Handbook of International Development and Education

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2. The economic impact of educational quality

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INTRODUCTION

Building upon several decades of thought about human capital – and centuries of general attention to education in the more advanced countries – it is natural to believe that a productive development strategy would be to raise the schooling levels of the population. And, indeed, this is exactly the approach of the Education for All initiative and a central element of the Millennium Development Goals.[1]

But there are also some nagging uncertainties that exist with this strategy. First, developed and developing countries differ in a myriad of ways other than schooling levels. Second, a number of countries – both on their own and with the assistance of others – have expanded schooling opportunities without seeing any dramatic catch-up with developed countries in terms of economic well-being. Third, countries that do not function well in general might not be more able to mount effective education programs than they are to pursue other societal goals. Fourth, even when schooling policy is made a focal point, many of the approaches undertaken do not seem very effective and do not lead to the anticipated student outcomes. In sum, is it obvious that education is the driving force, or merely one of several factors that are correlated with more fundamental development forces?

Our perspective is more focused. An overwhelmingly important problem, as we show below, is the appropriate measurement of human capital. Specifically, much of the existing literature has focused on quantity of schooling and has ignored the quality dimension of education. Recent evidence shows, however, that the cognitive skills of the population are overwhelmingly important for economic growth.

We begin with a review of research on economic growth, an area of considerable interest over the past quarter century. We then demonstrate two things: First, better measurement of human capital that incorporates international test data can dramatically enhance our ability to understand differences in international growth rates across countries; second, consideration of cognitive skills also dramatically lessens concerns about the modeling of cross-country differences in growth.

SCHOOL ATTAINMENT AND ECONOMIC GROWTH

There is extensive microeconomic evidence of the productivity-enhancing effects of education and skills.[2] This broad literature looks at the relationship between schooling and individual earnings and has been replicated in over 100 countries.[3] Individuals with more skills earn more throughout their careers. Thus, it is natural to extend the view to aggregate outcomes, specifically to the macroeconomic perspective of long-run economic growth of countries.

Our approach to the education–growth relationship parallels that for the education–earnings relationship. We pursue a simple model that aggregate human capital is relevant to growth. Our discussion is designed to compare and contrast simple school attainment measures, which have been the near universal measure of human capital, with direct international assessments of cognitive skills. This section introduces the broad literature based on school attainment; the next section provides the contrast with the use of cognitive skills measures.

From a theoretical viewpoint, there are at least three mechanisms through which education may affect economic growth. First, just as in the micro perspective, education increases the human capital inherent in the labor force, which increases labor productivity and thus more education leads to transitional growth towards a higher equilibrium level of output (as in augmented neoclassical growth theories, cf. Mankiw, Romer, and Weil (1992)). Second, education may increase the innovative capacity of the economy, and the new knowledge on new technologies, products, and processes promotes growth (as in theories of endogenous growth, cf., e.g., Lucas (1988); Romer (1990); Aghion and Howitt (1998)). Third, education may facilitate the diffusion and transmission of knowledge needed to understand and process new information and to implement successfully new technologies devised by others, which again promotes economic growth (cf., e.g., Nelson and Phelps (1966); Benhabib and Spiegel (2005)).

