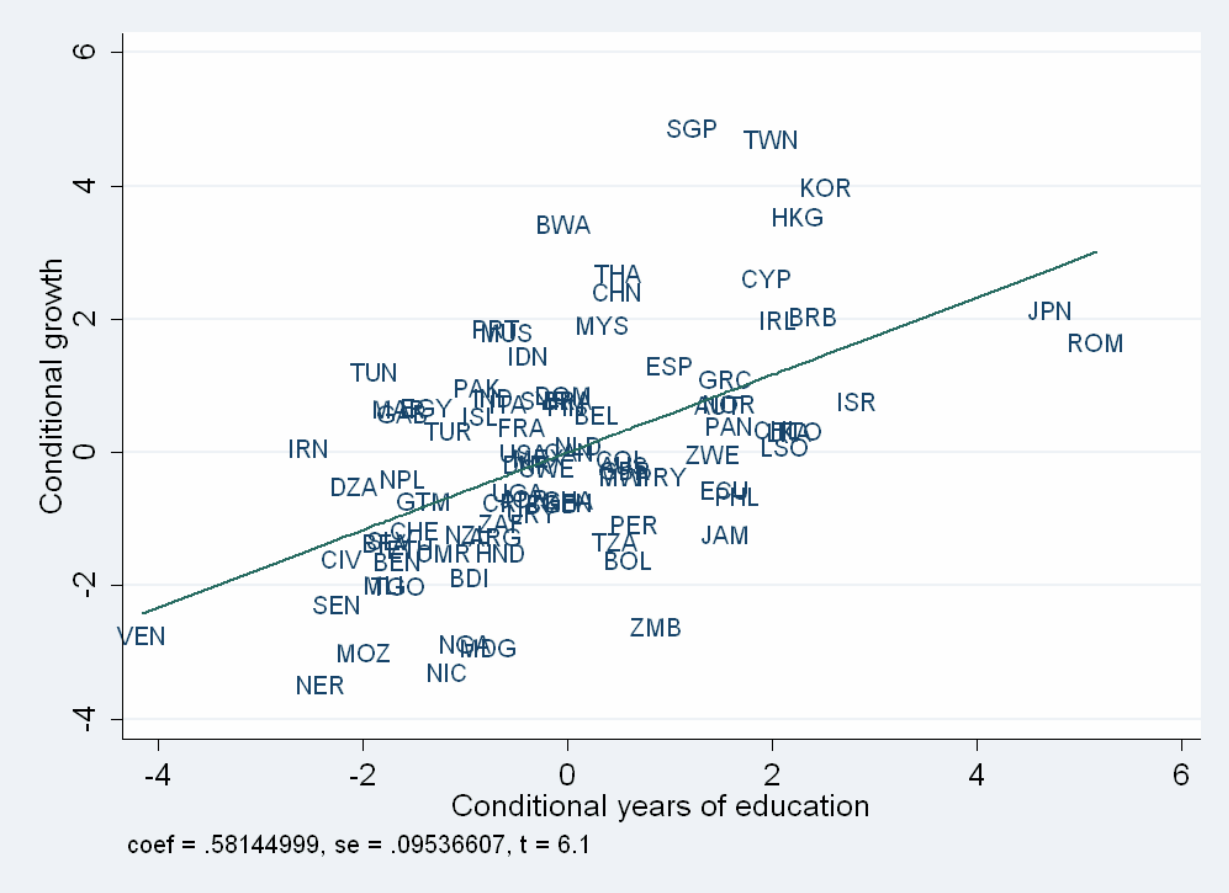
- Education can increase **the human capital inherent in the labor force**, which increases labor productivity and thus transitional growth toward a higher equilibrium level of output
- Education can increase **the innovative capacity of the economy**, and the new knowledge on new technologies, products, and processes promotes growth
- Education can **facilitate the diffusion and transmission of knowledge needed to understand and process new information and to successfully implement new technologies devised by others**, which again promotes economic growth

I. Early studies of schooling quality and economic growth
II. Initial evidence on the quality of education and economic growth
III. Recent evidence on the importance of cognitive skills for economic growth
IV. The interaction of educational quality with economic institutions
V. Stimulating the impact of educational reform on economic growth

