Higher Test Scores or More Schooling? An Analysis of the Causes of Economic Growth in Countries with Different Levels of Schooling

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Abstract

I use a dynamic augmented Solow model to estimate the effect of international test scores and investment in schooling and tutoring on economic growth rates in 54 countries during 1985-2005. Either test scores or investment in schooling and tutoring can explain growth rates in the full data set, or in countries that had less than eight years of schooling in 1985. In countries with more schooling in 1985, investment in schooling has a small effect and test scores have no effect on growth rates. In the 24 countries with scores above 470, higher scores have no effect on growth rates.

Key Words: Education Expenditures; Human Capital; Test Scores; Tutoring; Economic Growth

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I. Introduction

Over long periods of time, differences in economic growth rates lead to large differences in national output and income. Analyses of the effect of human capital on national income and growth rates using aggregate cross-country data are valuable because they estimate the external as well as the direct effects of human capital [Krueger and Lindahl, 2001]. Until recently, the cross-country growth literature used school enrollment rates to represent the flow and average years of schooling of the adult population to represent the stock of human capital in an economy.

In a series of recent articles, Hanushek and Kimko [2000] (hereafter HK) and Hanushek and Woessmann [2008, 2011a, 2011b, 2012a, and 2012b] have used an innovative measure of human capital, students' average scores on international tests, to estimate the effect of human capital on rates of economic growth. They argue that average test scores provide a much more accurate measure of a nation's human capital than adults' average years of schooling attainment (hereafter schooling attainment).

In all of their articles, Hanushek and Woessmann (hereafter HW) compare the effect of test scores and schooling attainment on growth rates and obtain similar results. HW [2008 and 2012b] show that over the period 1960-2000 average test scores explain three times the variation in growth explained by schooling attainment (73% vs. 25%). They also show that when test scores and schooling attainment are included in the same model, test scores explain <u>all</u> of the variation in growth. They conclude from these results that higher cognitive skills at ages 9 to 15 cause growth and more schooling often does not.

Breton [2011] challenges the validity of these results. He argues that HW's [2008] comparison of the effect of test scores and schooling on growth rates is flawed. Since HW

[2011a, 2011b, 2012a, and 2012b] and HW [2008] use the same methodology to estimate the effect of these measures, his criticism is applicable to the more recent analyses as well.

The most evident flaw in the methodology is that HW compare the effect of students' test scores from 1964-2003, and primarily from 1990-2003, to the effect of adults' schooling attainment in 1960. These two measures are not remotely comparable. Due to the lag between the testing of the students and their entry into the work force, average test scores from 1964-2003 are a proxy for a country's human capital in about 2010, or 50 years later than adults' schooling attainment in 1960. The average scores from 1990-2003 are a proxy for a country's human capital around 2020.[1]

The less evident flaw in the methodology is that the growth model is mis-specified. Hanushek and Kimko [2000] claim the model is an endogenous growth model, but it includes initial income, which is included in dynamic neoclassical growth models to control for conditional convergence. The empirical results in HK [2000] and in HW [2008, 2011a, 2012a, and 2012b] support the lagged income variable and reject the initial level of schooling. HW [2012a] include the initial level of physical capital in the model, and this variable also is rejected. So all of their results implicitly reject the endogenous growth model and accept the neoclassical growth model.

In the dynamic neoclassical growth model, the capital variables are the *flow* of capital into the economy during the growth period, not the initial capital stock [Breton, 2011]. The implication is that in the HK/HW model, students' average test scores at ages 9 to 15 during

[1] HW [2008] argue that students' average test scores during 1964-2003 or from 1990-2003 are a proxy for the cognitive skills of the work force during 1960-2000, under the assumption that the students' skills did not change over the 1960-2000 period. Breton [2011] points out two flaws in this argument. First, HW's data for developed countries shows a rising trend in scores over the period. Second, the work force in 1960 was schooled during 1910-1955, not during 1960-2000.

1964-2003 represent the flow of human capital into the economy during 1970-2010, or about 6-7 years after the testing period. The comparable schooling measure is the average rate of enrollment or the rate of investment in schooling during 1964-2003, not the schooling attainment of adults in 1960. Their model also lacks an analogous flow of physical capital into the economy. As a consequence, HK/HW's growth model is seriously mis-specified, and their estimates of the effects of test scores and schooling on growth are likely to be severely biased.

In this paper I re-examine whether higher tests scores or more schooling cause growth, using a dynamic augmented Solow growth model, comparable measures for test scores and investment in schooling, and data for these measures that are appropriate for the period of estimation. I also examine whether private tutoring affects growth and whether there are nonlinearities in the education-growth relationship that lead to different results in the complete data set than in subsets of countries with different levels of schooling.[2] As far as I know, these analyses have not been performed in the existing empirical literature.

I begin my analysis by examining the quantitative relationships between three measures of a nation's human capital stock: adults' schooling attainment, the financial stock of human capital/adult, and students' average test scores. I examine the relationship between stocks rather than flows because the data on stocks are more reliable and stocks measure the cumulative effect of flows over a long period.

I show that while these three measures are correlated, they have very different patterns across countries, which suggests that they quantify different aspects of a nation's human capital. The measures increase together in countries with relatively little schooling, but test scores

[2] Castelló-Clement [2010] finds evidence that human capital inequality affects rates of investment in human capital differently in high and low income countries.

stabilize once countries have more than nine years of schooling attainment or have invested more than $100,000/adult (2005 US$) in schooling.

Subsequently, I estimate the effects of higher test scores and more investment in schooling on growth rates, using Mankiw, Romer, and Weil's [1992] (hereafter MRW) dynamic version of the augmented Solow model. This model has a structure that is compatible with HW's test score data and their empirical results, and the validity of this model is supported by considerable recent empirical evidence [Cohen and Soto, 2007, Ding and Knight, 2009, Breton, 2010, 2013a, and 2013b, and Gennaioli, La Porta, Lopez-de-Silanes, and Shleifer, 2013].[3] Since the MRW model is a well-defined structural model, the nature, the form, and the vintage of the data required for its estimation are clearly specified. Since most of HW's test scores for less-educated countries were obtained after 1990, I estimate the growth model over the 1985-2005 period to ensure consistency with the vintage of their data.

I confirm HW's findings that average test scores explain cross-country growth rates quite well in the complete sample of countries. But I find that investment in schooling (and private tutoring) also explain growth rates quite well, although not quite as well as test scores. In both models the estimated parameters for the augmented Solow model are consistent with theoretical expectations and with estimates in other cross-country studies. These results reject HK's [2000] and HW's [2008, 2011a, 2011b, 2012a, and 2012b] findings that more schooling is not reliably correlated with growth. I also use an instrument for test scores and investment in schooling, and the results provide evidence that investment in schooling causes growth.

Perhaps more importantly, when I analyze the effect of higher test scores and more investment in schooling in countries with different levels of schooling, I find that these measures

[3] Breton [2013b] challenges Klenow and Rodriguez-Clare's [1997] and Hall and Jones' [1999] arguments that MRW's empirical results overestimate the effect of schooling on national output.

only explain growth rates well in countries with relatively low levels of schooling and test scores. Average test scores cannot explain growth rates during 1985-2005 in countries that had more than eight years of schooling attainment in 1985 or in countries that had average test scores over 470. These results call into question HW's [2011b] claim that raising students' test scores at ages 9 to 15 is an attractive growth strategy for OECD countries. In contrast, investment in schooling can explain growth rates in countries with more than eight years of schooling, but its estimated effect is smaller than in countries with less schooling.

The paper is organized as follows: Section II examines the quantitative relationship between the various measures of human capital. Section III presents the growth model used in the analysis, Section IV describes the data used in this analysis. Section V presents the results. Section VI concludes.