RESULTS OF CROSS-COUNTRY GROWTH REGRESSIONS

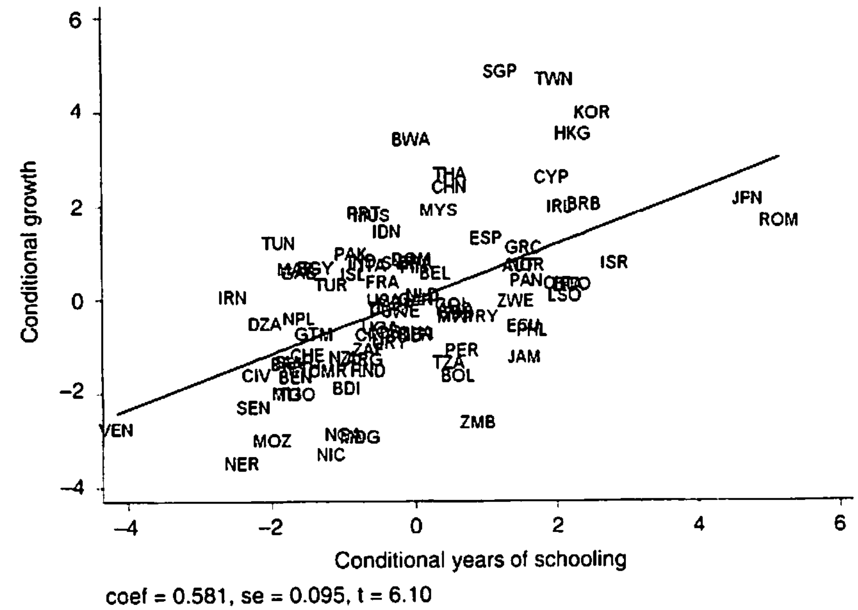
In parallel to the literature on microeconomic returns to education, the majority of the macroeconomic literature on economic growth employs the quantitative measure of years of schooling, averaged across the labor force. Early studies used school enrollment ratios (e.g., Barro (1991); Mankiw, Romer, and Weil (1992); Levine and Renelt (1992)) as proxies for the human capital of an economy. These were followed by attempts to measure average years of schooling based on perpetual inventory methods (cf. Lau, Jamison, and Louat (1991); Nehru, Swanson, and Dubey (1995)). An important innovation by Barro and Lee (1993, 2001, 2013) 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 or survey data on educational attainment wherever possible and using literacy and enrollment data to fill gaps in the census data.

But, using average years of schooling as the education measure 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 Indonesia is assumed to create the same increase in productive human capital as a year of schooling in Korea. Additionally, this measure assumes that formal schooling is the primary (sole) source of education and, moreover, that variations in nonschool 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.

The standard approach for estimating the effect of education on economic growth is to estimate cross-country growth regressions where countries' average annual growth in gross domestic product (GDP) per capita over several decades is expressed as a function of measures of schooling and a set of other variables deemed to be important for economic growth. Following the seminal contributions by Barro (1991, 1997) and Mankiw, Romer, and Weil (1992), a vast early literature of cross-country growth regressions has tended to find a significant positive association between quantitative measures of schooling and economic growth (for extensive reviews of the literature, see Hanushek and Woessmann (2008)). To give an idea of the robustness of this association, in the extensive robustness analysis by Sala-i-Martin, Doppelhofer, and Miller (2004) of 67 explanatory variables in growth regressions on a sample of 88 countries, primary schooling turns out to be the most robust influence factor (after an East Asian dummy) on growth in GDP per capita in 1960–1996.

CURRENT EVIDENCE ON THE RELATIONSHIP OF GROWTH AND YEARS OF SCHOOLING

To frame the discussion of cognitive skills that follows, we produce estimates of common models that incorporate school attainment.[4] Figure 2.1 plots the average annual rate of growth in GDP per capita over the 40-year period of 1960–2000 against years of schooling at the beginning



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; coef = coefficient, se = standard error, t = t-value. Own calculations. See Hanushek and Woessmann (2008).

Figure 2.1 Added-variable plot of growth and years of schooling without test-score controls

of the period for a sample of 92 countries. Both growth and education are expressed conditional on the initial level of output, to account for the significant conditional convergence effect.[5]

The regression results depicted by Figure 2.1 imply that each year of schooling is statistically significantly associated with a long-run growth rate that is 0.58 percentage points higher. The association is somewhat lower (at 0.32) but still significant when regional dummies (e.g., East Asia, Latin America) are added to the regression.