I. Early studies of schooling quality and economic growth

- The majority of macroeconomic literature on economic returns to education employ measures of the quantity of schooling.
- The standard method of estimating the effect of education on economic growth is to estimate cross country growth regressions where average annual growth in GDP per capita over several decades is expressed as a function of measures of schooling and a set of other variables deemed important for economic growth.
- A vast early liteature of cross-country growth regressions tended to find a **significant positive association between quantitative measures of schooling and economic growth** [Barro (1991, 1997), Mankiw et al. (1992), Topel (1999), Temple (2001), (2003), Krueger and Lindahl (2001), and Sianesi and Van Reenen (2003)]

Figure 1 Association between years of schooling and long-run economic growth
Added-variable Plot of Growth and Years of Schooling without Test-score Controls



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 average years of schooling in 1960 and the initial level of real GDP per capita in 1960. Own calculations.

- The regression results depicted by Figure 1 imply that **each year of schooling is statistically significantly associated with a long-run growth rate that is 0.58 percentage points higher.**
- The positive association is substantially larger in the sample of non-OECD countries (at 0.56) than in the sample of OECD countries (at 0.26), which is in line with the pattern of larger returns to education in developing countries discussed above.
- However, after controlling for the influence of openness and the security of property rights, the association becomes substantially smaller and turns insignificant, and it is close to zero when the total fertility rate is controlled for.
- Thus, while there is a clear positive association between years of schooling and growth in the latest available data, it is also somewhat sensitive to model specifications.

II. Initial evidence on the quality of education and economic growth

- Since the mid 1960, international agencies, such as the International Association for the Evaluation of Educational Achievement (IEA) and the Organization for Economic Co-operation and Development (OECD), have conducted many international tests such as the Trends in International Mathematics and Science Study (TIMSS), the Programme for International Student Assessment (PISA), and their predecessors – of student performance in cognitive skills mathematics, involving science, and other subjects

A total of 36 international tests from 12 testing occasions comparable, Hanushek and Woessmann (2009) develop a common metric to adjust both the level of test performance and its variation through two data transformation

- First, each of the separate international tests is benchmarked to a comparable level by calibrating the US international performance over time to the external standard of the available US longitudinal test (the National Assessment of Educational Progress, NAEP)

- Second, the dispersion of the tests is standardized by holding the score variance constant within a group of 13 OECD countries with relatively stable secondary school attendance rates over time