II. Measures of Human Capital

A country's human capital is analogous to its physical capital, but much more difficult to measure. A large fraction of human capital is created through the formal schooling process, particularly in higher-income countries, but human capital is also created in informal settings, such as in the home or on the job. Expenditures on formal schooling or on tutoring can be measured, but historically such data have not been collected as carefully or as regularly as expenditures on physical capital. The earnings that students forego while in school are an additional, unmeasured investment in schooling. And some kinds of schooling are an element of consumption rather than an investment in productive capital.[4] Due to all of these complications, estimates of a country's rate of investment in human capital or of its human capital stock inherently have more measurement error than analogous estimates for physical capital.

[4] The U.N. system of National Accounts classifies education as an element of consumption.

Economists have come to use adults' average years of schooling attainment as a proxy for a country's human capital because it is the only quantitative measure of workers' capability available across countries for long historic periods. Despite its limitations, this measure has acquired legitimacy because the effect of an additional year of schooling on workers' incomes (the Mincerian return) is relatively consistent across countries. Typically an additional year of schooling raises a worker's income by about 10 percent [Psacharopoulos and Patrinos, 2004]. HK and HW accept the legitimacy of academic learning as a measure of human capital, but they criticize analyses based on average schooling attainment, claiming that they erroneously assume that a year of schooling represents the same amount of human capital in every country. For example, they assert,

> "Average years of schooling is a particularly incomplete and potentially misleading measure of education for comparing the impacts of human capital on the economies of different countries. It implicitly assumes that a year of schooling delivers the same increase in knowledge and skills regardless of the education system."[5]

They also assert,

> "…all analyses using average years of schooling as the human capital measure implicitly assume that a year of schooling delivers the same increase in knowledge and skills regardless of the educational system. For example, a year of schooling in Peru is assumed to create the same increase in productive capacity as a year of schooling in Japan."[6]

[5] Hanushek and Woessmann, 2011b, P. 433.
[6] Hanushek and Woessmann, 2012b, P. 269.

These characterizations unfairly denigrate the schooling attainment measure and mischaracterize the analyses that use it to estimate the effect of schooling on national income. Virtually all cross-country analyses of national income or economic growth use the Mincerian log-linear relationship between income and schooling attainment. In this relationship each additional year of schooling implicitly raises human capital by an *exponential* amount, so a year of schooling provides much more education in countries with higher average schooling attainment, like Japan, than in countries with lower average schooling attainment, like Peru.

In addition, while the schooling attainment measure does not explicitly account for schooling quality, cross-country analyses of the effect of schooling attainment on income or growth implicitly include the effect of differences in quality that are correlated with a country's level of attainment. Since national income rises with schooling attainment and countries invest more in schools as income rises, schooling quality is positively related to schooling attainment [Breton, 2011].

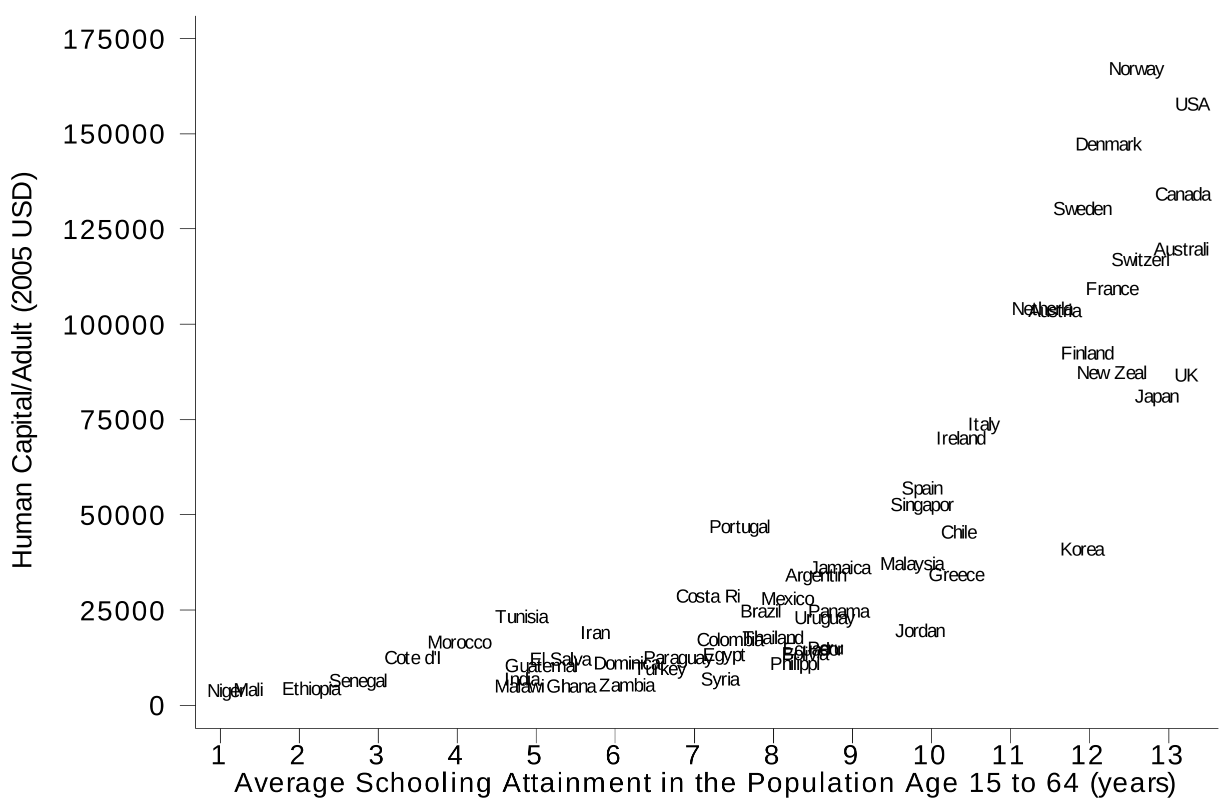
The main weakness in these analyses is that most of them implicitly assume that a year of schooling has the same quality in countries that have the <u>same</u> schooling attainment, e.g., in Australia and Canada. Arguably though, this assumption is not so unreasonable since countries with the same schooling attainment often do have a similar level of schooling quality.

One indicator of how much schooling quality might vary in countries with the same schooling attainment is the variation in cumulative investment in schooling per adult in countries with the <u>same</u> average schooling attainment. Countries that invest more in each year of schooling are more likely to provide higher quality schooling. The cumulative investment measure could capture differences in schooling quality to a greater degree than the average attainment measure, although differences in investment are also a result of institutional characteristics that are not related to schooling quality.

Figure 1 shows the relationship in 2005 between Breton's [2013c] estimates of the financial stock of human capital per adult of working age and Cohen and Soto's [2007] estimates of the schooling attainment of the population age 15 to 64.[7] Breton's measure of human capital is analogous to the standard financial measure of the stock of physical capital. It is created from the sum of the prior 40 years of investment in schooling and a depreciation rate of 2.5%/year. Since the investment is calculated from national income in Penn World Table 6.3 [Heston,

Figure 1

Human Capital/Adult vs. Average Schooling Attainment in 2005



[7] The estimates of average schooling attainment in 2005 are the average of schooling attainment in 2000 and 2010.

Summers, and Aten, 2009], the estimates of the stocks of human capital in the figure are adjusted for purchasing power differences across countries.

The data in the figure provide clear evidence that the relationship between schooling attainment and the financial stock of human capital is exponential. These data show that countries with two years of schooling in 2005 had invested about $2,000/adult. Countries with 13 years of schooling had invested about $130,000/adult, *or ten times as much* per year of schooling. The data also indicate that across countries there is a consistent tendency for investment per year of schooling to rise as average schooling attainment rises.