Three skeptical studies raise noteworthy caveats, however. First, Levine and Renelt (1992) and Levine and Zervos (1993), among others, raise questions about the sensitivity of cross-country growth regressions to samples, model specification, and estimation procedures. Second, Bils and Klenow (2000) raise the issue of causality, suggesting that reverse causation running from higher economic growth to additional education may be at least as important as the causal effect of education on growth in the cross-country association. Third, one of the conclusions that Pritchett (2001, 2006) draws from the fragility of the evidence linking changes in education to economic growth is that it is important for economic growth to get other things right as well, in particular the institutional framework of the economy. We discuss each of these issues below.

COGNITIVE SKILLS AND ECONOMIC GROWTH

Basic Results

The most important caveat with the literature on education and growth reviewed in the preceding section relates to measurement: it sticks to years of schooling as its measure of human capital at the neglect of qualitative differences in ensuing knowledge. This neglect is clearly more severe in cross-country comparisons than in analyses within countries (such as the work on earnings determination). Rather than just counting students' average years of schooling, it is crucial to focus on how much students have learned while in school when estimating the effect of education on economic growth.

Over the past 15 years, empirical growth research demonstrates that consideration of cognitive skills alters the assessment of the role of education and knowledge in the process of economic development dramatically. When using the data from the international student achievement tests through 1991 to build a measure of labor force quality, Hanushek and Kimko (2000) find a statistically and economically significant positive effect of the cognitive skills on economic growth in 1960–1990 that dwarfs the association between quantity of education and growth. Their estimate stems from a statistical model that relates annual growth rates of real GDP per capita to the measure of cognitive skills, years of schooling, the initial level of income, and a wide variety of other control variables (including in different specifications the population growth rates, political measures, openness of the economies, and the like). Hanushek and Kimko (2000) find that adding the international achievement test measures to a base specification including only initial income and educational quantity boosts the variance in GDP per capita among the 31 countries in their sample that can be explained by the model from 33 to 73 percent. The effect of years of schooling is greatly reduced by including cognitive skills, leaving it mostly insignificant. At the same time, adding the other factors leaves the effects of cognitive skills basically unchanged.

Several studies have since found very similar results. Another early contribution, by Lee and Lee (1995), found an effect size similar to Hanushek and Kimko (2000) using data from the 1970–1971 First International Science Study on the participating 17 countries, also leaving quantitative measures of education with no significant effect on growth. Using a more encompassing set of international tests, Barro (2001) also finds that, while both the quantity of schooling and test scores matter for economic growth, measured cognitive skills are much more important. Employing the measure of cognitive skills developed by Hanushek and Kimko (2000) in a development accounting framework, Wößmann (2002, 2003) finds that the share of cross-country variation in levels of economic development attributable to international differences in human capital rises dramatically when cognitive skills are taken into account. Building on Gundlach, Rudman, and Wößmann (2002), this work analyzes output per worker in 132 countries in 1990. The variation that can be attributed to international differences in human capital rises from 21 percent to 45 percent once the international achievement measures are taken into account, and to over 60 percent in samples with reasonable data quality.

Extensions of the measure of Hanushek and Kimko (2000) and its imputation in Wößmann (2003) are also used in the cross-country growth regressions by Bosworth and Collins (2003) and in the cross-country industry-level analysis by Ciccone and Papaioannou (2009). Both also find that measured cognitive skills strongly dominate any effect of educational quantity on growth. Coulombe, Tremblay, and Marchand (2004) and Coulombe and Tremblay (2006) use test-score data from the International Adult Literacy Survey in a panel of 14 Organisation for Economic Co-operation and Development (OECD) countries, confirming the result that the test-score measure outperforms quantitative measures of education.

Jamison, Jamison, and Hanushek (2007) further extend the Hanushek and Kimko (2000) analysis by controlling for a larger number of potentially confounding variables and extending the time period of the analysis. Using the panel structure of their growth data, they suggest that cognitive skills seem to improve income levels mainly through speeding up technological progress, rather than shifting the level of the production function or increasing the impact of an additional year of schooling.