Performance on international student achievement tests

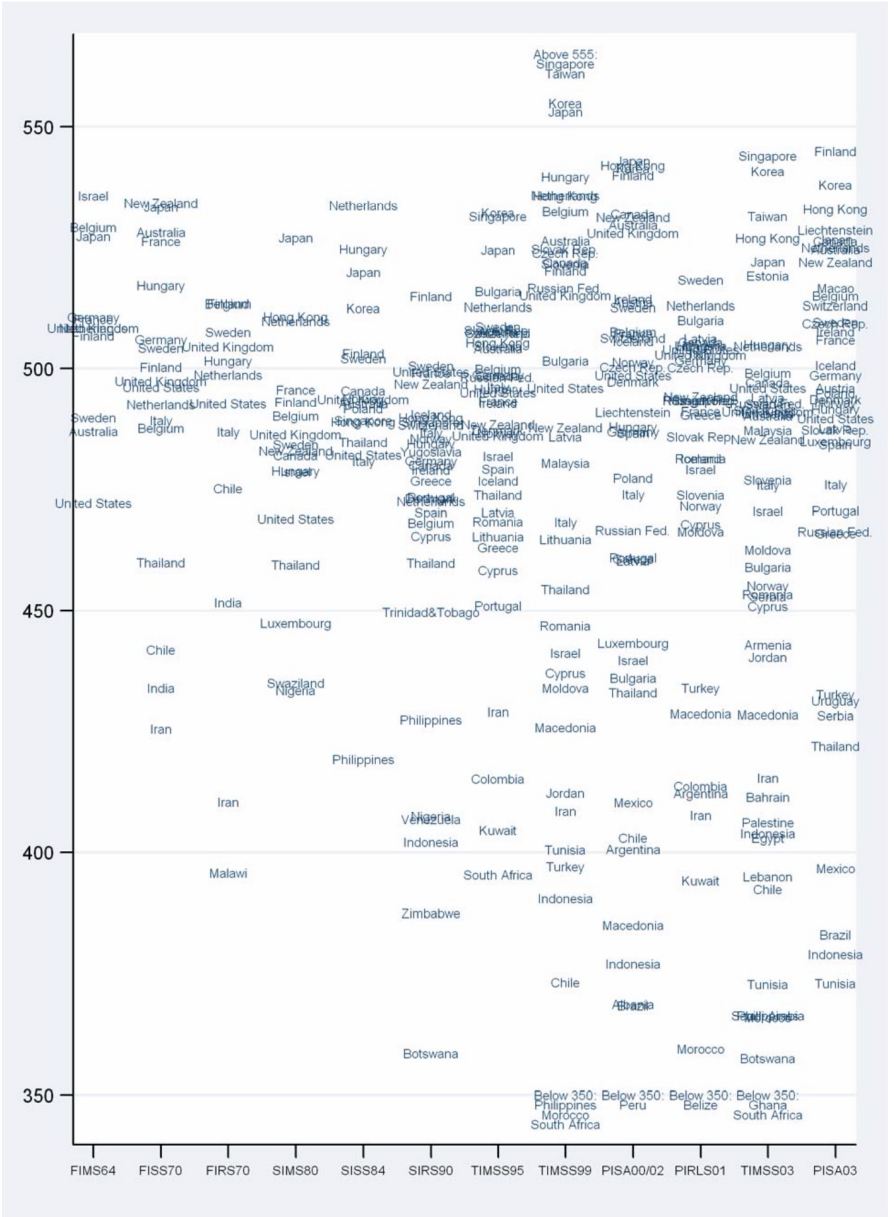
- Simple average of the mathematics and science scores over all available international tests, using the rescaled data by Hanushek and Woessmann (2009) that puts performance at different international tests on a common scale

- Average performance at the standardized tests, which serves as a proxy for the quality of education

Figure 2 Adjusted Performance on International Student Achievement Tests

- Figure 2 presents average student performance on twelve testing occasions on the transformed scale which maps performance on each test to the scale of the recent PISA international test. This scale has a mean of 500 and a standard deviation of 100 among the OECD countries in PISA.
- As is obvious from the figure, the developing countries that ever participated in one of the tests perform dramatically lower than any country in the group of OECD countries.
- The variation in the quality of education that exists among OECD countries is already substantial, but the magnitude of the difference to developing countries in the average amount of learning that has taken place after a given number of years of schooling dwarfs any within-OECD difference.

Source: Hanushek and Wößmann (in process), based on the different tests; see appendix to this section for details.