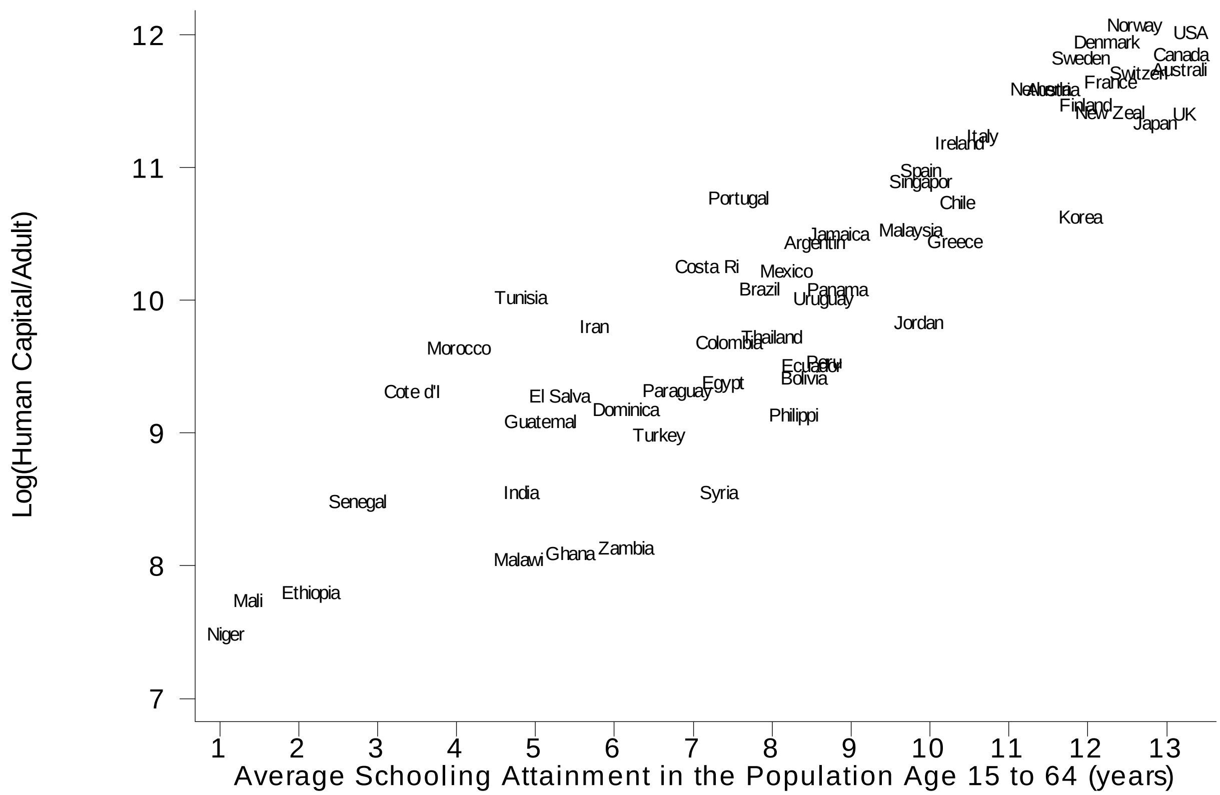
South Korea, Japan, and the UK, appear to have invested less per year of schooling than other highly-educated countries, but their investment in schooling does not include their expenditures on private tutoring, which are substantial [Dang and Rogers, 2008]. As will be addressed later, stocks or flows of human capital calculated from investment in schooling are underestimated in countries that spend considerable amounts on private tutoring.

Figure 2 shows the relationship between log(human capital/adult) and average schooling attainment. This relationship is clearly linear, and the two data sets are highly correlated (ρ = 0.91). If a nation's cumulative investment in schooling accounts for the quality of its schooling, then the very high correlation between the log of human capital/adult and average schooling attainment indicates that a log-linear relationship between income and average schooling implicitly accounts for the higher average quality of schooling in more educated countries.

But as shown in the figure, the differences in human capital/adult can be quite large in countries with the same average schooling attainment, and the range is particularly wide in countries in which average schooling attainment is between four and nine years. These data suggest that the quality of schooling is much higher in Argentina than in the Philippines and much higher in Costa Rica than in Syria.

Figure 2

Log(Human Capital/Adult) vs. Average Schooling Attainment in 2005



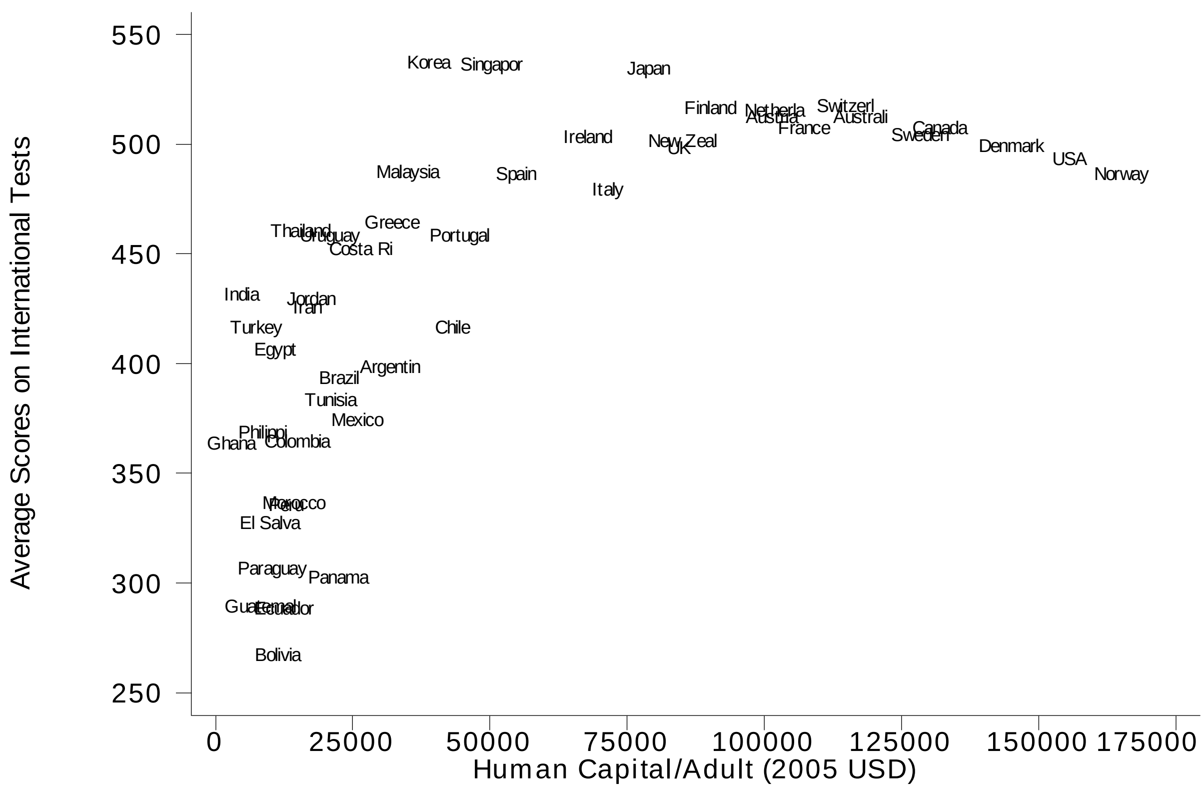
Breton [2013b] estimates MRW's static version of the augmented Solow model across countries in 1990 using the financial stock of human capital/adult and schooling attainment. Both measures explain the variation in national income quite well, but the financial measure explains more of the variation, suggesting that across countries it accounts for differences in schooling quality somewhat better than the schooling attainment measure.

HW [2008] assert that average test scores in science and mathematics at ages 9 to 15 provide a better measure of a nation's human capital than schooling attainment. Breton's [2011] empirical results challenge their assertion, since in his analysis average schooling attainment explains cross-country differences in national income in 2000 somewhat better than average test scores. However, given the vintage of most of HW's test scores, they might have provided a better explanation of the variation in national income than average schooling attainment if the comparison of the two measures could have been made in 2010 or later.