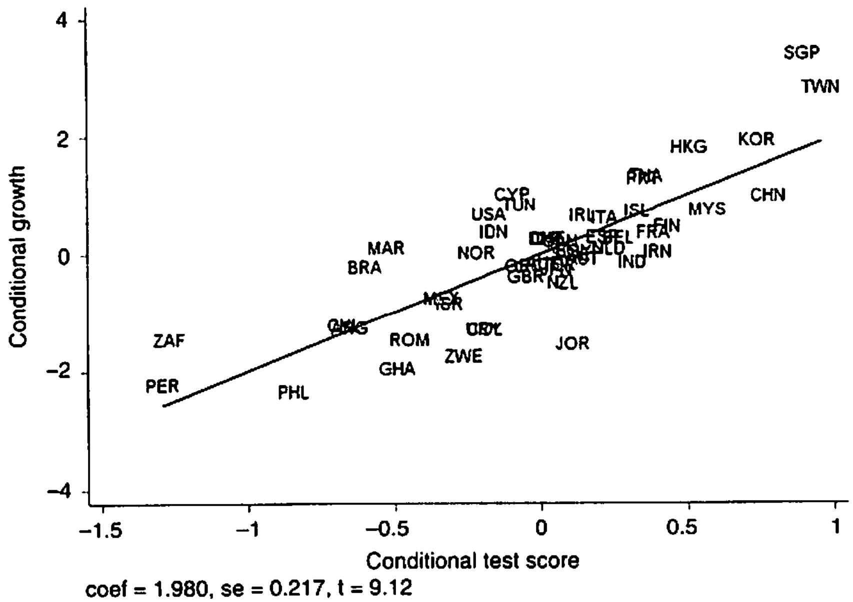
In sum, the evidence suggests that what students know as depicted in tests of cognitive skills is substantially more important for economic growth than the mere quantity of schooling.

Cognitive Skills and Growth

In order to understand the importance of cognitive skills, we can provide direct estimates of the impact of test measures on economic growth for the period 1960–2000. This analysis parallels that shown graphically in Figure 2.1 except that it employs existing international test data.

From the mid-1960s to today, international agencies have conducted many international tests of students' performance in cognitive skills such as mathematics and science (see Hanushek and Woessmann (2011)). The different tests contain both "academic" questions related to the school curricula as well as "life skill" questions requiring practical applications to real-world phenomena. Employing a re-scaling method that makes performance at different international tests comparable, we can use performance on these standardized tests as a measure of cognitive skills.[6]

Figure 2.2 relates test scores to long-run economic growth for the 50 countries that have both test information and data on growth in GDP.[7] When cognitive skills are added to a model that just includes initial income and years of schooling, the share of variation in economic growth explained by the model (the adjusted R^2) jumps from 0.25 to 0.73. Importantly, one



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; coef = coefficient, se = standard error, t = t-value. Own calculations. See Hanushek and Woessmann (2012).

Figure 2.2 Added-variable plots of growth and education

standard deviation in test scores relates to two percentage points per year faster growth.

It is useful to contrast this with the relationship of growth and school attainment. Quantity of schooling is statistically significantly related to economic growth in a specification that does not include the measure of cognitive skills, but the association between years of schooling and growth turns insignificant and its marginal effect is reduced to close to zero once cognitive skills are included in the model. In other words, school attainment has no independent effect over and above its impact on cognitive skills.

Institutions, Cognitive Skills, and Growth

In recent years, there has been an increasing emphasis on the role of economic institutions as the fundamental cause of differences in economic development (Acemoglu, Johnson, and Robinson (2005)). The quality of institutions as measured by the protection against expropriation is indeed significantly related to economic growth. A second measure of institutional quality, openness to international trade, also tends to be significantly related to economic growth, at least jointly with protection against expropriation. At the same time, though, the estimation shows that, on average, cognitive skills exert a positive effect on economic growth independent of these measures of the quality of institutions.