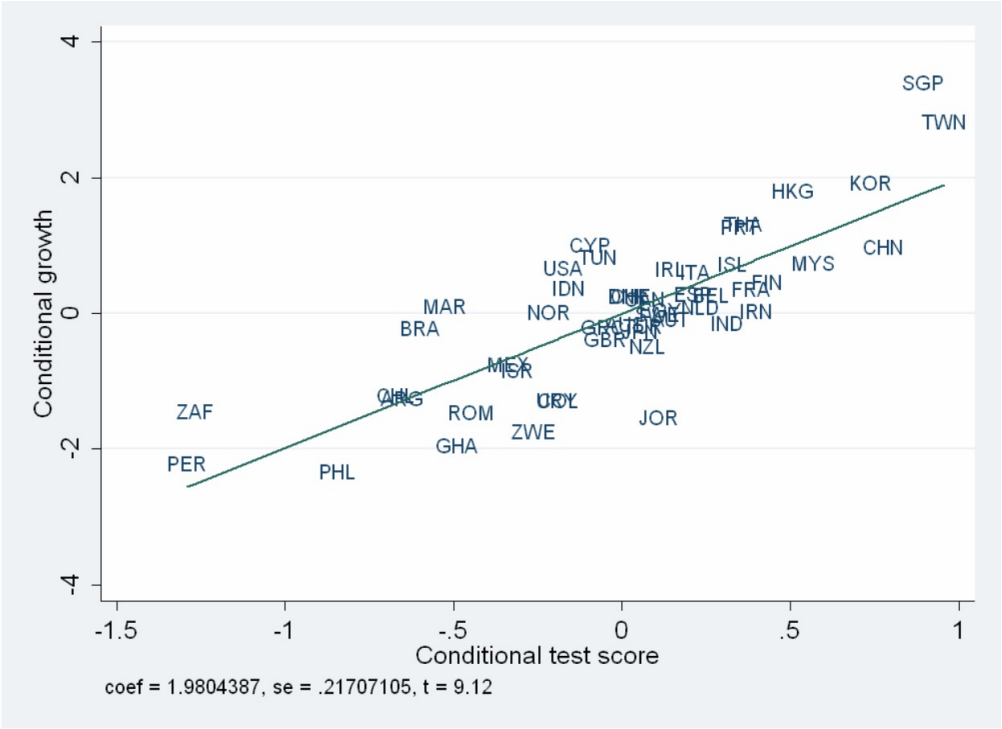


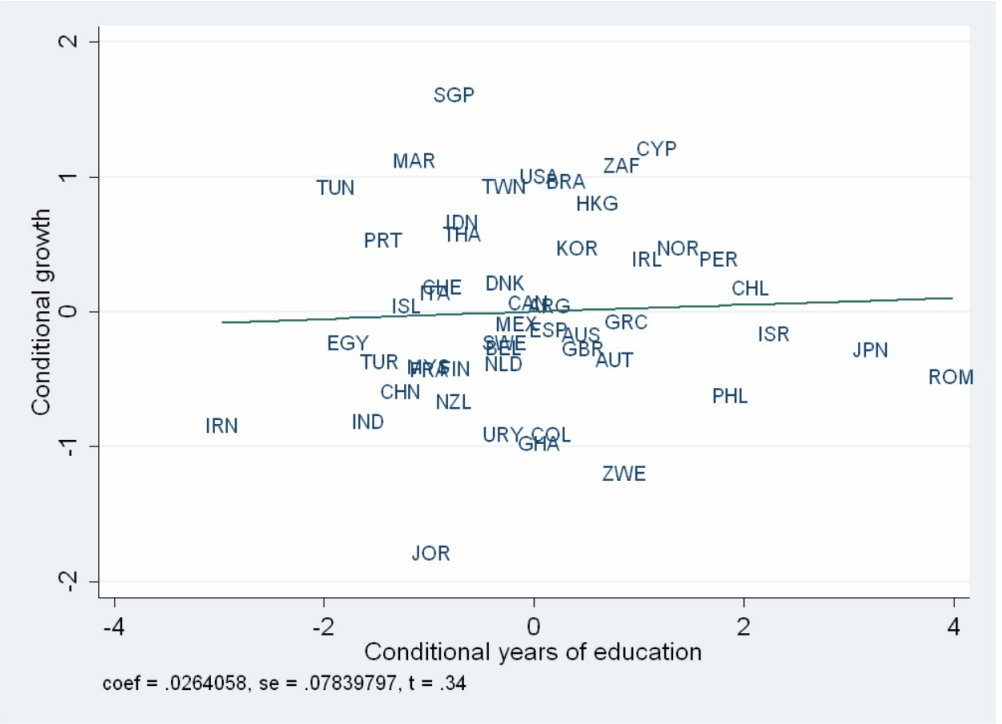
- Hanushek and Kimko (2000) find **a statistically an economically significant positive effect of the quality of education on economic growth in 1960-1990 that is far larger than the association between the quantity of schooling and growth**
- **Ignoring quality differences very significantly misses the true importance of education for economic growth**
- In sum, the evidence suggests that **the quality of education, measured by the knowledge that students gain as depicted in tests of cognitive skills, is substantially more important for economic growth than the mere quantity of schooling**