If the financial stock of human capital/adult is a more accurate measure of human capital than average schooling attainment, then it could be a more accurate measure of human capital than average test scores, particularly in countries with high average levels of schooling. Figure 3

Figure 3

HW's Average Test Scores vs. Human Capital/Adult in 2005

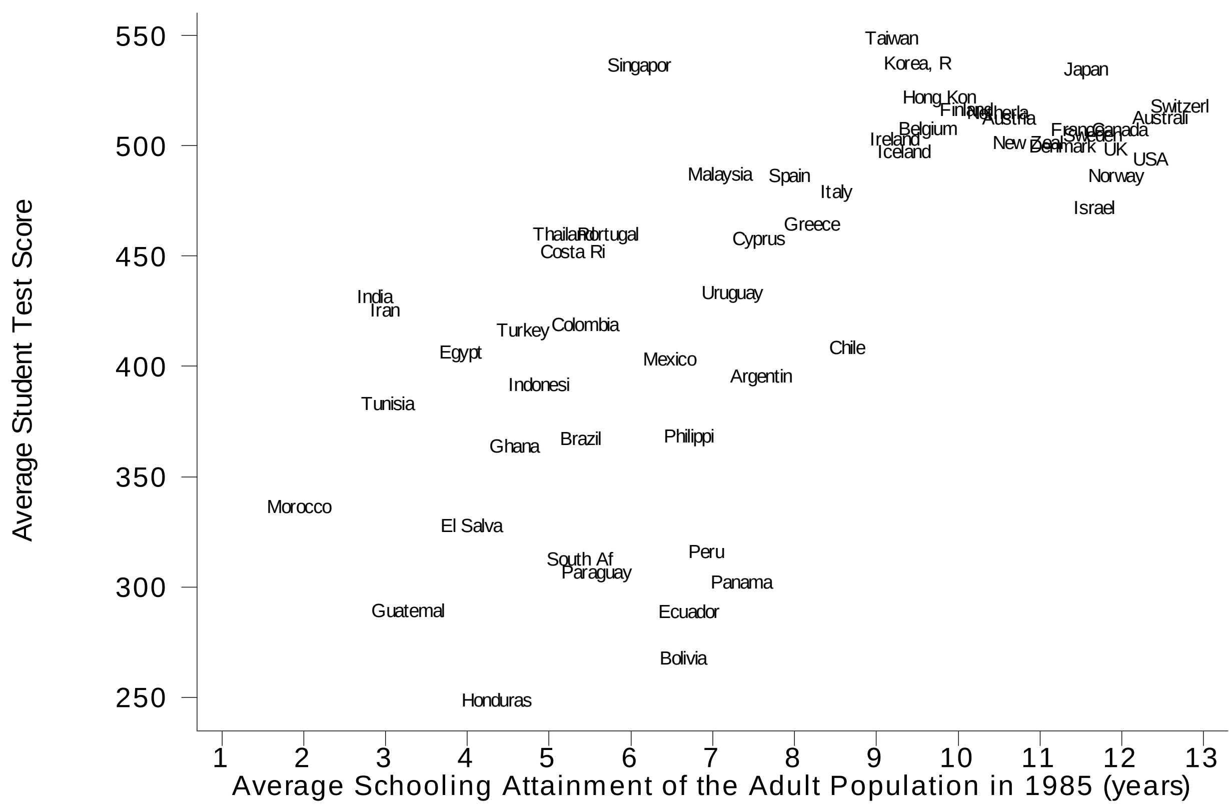


shows the relationship between HW's measure of average test scores and the financial stock of human capital/adult in 2005 in 46 countries. These two measures are correlated (ρ = 0.70), but the mathematical relationship between them is not linear or log-linear. The data show that average test scores at ages 9 to 15 rise as countries raise their investment in human capital/adult, but only up to about $100,000/adult (2005 USD). Beyond that level of investment, average scores tend to decline, although not by a substantial amount.

Figure 4 shows the relationship between HW´s measure of a students' average test scores obtained over the period 1964 to 2006 and the average schooling attainment of the adult population in 1985, the mid-point of the testing period. Average scores on international tests at

Figure 4

Average Student Test Score vs. Average Schooling Attainment in 1985



ages 9 to 15 increase across countries as the average schooling of the population age 15 to 64 rises to a level of about nine years and then scores stabilize at a mean of about 500.

These patterns suggest that a nation's average test scores at ages 9 to 15 and its average schooling attainment are measuring different aspects of its human capital. Average test scores measure students' competence in basic skills, while schooling attainment and the financial stock of human capital measure the overall educational level of the adult population. These measures rise together in countries with limited post-secondary schooling, but they diverge in more educated countries. The data in Figures 3 and 4 demonstrate that the test score measure cannot discern the differences in human capital in countries with widely differing levels of post-secondary schooling.

The test score measure also has limitations in countries where many students do not complete secondary schooling. In these countries average test scores are not representative of the skills of the entire school-age population. As an example, in HW's data India has relatively high average scores, but in the testing period its secondary school enrollment rate was under 50% [World Bank, 2013]. As a consequence, India's average test scores overestimate the skills of the school-age population. Although there is no way to eliminate this measurement error in countries with low enrollment rates, it can be minimized by using HW's average test scores to estimate growth during the latest possible period when a larger share of the school-age population attended secondary school.

These patterns in the data suggest that students' cognitive skills at ages 9 to 15 are an important component of human capital, but that they are an incomplete measure in countries with a financial stock of human capital/adult above $100,000, or with more than nine years of average schooling attainment. As a consequence, test scores may not be a sufficiently accurate measure to permit estimation of the effect of human capital on national income or on economic growth in the more educated countries. Since all measures of human capital have their limitations, which measure best represents cross-country human capital is an empirical issue that can only be determined in a properly-specified income or growth model.

III. Growth Model Specification

In this analysis I utilize MRW's augmented Solow model to compare the effect of higher test scores and more investment in schooling on national output:

1) $(Y/L)_t = (K/L)_t^{\,\alpha} (H/L)_t^{\,\beta} (A_0\, e^{gt})^{1-\alpha-\beta}$

In this model output (Y) changes in response to changes in physical capital (K), human capital (H), labor (L), and total factor productivity (A), which is assumed to grow at a constant rate g. Breton [2013b] shows that when H/L is defined as the financial stock of human capital/adult, $\beta = 0.36$ and $\alpha + \beta = 0.7$. His results support MRW's assumption that $\alpha + \beta < 1$, and they are consistent with MRW's results, in which human capital has large external effects on national income.

MRW derive a dynamic version of their model, in which economic growth is modeled as convergence to the steady state $y_t = y^*$, where $y_t = Y/(e^{gt}\, L)$:

2) $\log(y_t) - \log(y_0) = (1-e^{-\lambda t}) \log(y^*) - (1-e^{-\lambda t}) \log(y_0)$

They show that y* is a function of the shares of GDP invested in physical and human capital (s_k and s_h), the labor growth rate (n), and the capital depreciation rates (δ_k and δ_h):

3) $y^* = \alpha/(1-\alpha-\beta)\ [\log (s_k)/(n + g + \delta_k)] + \beta/(1-\alpha-\beta)\ [\log (s_h)/(n + g + \delta_h)]$

Substitution of equation (3) into equation (2) and rearrangement creates a growth model, which contains a lagged income variable, similar to the variable in the HK and HW analyses:

4) $\log(Y/L)_t - \log(Y/L)_0 = c + (1-e^{-\lambda t}) (\alpha/(1-\alpha-\beta) [\log (s_k)/(n+g+\delta_k)] + (1-e^{-\lambda t}) \beta/(1-\alpha-\beta) [\log (s_h)/(n+g+\delta_h)] - (1-e^{-\lambda t}) \log(Y/L)_0 + \varepsilon$

When this model is estimated over a period 0 to t, s_k, s_h, and n are the average of these rates during the growth period. The shares of investment s_k and s_h measure the *flow* of physical and human capital resources into the economy during this period.

The average test score for a cohort of students age 9 to 15 can be employed as a measure of the human capital flowing into the economy in each country 5-10 years later. HW's [2012b] data for average test scores are based on international tests taken between 1964 and 2003, but as described below, most of the scores in the less-educated countries were obtained between 1990 and 2003. As a consequence, HW's average test scores for developed countries are representative of the flow of human capital in about 1990, while most of their international test scores for developing countries are representative of the flow of human capital into the work force after 1995.

