Chapter 3

Economic analysis of school quality

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Abstract

Most empirical analyses of human capital have concentrated solely on the quantity of schooling attained by individuals, ignoring quality differences. This focus contrasts sharply with policy considerations that almost exclusively consider school quality issues. This paper presents basic evidence about the very substantial impacts of school quality on individual earnings and on economic growth. It then discusses the policy issues facing nations.

1. Introduction

Economists have devoted considerable attention to understanding how human capital affects a variety of economic outcomes. The underlying notion is that individuals make investment decisions in themselves through schooling and other routes. The accumulated skills that are relevant for the labour market from these investments over time represent an important component of the human capital of an individual. The investments made to improve skills then return future economic benefits in much the same way that a firm's investment in a set of machines (physical capital) returns future production and income. In the case of public education, parents and public officials act as trustees for their children in setting many aspects of the investment paths. This paper demonstrates that investments in quality — of the type frequently measured with standardised examinations — have a very high payoff if quality improvements are actually achieved.

In looking at human capital and its implications for future outcomes, economists are frequently agnostic about where these skills come from or how they are produced. Although we return to that below, it is commonly presumed that formal schooling is one of several important contributors to the skills of an individual and to human capital. It is not the only factor. Parents, individual abilities, and friends undoubtedly contribute. Schools nonetheless have a special place because they are most directly affected by public policies. For this reason, we frequently emphasise the role of schools.

The human capital perspective immediately makes it evident that the real issues are ones of long-run outcomes. Future incomes of individuals are related to their past investments. It is not their income while in school or their income in their first job. Instead, it is their income over the course of their working life.

The distribution of income in the economy similarly involves both the mixture of people in the economy and the pattern of their incomes over their lifetime. Specifically, most measures of how income and well-being vary in the population do not take into account the fact that some of the low-income people have low incomes only because they are just beginning a career. Their lifetime income is likely to be much larger as they age, gain experience, and move up in their firms and career. What is important is that any noticeable effects of the current quality of schooling on the distribution of skills and income will only be realised years in the future, when those currently in school become a significant part of the labour force. In other words, most workers in the economy were educated years and even decades in the past — and they are the ones that have the most impact on current levels of productivity and growth, if for no reason other than that they represent the larger share of active workers.

Much of the early and continuing development of empirical work on human capital concentrates on the role of school attainment, that is, the quantity of schooling. The revolution in the USA during the 20th century was universal schooling. This has spread around the world, encompassing both developed and developing countries. Quantity of schooling is easily measured, and data on years attained, both over time and across individuals, are readily available.

Today, however, policy concerns in most corners of the world revolve much more around issues of quality than issues of quantity.

1.1. Quality and individual incomes

One of the challenges in understanding the impact of quality differences in human capital has been simply knowing how to measure quality. Much of the discussion of quality — in part related to new efforts to provide better accountability — has identified cognitive skills as the important dimension. And, while there is ongoing debate about the testing and measurement of these skills, most parents and policy-makers alike accept the notion that cognitive skills are a key dimension of schooling out-

comes. The question is whether this proxy for school quality — students' performance on standardised tests — is correlated with individuals' performance in the labour market and the economy's ability to grow. Until recently, little comprehensive data have been available to show any relationship between differences in cognitive skills and any related economic outcomes. Such data are now becoming available.

Much of the work by economists on differences in worker skills has actually been directed at the issue of determining the average labour market returns to additional schooling and the possible influence of differences in ability. The argument has been that higher-ability students are more likely to continue in schooling. Therefore, part of the higher earnings observed for those with additional schooling really reflects pay for added ability and not for the additional schooling. Economists have pursued a variety of analytical approaches for dealing with this, including adjusting for measured cognitive test scores, but this work generally ignores issues of variation in school quality ([1]).

There is mounting evidence that quality measured by test scores is directly related to individual earnings, productivity, and economic growth. A variety of researchers documents that the earnings advantages to higher achievement on standardised tests are quite substantial ([2]). While these analyses emphasise different aspects of individual earnings, they typically find that measured achievement has a clear impact on earnings after allowing for differences in the quantity of schooling, the experiences of workers, and other factors that might also influence earnings. In other words, higher quality as measured by tests similar to those currently being used in accountability systems around the country is closely related to individual productivity and earnings.

Three recent US studies provide direct and quite consistent estimates of the impact of test performance on earnings (Mulligan (1999); Murnane et al. (2000); Lazear (2003)). These studies employ different nationally representative data sets that follow students after they leave schooling and enter the labour force. When scores are standardised, they suggest that one standard deviation increase in mathematics performance at the end of high schools translates into 12 % higher annual earnings.

Murnane et al. (2000) provide evidence from the high school and beyond and the national longitudinal survey of the high school class of 1972. Their estimates suggest some variation with males obtaining a 15 % increase and females a 10 % increase per standard deviation of test performance. Lazear (2003), relying on a somewhat younger sample from NELS88, provides a single estimate of 12 %. These estimates are also very close to those in Mulligan (1999), who finds 11 % for the normalised AFQT score in the NLSY data. By way of comparison, estimates of the value of an additional year of school attainment are typically 7–10 %.

There are reasons to believe that these estimates provide a lower bound on the impact of higher achievement. First, these estimates are obtained fairly early in the work career (mid-20s to early 30s), and other analysis suggests that the impact of test performance becomes larger with experience ([3]). Second, the labour market experiences that are observed begin in the mid-1980s and extend into the mid-1990s, but other evidence suggests that the value of skills and of schooling has grown throughout and past that period. Third, future general improvements in productivity are likely to lead to larger returns to skill ([4]).