III. Recent evidence on the importance of cognitive skills for economic growth

- The measure of the quality of education is a simple average of the mathematics and science scores over international tests, interpreted as a proxy for the average education performance of the whole labor force.
- This measure encompasses overall cognitive skills, not just those developed in schools
- After controlling for the initial level of GDP per capita and for years of schooling, the test score measure features a statistically significant effect on the growth of real GDP per capita in 1960- 2000 (Figure 3a)
- According to this simple specification, test scores that are larger by 1 SD (measured at the student level across all OECD countries in PISA) are associated with an average annual growth rate in GDP per capita that is two percentage points higher over the whole 40 year period which is almost identical to the prior estimates in Hanushek and Kimko (2000)

Figure 3 Test-scores and Long-run economic growth Added-variable Plots of Growth and Education





Notes: Added-variable plots 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. Author calculations; see Table 4.1, column (2).

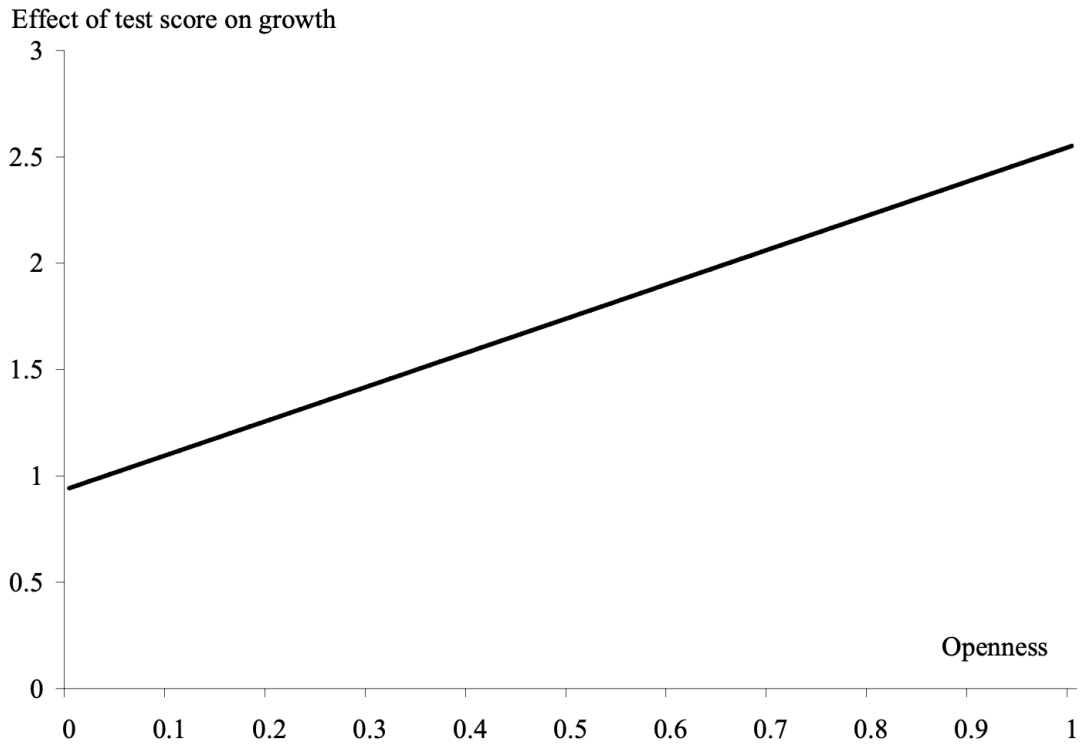
- Adding educational quality to a model that just includes initial income and years of schooling increases the share of variation in economic growth explained from 25% to 73%
- As reported above, the quantity of schooling is statistically significantly related to economic growth in a specification that neglects educational quality, but the association between years of schooling and growth turns insignificant and is reduced to close to zero once the quality of education is included in the model (Figure 3b)
- In addition, considering the variation just within each of five world regions, educational quality is significantly related to economic growth, indicating that it does not simple reflect economic differences across regions

IV. The interaction of educational quality with economic institutions

- Economic institutions appear to interact with the effect of educational quality on economic growth
- The institution framework of a country affects the relative profitability of piracy and productivity activity.
- The allocation of talent between rent-seeking and entrepreneurship matters for growth: countries with more engineering students grow faster and countries with more law students grow more slowly (Murphy et al., 1991)
- Education may not have much impact in less-developed countries that lack other facilitating factors such as functioning institutions for markets and legal systems (Easterly, 2001)