Since at least twenty years is required for a growth analysis, I estimate MRW's growth model over the 1985-2005 period. This period corresponds relatively well to the period when most of the test scores were obtained and certainly much better than the 1960-2000 period that HW use in their analyses. The test scores also are more representative of the flow of human capital in the less-educated countries in the later period because a much higher fraction of students remained in school until age 15 in these countries in 1985 than in 1960. As a consequence, there is less measurement error in HW's test score measure when it is used to explain growth during 1985-2005 than when it is used to explain growth during 1960-2000.

For average investment in schooling (s_h) during 1985-2005, I use average rates of investment in schooling during 1980-2000, adjusted for the higher implicit financing cost in countries with longer periods of schooling. I use an investment period that is five years earlier than the growth period to account for the delay between the expenditures on students' schooling and the entry of these students into the work force.[8]

As mentioned earlier, a limitation of this measure of investment is that some countries expend considerable resources on private tutoring to improve students' cognitive skills. Since rates of investment in schooling do not include these expenditures, they underestimate the rate of investment in human capital in these countries, and as shown in the empirical results, the failure to include these expenditures in the growth model seriously biases the estimated effect of investment in schooling. Since cross-country times-series data on expenditures on tutoring are not available, I control for the effect of tutoring by including a dummy variable for countries with high expenditures on tutoring.

Figure 5 shows the relationship between the growth rate over the 1985-2005 period and the average test score for the 54 countries in the data set. The scores exhibit regional patterns that could indicate that unknown factors affected growth rates. Average test scores are relatively high in the Asian countries and relatively low in the Latin American countries. I include dummy variables for these regions in some models to control for possible omitted variables.

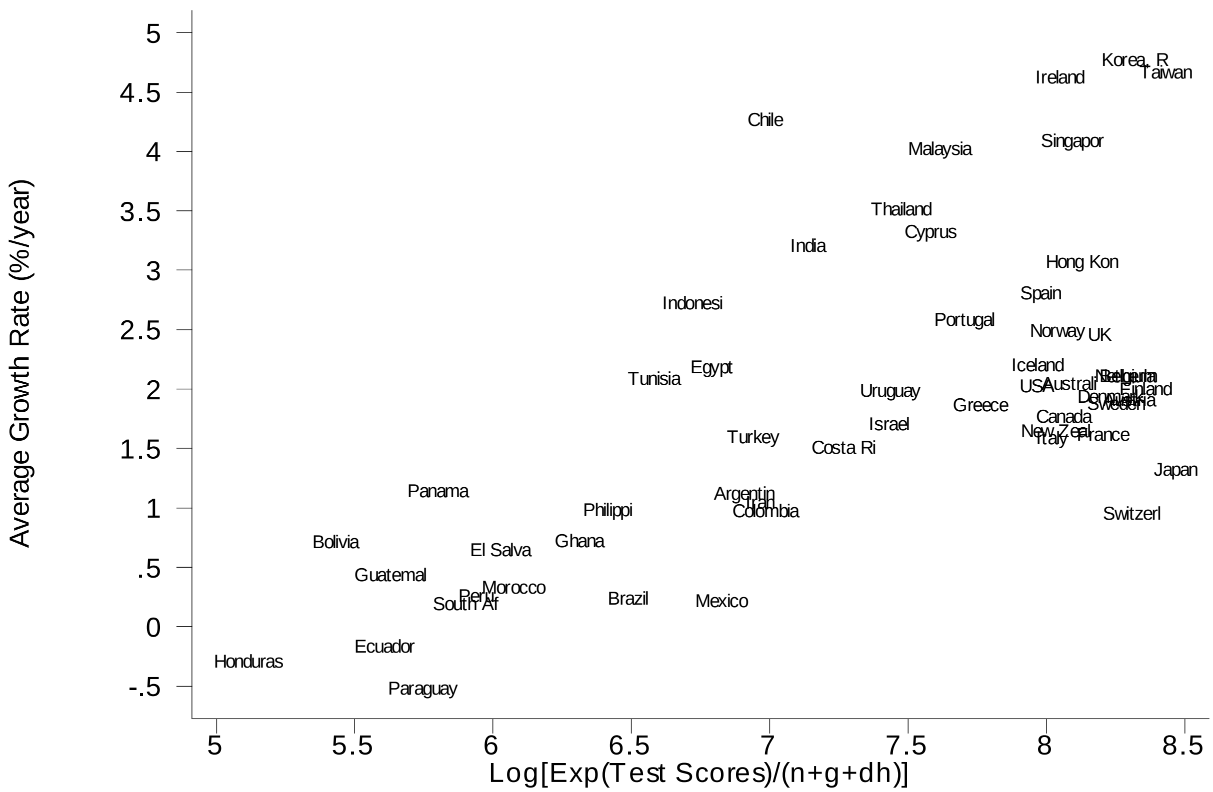
The human capital flows in the growth model could be endogenous. I use adults' average schooling attainment in 1980 as an instrument for average test scores and for investment in schooling to control for potential endogeneity. Average attainment in 1980 is positively correlated with schooling expenditures during 1980-2000 and with average test scores. The rationale for this instrument is that parents' level of schooling has a positive effect on student achievement and on investment in their children's schooling. Juerges and Schneider [2004] and

[8] Five years is a reasonable average lag from a financial standpoint since unit schooling costs rise with the level of schooling and the delay between expenditures and entry into the work force is shorter at higher levels of schooling.

Parcel and Dufur [2009] document the positive effect of parental education on students' test scores in mathematics and reading skills.

Figure 5

Economic Growth Rates vs. Test Scores in the Growth Model



Average attainment in 1980 is a valid instrument for investment in schooling or for test scores because it does not have a direct effect on growth rates during 1985-2005. MRW's growth model controls for the initial level of output in 1985 and, therefore, implicitly controls for the level of schooling attainment in 1985. There is no reason to expect that schooling attainment at an earlier time would have any effect on growth rates during 1985-2005 once the level of attainment in 1985 is taken into account.

III. Data Creation and Selection

MRW's growth model assumes that investment in physical capital and human capital, growth in workers, and the initial level of income are the only factors that affect growth. The model also assumes that factors of production are paid their marginal products. Countries with centrally-planned economies, with income largely determined by oil exports, with serious civil conflicts, or that are tax havens have factors affecting income and growth rates that are not included in the model. These countries are likely to be outliers in the model's growth-investment relationships. Particularly in estimates of the model with small data samples, these outliers can substantially bias the estimated coefficients and reduce their statistical significance. Nevertheless, given the very limited number of countries with data for average test scores and rates of investment in schooling, I include any countries in the data set that remotely meet the model's assumptions and subsequently address estimation problems due to outliers.

HW [2012b] provide international test score data for 50 countries. HW [2012a] provide scores for an additional nine Latin American countries created from regional tests. I began with these 59 countries and excluded five because their growth rates during 1985-2005 were not caused primarily by the variables in the model. I excluded China and Romania because they were not market economies at the beginning of the period.[9] I excluded Venezuela because its growth rate was heavily affected by rising oil prices. I excluded Zimbabwe and Jordan because GDP/adult declined dramatically in both countries due to non-economic factors.[10] So the estimates of the effect of test scores on growth are based on the scores in the remaining 54 countries.

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[9] China's average test scores correspond to tests taken in Shanghai, which is a relatively educated region.
[10] About half of Jordan's population resided in refugee camps during the growth period.

HW's international test scores are the simple arithmetic average of any available scores on tests of mathematics and science for students between 9 and 15 during the 1964-2003 period. The age distribution of the students tested may be different in each country, but they argue that this is not a serious problem because scores on different tests within the same country are highly correlated [HW, 2008 and 2012b]. The students participating in international tests are supposed to be a representative sample of the school population, but this is not always the case, particularly in the developing countries who are not regular participants in these tests.[11]

Since the international tests began as a means to compare students' skills in the more developed countries, there are few scores for developing countries prior to 1990. Most of the scores for developing countries and a majority of the scores for the developed countries were obtained during 1990-2003, toward the end of the 1964-2003 period.[12]

HW [2012a] create average test scores for 16 Latin American countries from regional tests of mathematics and reading skills in 4th and 6th grade given between 1997 and 2006. They use these scores to add nine Latin American countries to their international test score data set. The scores for these countries are less reliable, since the regional scores correspond to tests of different subjects, correspond to a later period, and had to be adjusted to merge them with the international scores. I estimate the effect of HW's average test scores on growth with and without the scores from these nine countries to confirm that their inclusion does not bias the results.