A limited number of additional studies are available for developed countries outside of the USA. McIntosh and Vignoles (2001) study wages in the United Kingdom and find strong returns to both numeracy and literacy ([5]).

([1]) The approaches have included looking for circumstances where the amount of schooling is affected by things other than the student's valuation of continuing and considering the income differences among twins (see Card, 1999). The various adjustments for ability differences typically make small differences on the estimates of the value of schooling, and Heckman and Vytlacil (2001) argue that it is not possible to separate the effects of ability and schooling. The only explicit consideration of school quality typically investigates expenditure and resource differences across schools, but these are known to be poor measures of school quality differences (Hanushek, 2002). Early discussion of ability bias can be found in Griliches (1974).

([2]) These results are derived from different specific approaches, but the basic underlying analysis involves estimating a standard 'Mincer' earnings function and adding a measure of individual cognitive skills. This approach relates the logarithm of earnings to years of schooling, experience, and other factors that might yield individual earnings differences. The clearest analyses from the USA are found in the following references (which are analysed in Hanushek, 2002). See Bishop (1989, 1991); O'Neill (1990); Grogger and Eide (1993); Blackburn and Neumark (1993, 1995); Murnane, Willett, and Levy (1995); Neal and Johnson (1996); Mulligan (1999); Murnane et al. (2000); Altonji and Pierret (2001); Murnane et al. (2001); and Lazear (2003).

([3]) Altonji and Pierret (2001) find that the impact of achievement grows with experience, because the employer has a chance to observe the performance of workers.

([4]) These analyses typically compare workers of different ages at one point in time to obtain an estimate of how earnings will change for any individual. If, however, productivity improvements occur in the economy, these will tend to raise the earnings of individuals over time. Thus, the impact of improvements in student skills are likely to rise over the work life instead of being constant as portrayed here.

([5]) Because they look at discrete levels of skills, it is difficult to compare the quantitative magnitudes directly with the US work.

Finnie and Meng (2002) and Green and Riddell (2003) investigate returns to cognitive skills in Canada. Both suggest that literacy has a significant return, but Finnie and Meng (2002) find an insignificant return to numeracy. This latter finding stands at odds with most other analyses that have emphasised numeracy or mathematics skills.

Another part of the return to school quality comes through continuation in school ([1]). There is substantial US evidence that students who do better in school, either through grades or scores on standardised achievement-tests, tend to go farther in school ([2]). Murnane et al. (2000) separate the direct returns to measured skill from the indirect returns of more schooling and suggest that perhaps one third to one half of the full return to higher achievement comes from further schooling. Note also that the effect of quality improvements on school attainment incorporates concerns about drop-out rates. Specifically, higher student achievement keeps students in school longer, which will lead among other things to higher graduation rates at all levels of schooling.

The US evidence on continuation may not generalise to all countries. The key element for the USA is that supply of higher education is essentially unconstrained. In other words, individuals meeting some minimal entry level of performance can for the most part attend an institution of higher education. For countries where the supply is more constrained, higher performance in school will generally have distributional impacts but will not yield the same returns from increased attainment that are found in the USA.

The impact of test performance on individual earnings provides a simple summary of the primary economic rewards to an individual. This estimate combines the impacts on hourly wages and on employment/hours worked. It does not include any differences in fringe benefits or non-monetary aspects of jobs. Nor does it make any allowance for aggregate changes in the labour market that might occur over time.

1.2. Impacts of quality on economic growth

The relationship between measured labour force quality and economic growth is perhaps even more important than the impact of human capital and school quality on individual productivity and incomes. Economic growth determines how much improvement will occur in the overall standard of living of society. Moreover, the education of each individual has the possibility of making others better off (in addition to the individual benefits just discussed). Specifically, a more educated society may lead to higher rates of invention; may make everybody more productive through the ability of firms to introduce new and better production methods; and may lead to more rapid introduction of new technologies. These externalities provide extra reason for being concerned about the quality of schooling.

The potential effect of differences in growth rates on economic well-being is easy to see. Figure 1 begins with the value of gross domestic product (GDP) per capita for a medium income OECD country in the year 2000 and shows its value in 2050 under different growth rates. If it grows at 1 % each year, this measure (in US dollars) would increase from USD 25 000 to over USD 41 000 — or increase by almost two thirds over the period. If it were to grow at 2 % per year, it would reach USD 67 000 in 2050! Small differences in growth rates have huge implications for the income and wealth of society.