- Due to deficiencies in the institutional environment, cognitive skills might be applied to socially unproductive activities in many developing countries (Pritchett, 2001)
- **Adding the interaction of educational quality and one institutional measure – openness to international trade – to the growth specification indicates not only that both have significant individual effects on economic growth but also that there is a significant positive interaction**

Figure 4 The Effect of Educational Quality on Growth Depending on Openness



Notes: Estimated effect of average achievement test scores on the average annual rate of growth of real GDP per capita in 1960-2000, depending on the degree of openness to international trade of a country. Author calculations; see Table 4.3, column (10).

- The effect of educational quality on economic growth is indeed significantly higher in countries that have been fully open to international trade than in countries that have been fully closed.
- The effect of educational quality on economic growth is significantly positive, albeit relatively low at 0.9, in closed economies, and it increases to a size of 2.5 in open economies.
- The reported result is robust to including the measure of protection against expropriation.
- When using protection against expropriation rather than openness to trade as the measure of quality of institutions, there is similarly a positive interaction term with educational quality, although it lacks statistical significance.

- In sum, both the quality of the institutional environment and the quality of education seem important for economic development
- The effect of educational quality on growth seems significantly larger in countries with a productive institutional framework, so that good institutional quality and good educational quality can reinforce each other
- The macroeconomic effect of education depends on other complementary growth-enhancing policies and institutions
- However, cognitive skills have a significant positive growth effect even in countries with a poor institutional environment

V. Stimulating the impact of educational reform on economic growth

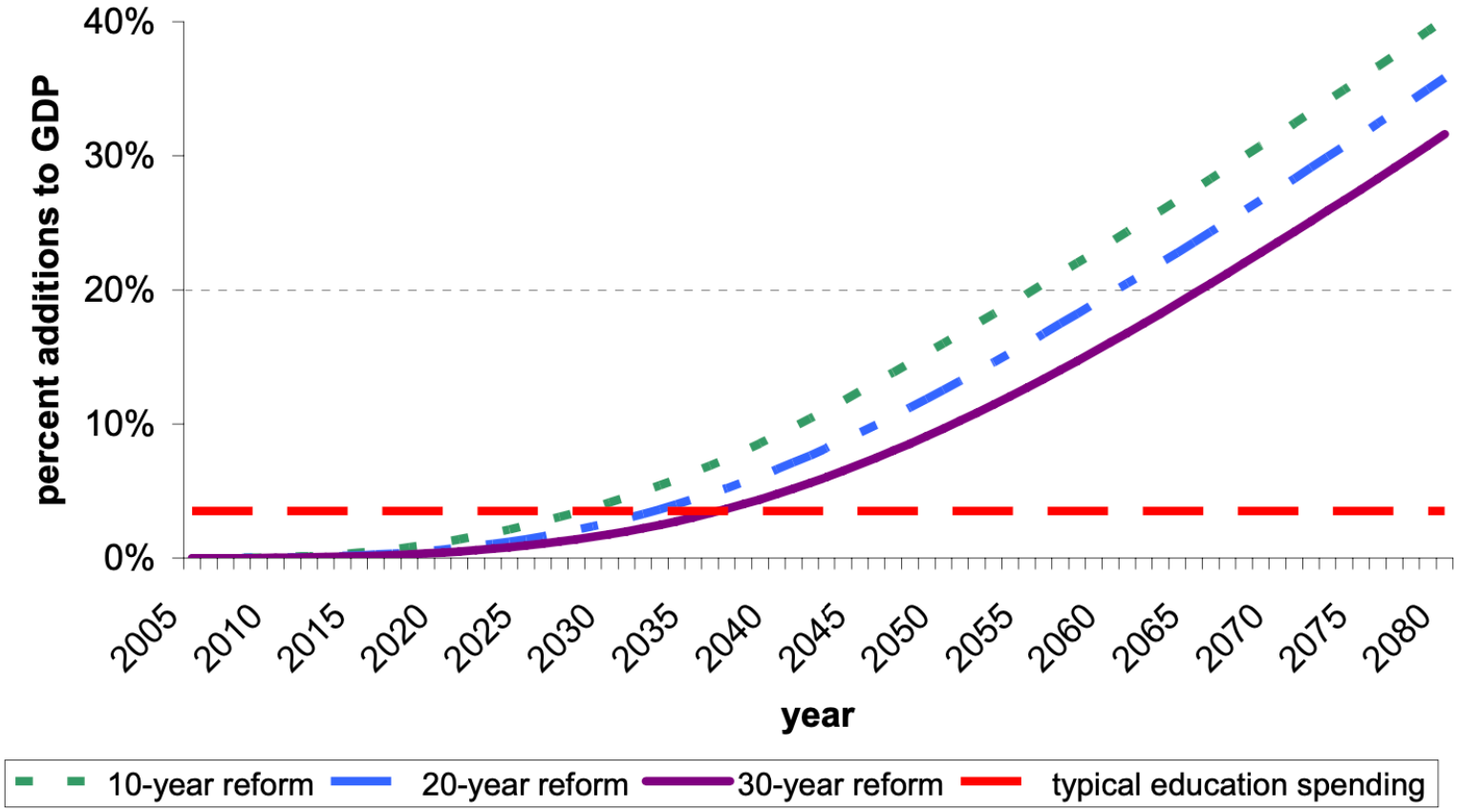
For a better understanding of the impact of improved achievement, it is useful to relate policy reforms directly to the pattern of economic outcomes consistent with feasible improvements