The shares of GDP invested in physical capital and human capital are conceptually identical in the growth model, but developing estimates of the investment rate for human capital

[11] HW [2011a] present empirical results showing that sample selectivity problems have not unduly biased their results.
[12] Figure 6 in HW [2008] shows the countries that participated in each of the tests that were used to calculate the average scores. The figure shows that few developing countries participated in the tests prior to 1990.

is much more difficult. Time series data on the investment/GDP ratio in non-OECD countries are only available for public schooling and are intermittent or unreliable in many countries. In addition, there is a considerable lag between the investment in a student's schooling and the student's entry into the work force. This lag varies across countries, depending on the amount of schooling provided, the structure of the economy, and practices related to child employment. As a consequence, the rate of investment in schooling does not affect economic growth rates until years later, and the total investment in schooling implicitly is increased by the opportunity cost of capital during this lag.

Breton [2013b] estimates human capital/adult in 1990 for 61 market economies from the shares of GDP invested in schooling from 1950 to 1985, using UNESCO data on expenditures for public education (% of GDP), increased by factors to account for private schooling, the opportunity cost of capital while students are in school, and students' foregone earnings. He assumes that there is a five-year lag between a country's investment in schooling and the flow of this investment into the economy. While the average lag is longer for students in more-educated countries, the financially-weighted lag is about five years because schooling unit costs are much higher in the later years of schooling.

I use the data elements from Breton [2013b] to calculate the average rate of investment in schooling over the 1980-2000 period, but with additional UNESCO data on expenditures in public education for the period 1990-2000.[13] I assume the annual opportunity cost of invested capital is 8 percent real, based on Caselli and Feyrer's [2007] estimates of the marginal product of reproducible physical capital across countries in 1996.[14] I estimate the total cost of invested

[13] I use the investment/GDP ratio in 1980, 1985, 1990, 1995, and 2000 to estimate the average ratio in each five-year period and then average these four ratios to obtain the 20-year average.
[14] They find that the MPK is similar across countries after adjusting for differences in purchasing power.

capital in each country using data on the amount of schooling by level of schooling in Cohen and Soto's [2007] data.

HW's [2012a and 2012b] data provide test scores for 48 of the 61 countries in Breton's data set. After excluding Zimbabwe and Jordan, the sample with data for test scores and investment rates is reduced to 46 countries. These countries provide the basis for the comparison of the effect of average test scores and investment in schooling in the growth model.

Dang and Rogers [2008] present information on the extent of private tutoring across countries. I include a dummy variable for tutoring expenditures in the eight countries[15] that appear to have particularly high annual expenditures.

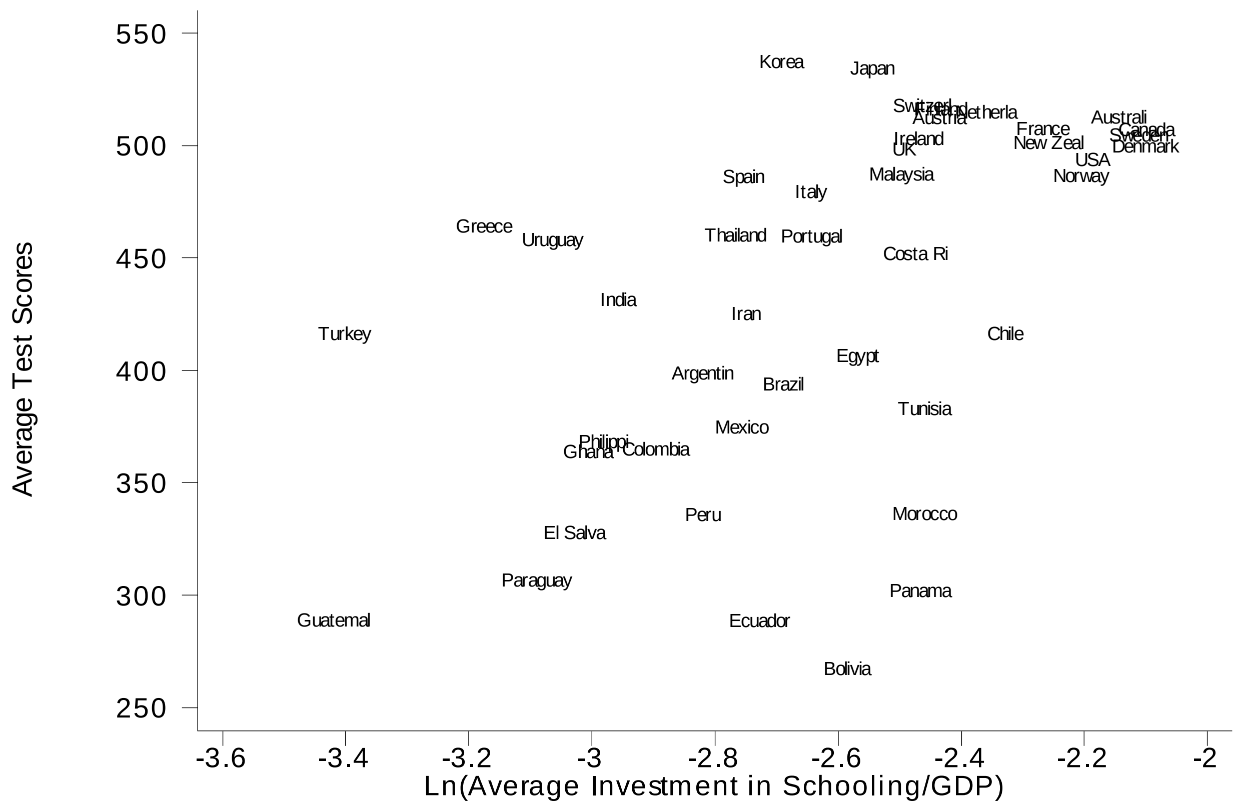
I use Cohen and Soto's [2007] data on average schooling attainment in the population age 15 to 64 in 1980 as an instrument, and I use an estimate of average attainment in 1985 to separate the countries into subsets with low and high levels of schooling at the beginning of the growth period. Four of the 54 countries with test score data are not included in Cohen and Soto's average schooling attainment data.[16] I estimate average attainment for these countries from Barro and Lee's [2010] data on average attainment in the population over 15, using the econometric relationship between the two data sets.

Figure 6 shows the relationship between average test scores and $\log(s_h)$ in 2005. Although the correlation between these two data sets is not very high, the pattern in the data indicates that the relationship between investment in schooling and average test scores could be log-linear. I represent $\log(s_h)$ in equation (4) by the average test score rather than by the log of the average test score because it provides better results. HW [2012a] use a linear-exponential relationship between growth rates and test scores in their analyses for the same reason.

[15] Egypt, Greece, Hong Kong, Japan, South Korea, Singapore, Turkey, and UK.
[16] Hong Kong, Iceland, Israel, and Taiwan.

Figure 6

Average Test Score vs. Log(Investment in Schooling/GDP) in 1980-2000



I use economic data from Penn World Table (PWT) 6.3 [Heston, Summers, and Aten, 2009] in the analysis. I use adults as the proxy for workers and estimate the number of adults from GDP/capita (rgdpch) and GDP/equivalent adult (rgdpqa). I then calculate n from the growth in the adult population over the 1985-2005 period. I assume $g = 0.01$, $\delta_h = 0.025$, and $\delta_k = 0.06$. The rate g is the average rate derived from the Solow residual during 1910-2000 estimated in Breton [2013a]. The depreciation rate for human capital is based on a 40-year work life, as described in Breton [2013b]. The depreciation rate for physical capital is from Caselli [2005]. I use the average investment rate (ci) over the period 1985-2004 as the investment share s_k during the growth period. The data used in the models are shown in the Appendix.