The current economic position of the USA, for example, is largely the result of its strong and steady growth over

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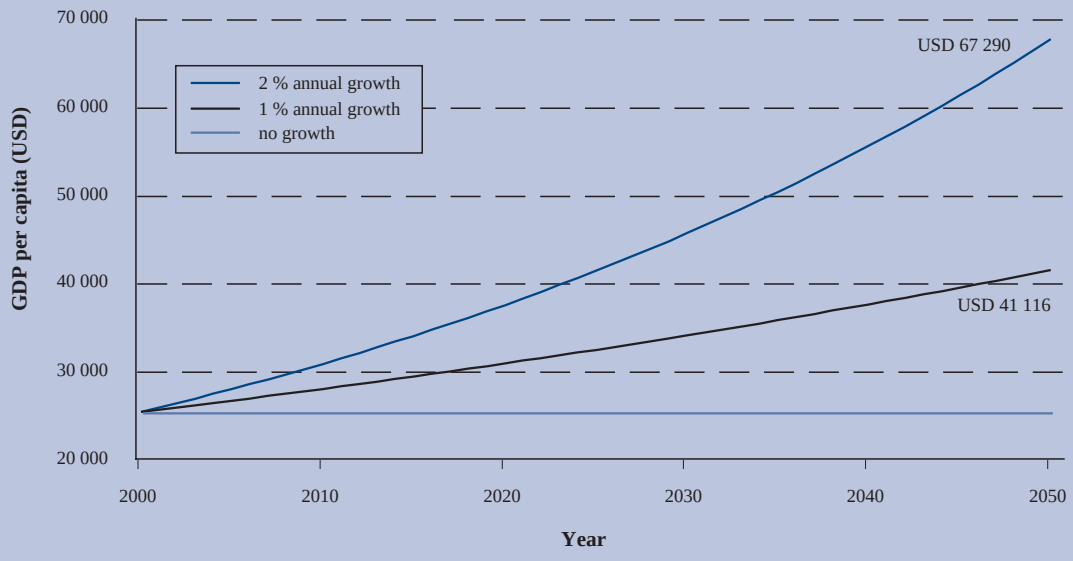
([2]) See, for example, Dugan (1976); Manski and Wise (1983)). Rivkin (1995) finds that variations in test scores capture a considerable proportion of the systematic variation in high school completion and in college continuation, so that test score differences can fully explain black–white differences in schooling. Bishop (1991) and Hanushek, Rivkin, and Taylor (1996), in considering the factors that influence school attainment, find that individual achievement scores are highly correlated with continued school attendance. Neal and Johnson (1996) in part use the impact of achievement differences of blacks and whites on school attainment to explain racial differences in incomes. Their point estimates of the impact of cognitive skills (AFQT) on earnings and school attendance appear to be roughly comparable to that found in Murnane et al. (2000). Behrman et al. (1998) find strong achievement effects on both continuation into college and quality of college; moreover, the effects are larger when proper account is taken of the various determinants of achievement. Hanushek and Pace (1995) find that college completion is significantly related to higher test scores at the end of high school.

Figure 1: **Effect of economic growth on GDP per capita (from base of USD 25 000 in 2000)**



the 20th century. Economists have developed a variety of models and ideas to explain differences in growth rates across countries — invariably featuring the importance of human capital ([1]).

The empirical work supporting growth analyses has emphasised school attainment differences across countries. Again, this is natural because, while compiling comparable data on many things for different countries is difficult, assessing quantity of schooling is more straightforward. The typical study finds that quantity of schooling is highly related to economic growth rates. But, quantity of schooling is a very crude measure of the knowledge and cognitive skills of people — particularly in an international context.

Hanushek and Kimko (2000) go beyond simple quantity of schooling and delve into quality of schooling ([2]). We incorporate the information about international differences in mathematics and science knowledge that has been developed through testing over the past four decades. And we find a remarkable impact of differences in school quality on economic growth.

The international comparisons of quality come from piecing together results of a series of tests administered over the past four decades. In 1963 and 1964, the International Association for the Evaluation of Educational Achievement (IEA) administered the first of a series of mathematics tests to a voluntary group of countries. These initial tests suffered from a number of problems, but they did prove the feasibility of such testing and set in motion a process to expand and improve on the undertaking ([3]).

Subsequent testing, sponsored by the IEA and others, has included both mathematics and science and has expanded on the group of countries that have been tested. In each, the general model has been to develop a common assessment instrument for different age groups of students and to work at obtaining a representative group

([1]) Barro and Sala-I-Martin (1995) review recent analyses and the range of factors that are included.

([2]) Barro and Lee (2001) provide an analysis of qualitative differences that also includes literacy.

([3]) The problems included issues of developing an equivalent test across countries with different school structure, curricula, and language; issues of selectivity of the tested populations; and issues of selectivity of the nations that participated. The first tests did not document or even address these issues in any depth.

of students taking the tests. An easy summary of the participating countries and their test performance is found in Figure 2. This figure tracks performance aggregated across the age groups and subject area of the various tests and scaled to a common test mean of 50 ([1]). The USA and the United Kingdom are the only countries to participate in all of the testing.

There is some movement across time of country performance on the tests, but for the one country that can be checked — the USA — the pattern is consistent with other data. The National Assessment of Educational Progress (NAEP) in the USA is designed to follow performance of US students for different subjects and ages. NAEP performance over this period, shown in Figure A1, also exhibits a sizeable dip in the 1970s, a period of growth in the 1980s, and a levelling off in the 1990s.

Kimko's and my analysis of economic growth is very straightforward. We combine all of the available earlier test scores into a single composite measure of quality and consider statistical models that explain differences in growth rates across nations during the period 1960 to 1990 ([2]). The basic statistical models, which include the initial level of income, the quantity of schooling, and population growth rates, explain a substantial portion of the variation in economic growth across countries.

Most important, the quality of the labour force as measured by mathematics and science scores is extremely important. One standard deviation difference on test performance is related to 1 % difference in annual growth rates of gross domestic product (GDP) per capita ([3]).