The timing of the reform is important in two ways:

- First, such **a movement of student performance cannot be achieved instantaneously but requires changes in schools that will be accomplished over time (say, through systematic replacement of teachers through retirement and subsequent hiring).** The time frame of any reform is difficult to specify, but achieving the change of 0.5 SD described above for an entire nation may take 20-30 years
- Second, if the reforms succeed, **their impact on the economy will not be immediate – initially the new graduates will be a small part of the labor force.** It will be some time after the reform of the schools before the impact on the economy is realized. In other words, the prior estimates are best thought of as the long-run, or equilibrium, outcomes of a labor force with a given educational quality

- Faster reforms will have larger impacts on the economy, simply because the better workers become a dominant part of the workforce sooner (Figure 5)
- Simulation of the impact on the economy of reform policies beginning in 2005 and taking 20 or 30 years for a 0.5 SD improvement in student outcomes at the end of upper secondary schooling
- The figure indicates how much larger the level of GDP is at any point after the reform policy is begun as compared to that with no reform; that is, the estimates suggest that increase in GDP expected over and above any growth from other factors
- The figure also plots 3.5% of GDP, an aggressive spending level for education in many countries of the world
- Even a 30-year reform program would yield a growth dividend covering the whole of this spending level by 2036 (See Hanushek and Woessmann (2008))

Figure 5 Improved GDP with Moderately Strong Knowledge Improvement (0.5 s.d.)



- To show the impact of these elements of reform, Figure 5 simulates the impact on the economy of reform policies taking 10, 20, or 30 years for a 0.5 standard deviation improvement in student outcomes at the end of upper secondary schooling – what we label as a "moderately strong knowledge improvement."
- For the calibration, policies are assumed to begin in 2005 – so that a 20-year reform would be complete in 2025.
- The actual reform policy is presumed to operate linearly such that, for example, a 20-year reform that ultimately yielded 1⁄2 standard deviation higher achievement would see the performance of graduates increasing by 0.025 standard deviations each year over the period.
- It is also necessary to characterize the impact on the economy, which we assume is proportional to the average achievement levels of prime age workers.
- Finally, for this exercise we project the growth impact according to the basic achievement model that also includes the independent impact of economic institutions

- This simulation shows that the previous estimates of the effects of education quality on growth have large impacts on national economies
- At the same time, while the rewards are large, they also imply that policies must be considered across long periods, requiring patience – patience that is not always clear in national policymaking
- These reforms must also be put in a broader perspective because other kinds of institutional changes and investments will also take time
- Changing basic economic institutions seldom happens overnights and the economy needs time to adjust

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