IV. Empirical Results

Table 1 presents OLS estimates of the growth model and shows the implied values of α, β, and λ in the estimated coefficients. The mathematical structure of the MRW model implies that α and β are the shares of national income that accrue to the stock of physical capital (K) and human capital (H), and the speed of income convergence is mathematically related to the values of α, β, n, g, δ_k and δ_h [MRW, 1992]. One of the desirable features of the MRW model relative to unstructured models, such as those specified by HW, is that the validity of the MRW model can be evaluated based on whether the estimated parameters of the model are consistent with its theoretical predictions.

Table 1
OLS Effect of Human Capital Measures on Growth Rates 1985-2005
[Dependent variable is Δlog(GDP/adult)]

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Countries	54	46	46***	46	44	46	44	46	44
	Test Scores			**Investment/GDP**				**Both**	
$Ln(s_k/(n+g+\delta_k))$	0.20* (.08)	0.22* (.10)	0.28** (.09)	0.51** (.10)	0.48** (.09)	0.46** (.07)	0.46** (.07)	0.31** (.08)	0.31** (.08)
$Ln(s_h/(n+g+\delta_h))$				0.21* (.10)	0.33** (.07)	0.30** (.07)	0.37** (.07)	0.13 (.09)	0.21* (.09)
Tutoring dummy						0.22** (.08)	0.15* (.07)	0.11 (.08)	0.05 (.08)
$Ln(ExpTest/(n+g+\delta_h))$	0.25** (.03)	0.24** (.06)	0.22** (.03)					0.18** (.05)	0.16** (.05)
Ln(Y/L-1985)	-0.28** (.04)	-0.28** (.05)	-0.30** (.04	-0.29** (.08)	-0.37** (.06)	-0.32** (.06)	-0.37** (.06)	-0.34** (.06)	-0.37** (.06)
R^2	.63	.53	.60	.42	.51	.52	.55	.62	.64
Implied α	.27	.30	.35	.50	.41	.43	.38	.32	.30
Implied β	.34	.33	.27	.21	.28	.28	.31	.32	.35
Implied λ	.016	.016	.018	.017	.023	.019	.023	.021	.023

*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.
***Same 46 countries as in columns 4, 6, and 8.

Note: Robust standard errors in parentheses

The first three columns in the table present the model's results with the test score data. Column 1 shows the effect of test scores using the expanded HW data set, including the scores created from regional tests in Latin America. Column 2 shows the effect using only the international test scores. Column 3 shows the effect for the 46 countries in the models for investment in schooling shown in columns 4-7 to facilitate the comparison of the statistical results for the two measures.

The estimated coefficients for all the models with the test score measures are similar, have estimated coefficients that are highly statistically significant, and provide estimated parameters for the effect of physical capital, human capital, and the rate of convergence that are consistent with expectations for the MRW model. The implied values of α in the three models range from 0.27 to 0.35, which are consistent with Bernanke and Gurkaynak's [2001] and Gollin's [2002] estimates of the share of national income accruing to physical capital, which are about 0.35 across countries. The implied values of β range from 0.27 to 0.34, which are consistent with Breton's [2013b] estimates. The implied values of λ, the rate of convergence to the steady state, range from 0.016 to 0.018, which are consistent with expectations [MRW, 1992]. Although not shown, all of the parameter values are statistically significant at the one percent level. Since the estimated coefficients are similar with the international test score data and the expanded test score data, I use the expanded test score data for all the subsequent analyses.

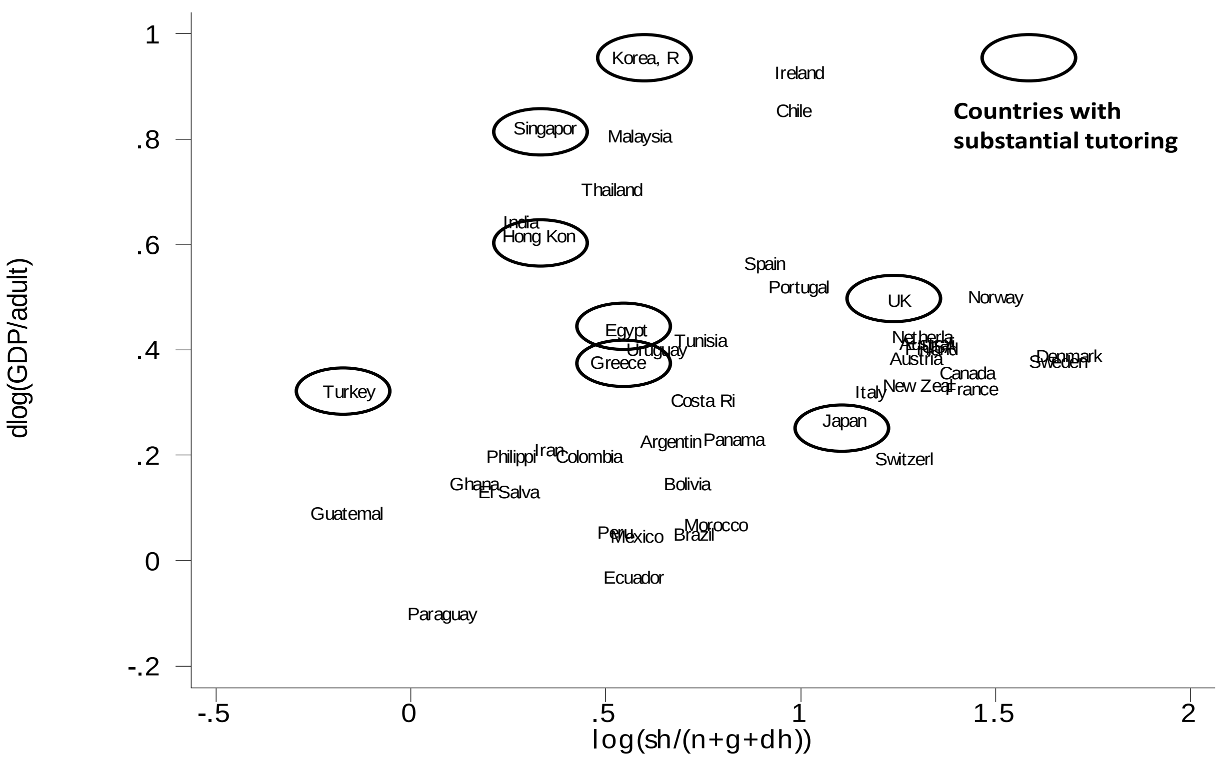
Columns 4 to 7 present the OLS estimates of the effects of investment in schooling and private tutoring on growth rates. Two data samples are shown: the complete 46-country data set and a data set with 44 countries that excludes Hong Kong and Singapore. The results in columns 4 and 5 show that investment in schooling has an effect on growth that is larger and more statistically significant in the 44-country sample than in the 46-country sample. The results with these two samples are different because Hong Kong and Singapore are outliers, in that they have high economic growth rates but relatively low rates of investment in schooling. Hong Kong became a Special Administrative Region of China in 1997, with additional legal protection for private investment destined for mainland China. Singapore is considered a tax haven. So the high growth rates in these jurisdictions may be due in part to the reporting of income that is earned elsewhere. But Hong Kong and Singapore also have very high average test scores, which appear to be related to their reliance on private tutoring to supplement student learning in school.

Figure 7 shows the relationship between the economic growth variable and the investment in schooling variable [$\log(sh/(n+g+\delta h))$] in the model. Some of the countries in this figure appear to be outliers, in that they have high growth rates and relatively low values for the this schooling variable relative to the growth in the adult population. Some of these countries supplement their investment in schooling with substantial expenditures on private tutoring. These countries are circled in the figure.