([1]) The details of the tests and aggregation can be found in Hanushek and Kimko (2000) and Hanushek and Kim (1995). This figure excludes the earliest administration and runs through the Third International Mathematics and Science Study (TIMSS) (1995). Other international tests have been given and are not included in the figure. First, reading and literacy tests have been given in 1991 and very recently. The difficulty of unbiased testing of reading across languages plus the much greater attention attached to mathematics and science both in the literature on individual earnings and in the theoretical growth literature led to the decision not to include these test results in the empirical analysis. Second, the more recent follow-up to the 1995 TIMSS in mathematics and science (given in 1999) is excluded from the figure simply for presentational reasons.

([2]) We exclude the two TIMSS tests from 1995 and 1999 because they were taken outside of the analytical period on economic growth. We combine the test measures over the 1965–91 period into a single measure for each country. The underlying objective is to obtain a measure of quality for the labour force in the period during which growth is measured.

This quality effect, while possibly sounding small, is actually very large and significant. Because the added growth compounds, it leads to powerful effects on national income and on societal well-being. One needs only to return to the calculations presented in Figure 1 to understand the impact of such skill-based improvements in economic growth.

1.3. Importance of quality

The frequent focus of governmental programmes has been increasing school attainment and expanding on the years of schooling of the population. The previous discussion, however, highlights the central importance of quality. While years of schooling attainment are important, that holds only if quality is maintained.

The impact of improved quality can be calculated from the considerations of how quality affects growth rates for economies. Consider the effects of beginning a successful school improvement programme in 2005. Of course school reform takes time. And, even if successful, it takes some time before the school graduates work their way into the labour force and thus some time before the impact will be felt.

Figure 3 illustrates the impact that reform could be expected to have over time if it is successful at achieving moderately strong knowledge improvement (corresponding to a 0.5 standard deviation increase in test score achievement) ([4]). The curves sketch out the path of GDP improvement that would occur with a reform plan that reaches its improvement goal within 10, 20, or 30 years.

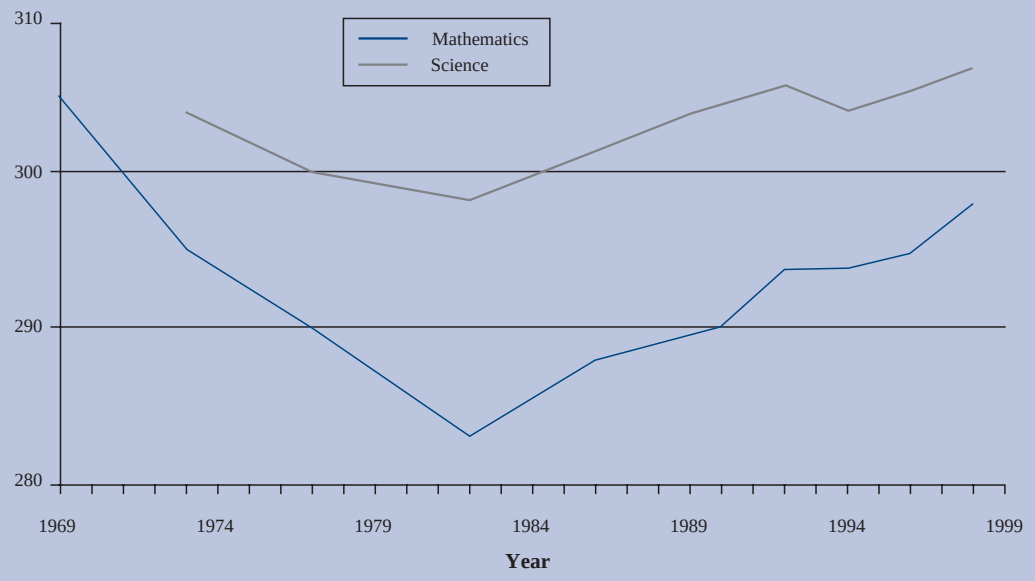
Consider just the slow improvement of schools over a 30-year period. In 2040, the GDP would be almost 4 % higher than projected without the schooling reforms. Of course, faster reforms would yield even greater gains in GDP. This magnitude would cover total school spending in most countries of the world.

([3]) The details of this work can be found in Hanushek and Kimko (2000) and Hanushek (2003b). Importantly, adding other factors potentially related to growth, including aspects of international trade, private and public investment, and political instability, leaves the effects of labour force quality unchanged.

([4]) These calculations are calibrated to scores on international mathematics and science exams. The 'moderately strong' improvement implies an increase in scores by 0.5 standard deviations across the international comparisons. This is equivalent of bringing a country at the 31st percentile of performance up to the median for the world.

Figure 2: **Normalised test scores on mathematics and science examinations, 1970–95**