It is possible that the effect of cognitive skills on economic growth may differ depending on the economic institutions of a country. North (1990), for example, emphasizes that the institutional framework plays an important role in shaping the relative profitability of piracy versus productive activity. If the available knowledge and skills are used in the former rather than the latter activity, one may certainly expect the effect on economic growth to be substantially different, and maybe even to turn negative. Similarly, Murphy, Shleifer, and Vishny (1991) show that the allocation of talent between rent-seeking and entrepreneurship matters for economic growth: countries with relatively more engineering college majors grow faster and countries with relatively more law concentrators grow more slowly. Easterly (2002) argues that education may not have much impact in less developed countries that lack other facilitating factors such as functioning institutions for markets and legal systems. In a similar way, Pritchett (2001, 2006) suggests that due to deficiencies in the institutional environment, cognitive skills might have been applied to socially unproductive activities in many developing countries, rendering the average effect of education on growth across all countries negligible.

On the other hand, Glaeser et al. (2004) argue that institutions themselves may be a function of human capital. They focus on school attainment, but the arguments would carry over to our cognitive skills measures. These issues are currently under debate, and the precise role of institutional structure for long-run growth is surrounded by some uncertainty.

Issues of Endogeneity

Growth modeling is naturally subject to a common concern: do the identified factors represent truly causal influences or mere associations that will not affect growth if altered by policy? Causality is difficult to establish conclusively within the aggregate growth context, but it is possible to rule out the most important alternative hypotheses about the nature of the cognitive skills-growth relationship. Various authors have addressed part of this issue. In a broad analysis of the question, Hanushek and Woessmann (2012) conclude that causation concerns are very different in the case of cognitive skills than with quantity of schooling and are much less likely to be a significant issue in interpreting the results. In simplest terms, by showing that the estimation is robust to major alternative specifications while also not being the result of other hypothesized mechanisms, they provide strong additional support for the validity of a causal interpretation.

One common concern in growth analyses 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, the East Asian countries consistently score very highly on the international tests, and they also had extraordinarily high growth over the past half century. It may be that other aspects of these East Asian economies have driven their growth and that the statistical analysis of labor 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 between growth and test performance. This consistency of results across alternative samples suggests the basic importance of cognitive skills.

Another concern is that other factors that affect growth, such as efficient market organizations, are also associated with efficient and productive schools – so that, again, the test measures might really be a proxy for other attributes of the country. To investigate this, Hanushek and Kimko (2000) and, in an expanded analysis, Hanushek and Woessmann (2012) concentrate on immigrants to the United States who received their education in their home countries. They find that immigrants who were schooled in countries that have higher scores on the international math and science examinations earn more in the United States. On the other hand immigrants receiving their schooling in the United States do not see any earnings advantage linked to the cognitive skills of their home country. This analysis makes allowance for any differences in school attainment, labor market experience, or being native English-language speakers. In other words, skill differences as measured by the international tests are clearly rewarded in the U.S. labor market, reinforcing the validity of the tests as a measure of individual skills and productivity (and also discounting the notion that the economic performance of these immigrants simply reflects the culture and family practices of the immigrants).

It is possible that the observed relationships could simply reflect reverse causality, that is, that countries that are growing rapidly have the added 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, Hanushek and Woessmann (2011) summarize evidence on whether the international math and science test scores were systematically related to the resources devoted to the schools in the years prior to the tests. If anything, however, the results suggest relatively better performance in those countries spending less on their schools.

In perhaps the most stringent test of the relationship of cognitive skills and growth, Hanushek and Woessmann (2012) consider the time-series evidence on test performance within each country to identify the impact of skills on growth. Specifically, countries that improve the skills of their population – no matter how it is done – by the underlying growth model should see commensurate improvements in their rate of growth. Such estimation removes any country-specific fixed effects affecting growth rates – such as basic economic institutions, cultural factors, political environment, and the like – and focuses on whether a country that alters the cognitive skills of its population is observed to receive an economic return.

To do this test, they estimate trends tests scores separately for countries that have taken tests since the early 1980s or before. They similarly estimate country-specific trends in annual growth rates in GDP per capita. Hanushek and Woessmann (2012) show that these two trends are indeed positively related.