Figure A1: **National assessment educational progress (NAEP), age 17**



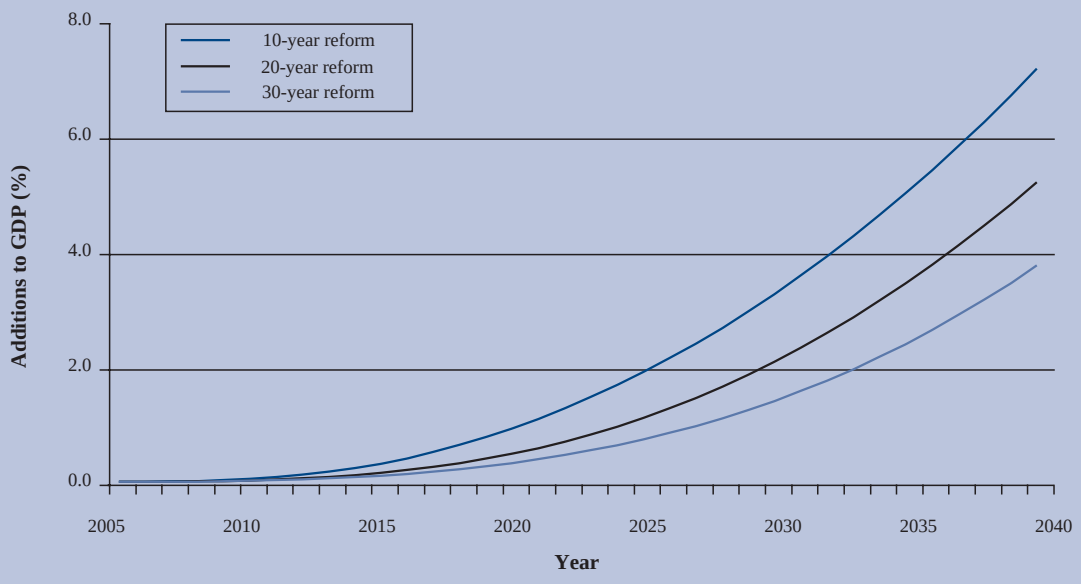
1.4. Causality

One common concern in analysis such as this is that schooling might not be the actual cause of growth but, in fact, may just reflect other attributes of the economy that are beneficial to growth. For example, as seen in Figure 2, the East Asian countries consistently score very highly on the international tests, and they also had extraordinarily high growth over the 1960–90 period. It may be that other aspects of these East Asian economies have driven their growth and that the statistical analysis of labour force quality simply is picking out these countries. But in fact, even if the East Asian countries are excluded from the analysis, a strong — albeit slightly smaller — relationship is still observed with test performance. This test of sensitivity of the results seems to reflect a basic importance of school quality, a factor that contributes also to the observed growth of East Asian countries.

Another concern might be that other factors that affect growth, such as efficient market organisations, are also associated with efficient and productive schools — so that, again, the test measures are really a proxy for other attributes of the country. In order to investigate this, we concentrate on immigrants to the USA who received their education in their home countries. We find that immigrants who were schooled in countries that have higher scores on the international mathematics and science examinations earn more in the USA. This analysis makes allowance for any differences in school attainment, labour market experience, or being native English-language speakers. In other words, skill differences as measured by the international tests are clearly rewarded in the US labour market, reinforcing the validity of the tests as a measure of individual skills and productivity.

Finally, the observed relationships could simply reflect reverse causality, that is, that countries that are growing rapidly have the resources necessary to improve their schools and that better student performance is the result of growth, not the cause of growth. As a simple test of this, we investigated whether the international mathematics and science test scores were systematically related to the resources devoted to the schools in the years prior to the tests. They were not. If anything, we found relatively better performance in those countries spending less on their schools.

Figure 3: **Improved GDP with moderately strong knowledge improvement**



In sum, the relationship between mathematics and science skills on the one hand and productivity and growth on the other comes through clearly when investigated in a systematic manner across countries. This finding underscores the importance of high-quality schooling.

1.5. Why has US growth been so strong?

Figure 2 on international test score differences does introduce an important issue of interpretation. Namely, the USA has not been competitive on an international level in terms of tests. It has scored below the median of countries taking the various tests. Moreover, this figure — which combines scores across different age groups — disguises the fact that performance on tests of US students is much stronger at young ages but falls off dramatically at the end of high school (Hanushek, 2003b).

Earlier, we introduced the discussion of the importance of growth by recounting the USA's successful economic growth during the 20th century. Yet, looking at Figure 2, we see that the USA has been at best mediocre in mathematics and science ability. Regardless of the set of countries taking the test, the USA has performed in the middle of the pack or below. Some people find this anomalous. How could mathematics and science ability be important in light of the strong US growth over a long period of time?

The answer is that the quality of the labour force is just one aspect of the economy that enters into the determination of growth. A variety of factors clearly contribute, and these factors work to overcome any deficits in quality. These other factors may also be necessary for growth. In other words, simply providing more or higher-quality schooling may yield little in the way of economic growth in the absence of other elements, such as the appropriate market, legal, and governmental institutions to support a functioning modern economy. Past experiences investing in less developed countries that lack these institutional features demonstrate that schooling is not itself a sufficient engine of growth.

Indeed, some have questioned the precise role of schooling in growth. Easterly (2002), for example, notes that education without other facilitating factors such as functioning institutions for markets and legal systems may not have much impact. He argues that World Bank invest-

ments in schooling for less developed countries that do not ensure that the other attributes of modern economies are in place have been quite unproductive. As discussed below, schooling clearly interacts with other factors, and these other factors have been important in supporting US growth. They are also surely relevant for other countries.

It is useful to describe some of the other contributing factors to US growth. This is done in part to understand more fully the character of economic growth, but more importantly to highlight some important related issues that are central to thinking about human capital policies.

2. Economic structure

Almost certainly the most important factor sustaining the growth of the US economy is the openness and fluidity of its markets. The USA maintains generally freer labour and product markets than most countries in the world. The government generally has less regulation on firms (both in terms of labour regulations and in terms of overall production), and trade unions are less extensive than those in many other countries. Even broader, the USA has less intrusion of government in the operation of the economy — not only less regulation but also lower tax rates and minimal government production through nationalised industries. These factors encourage investment, permit the rapid development of new products and activities by firms, and allow US workers to adjust to new opportunities. While identifying the precise importance of these factors is difficult, a variety of analyses suggest that such market differences could be very important explanations for differences in growth rates ([1]).

Because of the generally favourable institutional conditions, US growth has been strong, even if some of the underlying factors are not as competitive. In other words, the economic structure can mask problems within the economy. But this does not negate the fact that improving our schools and the quality of our labour force would enhance growth and incomes.

([1]) See, for example, Krueger (1974); World Bank (1993); Parente and Prescott (1994, 1999).

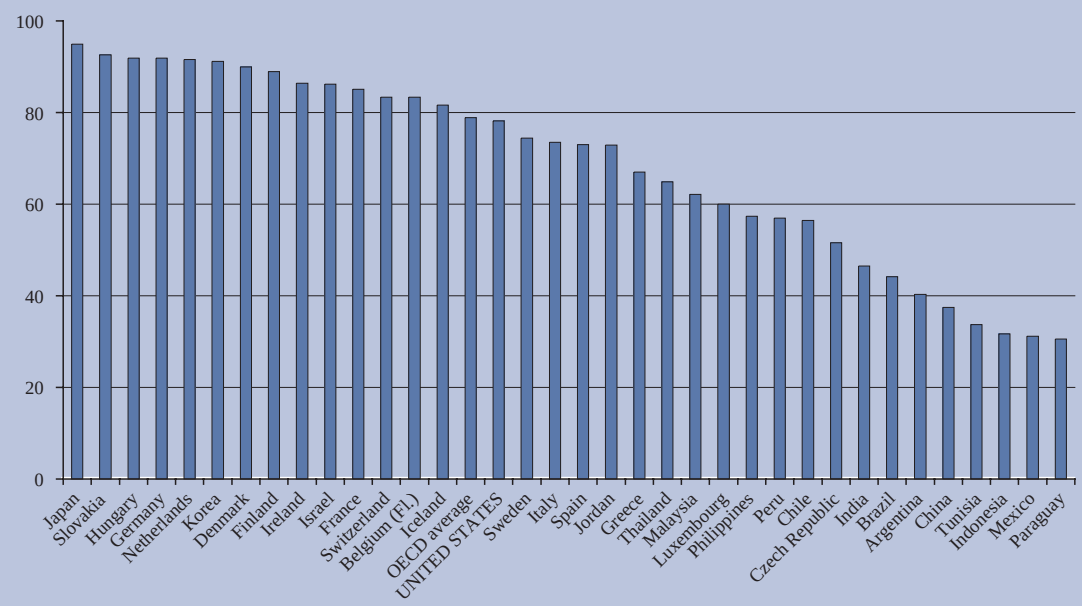
3. Substitution of quantity for quality

Over the 20th century, the expansion of the education system in the USA outpaced that around the world. The USA pushed to open secondary schools to all citizens. With this came also a move to expand higher education with the development of land grant universities, the GI bill for veterans, and direct grants and loans to students. In comparison with other nations of the world, the US labour force has been better educated, even after allowing for the lesser achievement of its graduates. In other words, more schooling with less learning each year has yielded more human capital than found in other nations that have less schooling but learn more in each of those years.

This historical approach, however, appears on the verge of reaching its limits for the USA. Other nations of the world, both developed and developing, have rapidly expanded their schooling systems, and many now surpass the USA. Figure 4 shows secondary school completion rates for both Organisation for Economic Cooperation and Development (OECD) countries and a selection of others in 1999 ([1]). Remarkably, the USA trailed a

([1]) Data come from the Organisation for Economic Cooperation and Development (2001) which has made an effort to use standardised definitions. The non-OECD countries are included in the World Education Indicators project.

Figure 4: **Secondary school completion rates, 1999**



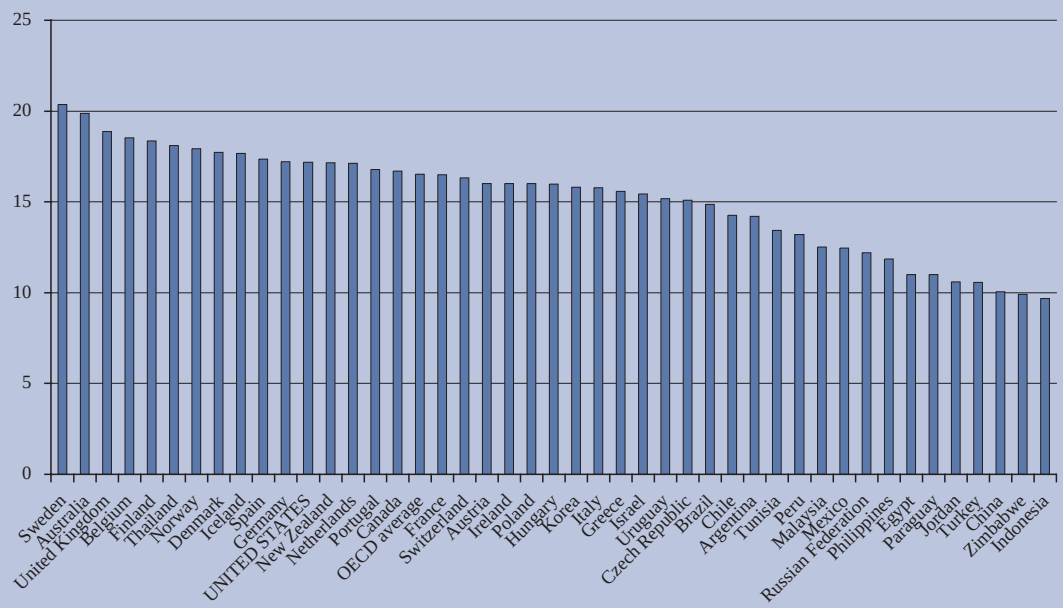
large number of other countries in 1999 and falls just slightly below the OECD average completion rate. The USA gains some by having rates of college attendance above the typical OECD country. Nonetheless, as summarised in Figure 5, US students are not likely to complete more schooling.