One final issue warrants consideration: the United States has never done well on these international assessments, yet its growth rate has been very high for a long period of time. The reconciliation is that quality of the labor 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.

Four factors immediately come to mind as being important in U.S. growth and as potentially masking to detrimental effects of low school quality. First, almost certainly the most important factor sustaining the growth of the U.S. economy is the openness and fluidity of its markets. The United States maintains generally freer labor and product markets than most countries in the world. The government generally has less regulation on firms, and trade unions are less extensive than those in many other countries. Even broader, the United States has generally less intrusion of government in the operation of the economy, including lower tax rates and minimal government production through nationalized industries. These factors encourage investment, permit the rapid development of new products and activities by firms, and allow U.S. 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 (see, e.g., Krueger (1974); World Bank (1993); Parente and Prescott (1994, 1999)).

Second, over the twentieth century, the expansion of the education system in the United States outpaced that around the world. The United States 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 G.I. bill, and direct grants and loans to students. More schooling with less learning each year still yielded more human capital than found in other nations that have less schooling but more learning in each of those years. (This advantage has, however, clearly ended as many OECD countries have expanded schools to exceed the quantity of schooling found in the United States; see Organisation for Economic Co-operation and Development (2013).

Third, the analysis of growth rates across countries emphasizes quality of the primary and secondary schools of the United States. It does not include any measures of the quality of U.S. colleges. By most evaluations, U.S. colleges and universities rank at the very top in the world.[8] A number of models of economic growth in fact emphasize 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 United States appears to have the best programs.

Finally, and consistent with the overall picture above, the United States has been able to attract highly skilled immigrants. Thus, foreign education and training have been substituted for the U.S. development of its own population.

SOME CONCLUSIONS

It is clear that the economic development of countries is fully dependent on having strong economic growth. And for that the human capital of the nation is the key to long-run success.

Confirming this view has, however, been difficult. Early attempts that relied largely on measuring human capital by school attainment proved to be unreliable, with empirical estimates that were very sensitive to model specification and subject to significant interpretive problems.

Recent analysis, based on test-score measures of cognitive skills, has altered the support for the central role of human capital. When appropriately measured, human capital is seen as the dominant pre-requisite of economic growth.

NOTES

1. See, e.g., UNESCO (2014) and Bloom (2006).
2. Hanushek and Woessmann (2008).
3. Psacharopoulos and Patrinos (2004).
4. We use an extended version of the education data by Cohen and Soto (2007), representing the average years of schooling of the population aged 15 to 64. One line of investigation has been the impact of mismeasurement of the quantity of education on growth; the Cohen and Soto (2007) data improved upon the original quantity data by Barro and Lee (1993, 2001). This has recently been further improved by Barro and Lee (2013). Data on real GDP per capita in 1960–2000 comes from version 6.1 of the Penn World Tables by Heston, Summers, and Aten (2002).
5. Added-variable plots show the association between two variables after the influences of other control variables are taken out. The procedure is numerically equivalent to including the other controls in a multivariate regression of the dependent variable (growth) on the independent variable under consideration in the graph.
6. See Hanushek and Woessmann (2012) for details of the test aggregation. The precise scaling on the transformed metric is of course subject to considerable noise, in particular for the early tests and for countries performing far below the international mean. The tests are usually not developed to provide reliable estimates of performance in the tails of the achievement distribution, which would be relevant for very poorly performing countries.
7. See Hanushek and Woessmann (2012, 2015).
8. Ranking colleges and universities is clearly difficult, but the available attempts confirm the position of U.S. research universities. In the 2013 academic rankings of the world's research universities by the Center for World-Class Universities of Shanghai Jiao Tong University, the United States had 17 of the top 20 universities and 53 of the top 100 (see http://www.shanghairanking.com/ARWU2013.html, accessed May 22, 2014). The Times Higher Education World University Rankings placed 15 U.S. universities in the top 20 of the world in 2013–2014 (see http://www.timeshighereducation.co.uk/world-university-rankings/2013-14/world-ranking, accessed May 22, 2014).

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