The past advantage of the USA in amount of school completed has gone away as other nations have discovered the importance of schooling. Thus, going into the future, the USA appears unlikely to continue dominating others in human capital unless it can improve on the quality dimension.

Note, however, that this story about US school quality does not generalise well to developing countries — countries that are often not close in any quality dimension. Thus, the US success with expanding mediocre schools does not imply that the practice seen in many developing countries of expanding totally dysfunctional schools is the right path ([1]). Indeed, as argued in Hanushek (1995), it appears to be a considerable mistake for developing countries to expand quantity or access to schools while ignoring quality. Indeed there is an argument that improving quality would actually make it easier to expand access by reducing repetition and other counterproductive aspects of schools (Hanushek, 1995).

([1]) A direct discussion and analysis of poor schools in rural Brazil is found in Harbison and Hanushek (1992).

Figure 5: **Expected years of schooling, 1999**



4. Quality of US colleges

The analysis of growth rates across countries emphasises quality of the elementary and secondary schools of the USA. It did not include any measures of the quality of US colleges. By most evaluations, US colleges and universities rank at the very top in the world. No direct measurements of quality of colleges across countries exist. However, there is indirect evidence. Foreign students by all accounts are not tempted to emigrate to the USA to attend elementary and secondary schools — except perhaps if they see this as a way of gaining entry into the country. They do emigrate in large numbers to attend US colleges and universities. They even tend to pay full, unsubsidised tuitions at US colleges, something that many fewer US citizens do.

A number of the economic models of economic growth in fact emphasise the importance of scientists and engineers as a key ingredient to growth. By these views, the technically trained college students who contribute to invention and to development of new products provide a special element to the growth equation. Here, again, the USA appears to have the best programmes. If this view is correct, US higher education may continue to provide a noticeable advantage over other countries.

But the raw material for US colleges is the graduates of our elementary and secondary schools. As has been frequently noted, the lack of preparation of our students leads to extensive remedial education at the post-secondary level, detracting from the ability of colleges and universities to be most effective. And, pre-college preparation is likely an important factor driving the increased proportions of foreign-born graduates from the science and engineering programmes of US colleges and universities.

4.1. Improving quality

Much of school policy is traditionally thought of as an exercise in selecting and ensuring that the optimal set of resources, somehow defined, is available. Matched with this policy perspective has been a line of research considering the relationship between resource usage and student performance. If the effectiveness of different resources or combinations of resources were known, it would be straightforward to define an optimal set of resources. Moreover, we could often decide about policies that would move us toward such an optimal set of resources. Unfortunately, this alludes us.

Schools in the USA have been the focus of extensive research. Both aggregate data about performance of schools over time and more detailed school and classroom data point to a simple conclusion: there is a lack of any consistent or systematic effect of resources on student achievement. While controversial, partly because of the conflict with existing school policies, the evidence is very extensive (Hanushek, 2003a).

Most other countries of the world have not tracked student performance over any length of time, making analyses comparable with the US discussion impossible. Nonetheless, international testing over the past four decades permits an overview of spending across countries. Seven different mathematics and science tests (the data for the growth analysis) were given between the early 1960s and 1995 to students at different grade levels in a varying set of voluntarily participating nations. Performance bears little relationship to the patterns of expenditure across the countries. Hanushek and Kimko (2000) estimate models that relate spending, family backgrounds, and other characteristics of countries to student performance for the tests prior to 1995. This estimation consistently indicates a statistically significant negative effect of added resources on performance after controlling for other influences. Similar findings hold for the OECD countries.

In sum, a wide range of analyses indicate that overall resource policies have not led to discernible improvements in student performance. It is important to understand what is and is not implied by this conclusion. First, it does not mean that money and resources never matter.

There clearly are situations where small classes or added resources have an impact. It is just that no good description of when and where these situations occur is available, so that broad resource policies such as those legislated from central governments may hit some good uses but also hit bad uses that generally lead to offsetting outcomes. Second, this statement does not mean that money and resources cannot matter. Instead, as described below, altered sets of incentives could dramatically improve the use of resources.

The evidence on resources is remarkably consistent across countries, both developed and developing. Had there been distinctly different results for some subsets of countries, issues of what kinds of generalisations were possible would naturally arise. Such conflicts do not appear particularly important.

Many countries have of course attempted to improve their schools. While some have succeeded, many have not. One explanation for past failure is simply that insufficient attention has been paid to teacher quality. By many accounts, the quality of teachers is the key element to improving student performance. But the research evidence also suggests that many of the policies that have been pursued around the world have not been very productive. Specifically, the chosen policies of individual countries may have led to changes in measured aspects of teachers such as degrees or teacher qualifications, but they have not tended to improve the quality of teachers — at least when quality is identified by student performance ([1]).

Rivkin, Hanushek, and Kain (2001) describe estimates of differences in teacher quality on an output basis. Specifically, the concern is identifying good and bad teachers on the basis of their performance in obtaining gains in student achievement. An important element of that work is distinguishing the effects of teachers from the selection of schools by teachers and students and the matching of teachers and students in the classroom. In particular, highly motivated parents search out schools that they think are good, and they attempt to place their children in classrooms where they think the teacher is particularly able. Teachers follow a similar selection process (Hanushek, Kain, and Rivkin (2004a); Hanushek, Kain, and Rivkin (2004b)). Thus, from an analytical viewpoint, it is difficult to sort out the quality of the teacher from the quality of the students that she has in her classroom. The analysis of teacher performance in Rivkin, Hanushek, and Kain (2001) goes to great lengths to avoid contamination from any such selection and matching of children and teachers.

Estimates that the differences in annual achievement growth between an average and a good teacher are large. Within one academic year, a good teacher can move a typical student up at least four percentiles in the overall distribution (equal to a change of 0.12 standard deviations of student achievement). From this, it is clear that having a series of good teachers can dramatically affect the achievement of any student. In fact, a series of good teachers can erase the deficits associated with poor preparation for school.

The difficulty, as pointed out in the preceding discussion, is that hiring good teachers is not easily done. Teaching ability is not closely related to training or experience. Moreover, common salary systems do not target particularly high-quality teachers. Although a discussion of alternative policies is beyond the scope of this paper, an outline of alternatives can be found in Hanushek (2003a).

From a policy viewpoint the primary objective should be improving the overall quality of the teaching force. If one were simply to redistribute existing teachers, the overall policy goals would not be achieved.

4.2. Conclusions

In making decisions about schools, countries always face limited budgets. If there are the two commonly accepted objectives of expanding access and of improving quality, these objectives will conflict because they must compete for the same budget. Thus, by this standard formulation policy-makers are faced with a particularly unpleasant dilemma: choose between broad availability of schools and good schools.

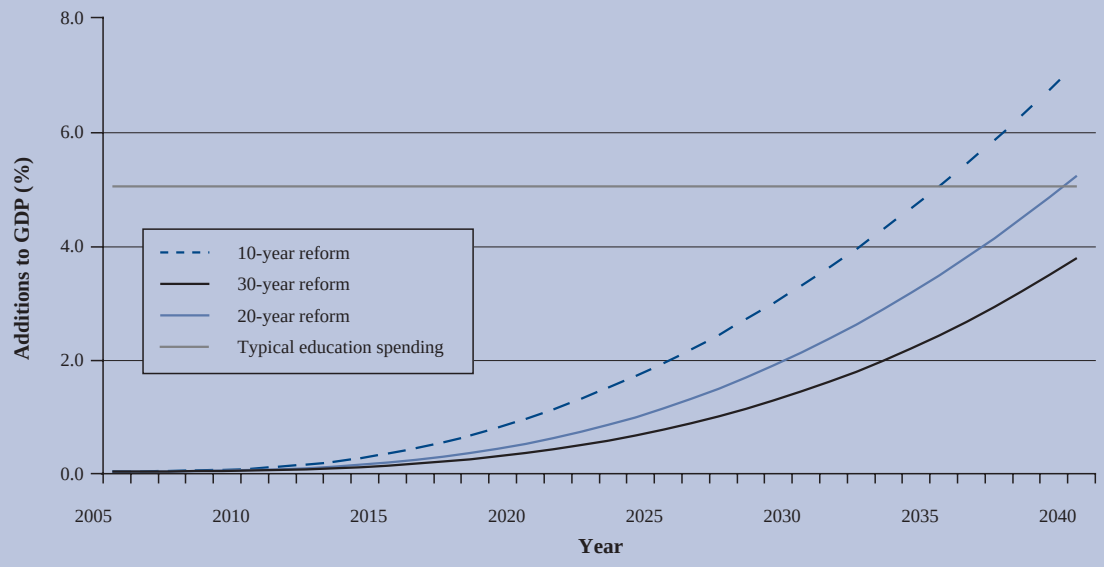
An alternative view that is set out here is that such a trade-off is not the right way to think about it when there are productive investments being made. To obtain some feel for this, consider a typical developed country that is spending 5 % of its GDP on education. Figure 6 displays such spending but superimposes the effects of real school reform that increases quality. Again, for illustrative purposes, this plot shows the implications of a moderately strong school

([1]) For a review of existing US literature, see Hanushek and Rivkin (2004). This paper describes various attempts to estimate the impact of teacher quality on student achievement. Similar studies are currently much less available in other countries.

reform that lifts performance by one-half standard deviation over varying periods of time. From this graph, it is apparent that by 2040 all of education expenditures could be absorbed into the growth dividend from either a 10-year or a 20-year reform. Even a 30-year reform would cover a majority of educational expenditure.

The message is quite simple. Real reform of schools — defined as reform that actually increases the knowledge of students — can be expected to have truly substantial impacts on the well-being of society. The difficult part of course is ensuring the reform of schools really accomplishes its objectives.

Figure 6: **Improved GDP with moderately strong knowledge improvement**



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