Columns 6 and 7 show the effect of investment in schooling when a dummy variable is included to control for these tutoring expenditures. The effect of tutoring is statistically significant in both samples, but the effect is larger and more statistically significant in the sample that includes Hong Kong and Singapore. With the tutoring dummy in the model, the effect of investment in schooling is much larger and more statistically significant in both data samples. In columns 5 to 7 the implied values of α, β, and λ are consistent with expectations for the MRW model and are statistically significant at the one percent level. The results in columns 3 and 6, which are based on the same 46 countries, shows that the model with test scores and the model with investment in schooling and tutoring provide similar empirical results, although the model with test scores explains somewhat more of the variation in growth rates (R^2 = 0.60 vs. 0.52).

Figure 7

Economic Growth vs. Rates of Investment in Schooling



Columns 8 and 9 show the results when test scores and investment in schooling (and tutoring) are included in the same model. In the sample that includes Hong Kong and Singapore, the effect of investment in schooling is positive, but only the effect of test scores is statistically significant. In the sample that excludes Hong Kong and Singapore, the effect of both measures is large and statistically significant. The effect of tutoring is smaller and not statistically significant in these results, suggesting that a considerable portion of the effect of tutoring on growth rates occurs through its effect on test scores.[17] The implied values of the parameters in these models continue to be consistent with the expectations for the MRW model, although with less statistical significance.

Table 2 presents two additional tests of the same models. The implied values of the parameters are not shown, but they are similar to the values in Table 1. The first test uses schooling attainment in 1980 as an instrument to investigate whether the human capital measures are only correlated with economic growth or whether they may cause this growth. Columns 1 and 4 confirm that the direct effect of the instrument on growth is negligible, as expected. Columns 2, 5, and 6 present the 2SLS results using this instrument. The estimated coefficients are similar to the OLS estimates. The effect of test scores and investment in schooling are statistically significant at the five percent level in columns 2 and 5. The effect of investment in schooling is statistically significant at this level in the sample with 44 countries in column 6. The F statistics for the first stage of the regressions show that the attainment instrument is particularly strong in column 5. These results provide evidence that increased test scores and investment in schooling cause economic growth.

Columns 3 and 7 show the results when dummy variables for the Asian and Latin American regions are included in the model. HW [2012a] show that the effect of a Latin America dummy is negative in models that included adult schooling attainment in 1960, and they argue that this is due to the low quality of schooling in this region. In the results with the investment in schooling measure (column 7), the coefficient on the Latin America dummy is small and not statistically significant, suggesting that HW's [2012a] results were due to the mis-

[17] Alternatively, large investments in tutoring may be an indicator that the educational system is test-based. If students work harder to raise their skills in these countries, it may be that the coefficient on tutoring is capturing the effect of the additional effort students expend in a test-based system rather than just the effect of the tutoring.

specification of their growth model. The effect of the Asia dummy is positive, but it is not statistically significant. The estimated coefficients on the physical capital and human capital variables continue to be statistically significant when the regional dummies are included in the models.

Table 2
2SLS Effect of Human Capital Measures on Growth Rates 1985-2005
[Dependent variable is Δln(GDP/adult)]

	1	**2**	**3**	**4**	**5**	**6**	**7**
Countries	54	54	54	46	46	44	46
Technique	OLS	2SLS	OLS	OLS	2SLS	2SLS	OLS
	Test Scores			**Investment/GDP**			
$Ln(s_k/n+g+\delta_k)$	0.20* (.08)	0.22 (.13)	0.17* (.08)	0.46** (.07)	0.46** (.07)	0.45** (.07)	0.34** (.10)
$Ln(s_h/(n+g+\delta_h)$				0.30** (.09)	0.29 (.15)	0.40* (.16)	0.27* (.10)
Tutoring dummy				0.22** (.08)	0.22* (.09)	0.15* (.08)	0.15 (.09)
$Ln(ExpTest/(n+g+\delta_h))$	0.25** (.04)	0.23 (.12)	0.23** (.05)				
Latin America dummy			0.00 (.08)				-0.04 (.09)
Asia dummy			0.10 (.10)				0.14 (.12)
Ln(Y/L-1985)	-0.28** (.07)	-0.27** (.08)	-0.24** (.06)	-0.32** (.07)	-0.32** (.09)	-0.39** (.09)	-0.24* (.09)
Attainment 1980	-0.002 (.014)			-0.001 (.015)			
R^2	.63	.63	.64	.52	.52	.54	.55
F-stat 1st stage		7.5			10.6	7.7	

*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.

Note: Robust standard errors in parentheses

The data patterns for the human capital measures in Figures 3, 4, and 5 suggest that the estimated effects of test scores in Table 1 could be the average of different effects in countries with high and low levels of schooling. Since test scores do not continue to rise once countries achieve nine years of schooling attainment or a financial stock of human capital of $100,000/adult, growth in the more educated countries may be caused by more investment in schooling rather than by increases in test scores. To investigate this possibility I examine the effect of the two measures on growth rates in countries with high and low levels of schooling.

I separate the two groups of countries at eight years of average schooling in 1985, rather than nine years, to increase the sample size of the subset of countries with more schooling. I divide the countries using schooling attainment in 1985, rather than test scores or investment in schooling during 1985-2005 because the flow measures during the growth period do not provide any indication of the level of education of the countries at the beginning of the growth period.

Table 3 presents the results for three subsets of the countries, those with less or more than eight years of schooling in 1985 and those with test scores above 470 during 1964-2003. The results in the two subsets of countries in columns 1 to 7 show that the effects of higher test scores and more investment in schooling in the complete data set are due to the effect in countries that had less than eight years of schooling in 1985. The implied values of the parameters in this subset of countries are consistent with expectations for the MRW model, and the variation in growth rates explained in this subset (R^2) is notably higher than in the complete data set.

The 24 countries in the data set with more than eight years of schooling in 1985 have an average test score of 498, with a range from 405 to 545. As shown in column 4, there is no evidence that higher test scores affected growth rates in these countries during the 1985-2005 period. There are 20 countries with more than eight years of schooling in 1985 that had data on rates of investment in schooling. As shown in column 5, there is no evidence that this investment affected growth rates. Clearly these results are not consistent with the predictions of the MRW model.

Table 3
Effect of Human Capital Measures on Growth Rates 1985-2005
[Dependent variable is Δln(GDP/adult)]

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Schooling < 8 years			**Schooling > 8 years**				**TS>470**
Countries	30	26	26	24	20	20	20	24
$\text{Ln}(sk/n+g+\delta_k)$	0.16* (.07)	0.46** (.07)	0.25** (.05)	-0.04 (.17)	0.04 (.18)	0.01 (.15)	-0.05 (.13)	0.08 (.18)
$\text{Ln}(sh/n+g+\delta_h)$		0.36** (.10)	0.20 (.11)		-0.16 (.16)	0.12* (.04)	0.11* (.04)	
Tutoring dummy		0.32** (.10)	0.17* (.07)		-0.05 (.11)			
$\text{Ln}(\text{ExpTest}/(n+g+\delta_h))$	0.27** (.03)		0.21** (.04)	0.07 (.07)			0.06 (.08)	-0.14 (.17)
High Income dummy						0.32** (.05)	0.32** (.05)	
Ln(Y/L-1985)	-0.18** (.05)	-0.30** (.07)	-0.26** (.04)	-0.52** (.07)	-0.48** (.10)	-0.56** (.09)	-0.59** (.11)	-0.54** (.08)
R^2	.78	.63	.82	.64	.59	.86	.86	.66
Implied α	.26	.41	.27			.01		
Implied β	.44	.32	.45			.17		
Implied λ	.010	.018	.015	.037	.033	.041	.045	.039

*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.

Note: Robust standard errors in parentheses

The growth model explains about 60 percent of the variation in growth rates in the countries with more than eight years of schooling, but this variation is explained by the rate of income convergence. In these models test scores and investment rates have no effect, so the convergence is absolute rather than conditional. These empirical results show slow conditional income convergence in the less-educated countries and rapid absolute income convergence in the more-educated countries.

In such a small data set, outliers can seriously impact the results. A review of the residuals in the regressions for the more-educated countries reveals that three countries, Hong

Kong, Ireland, and Norway, are outliers. Hong Kong has an unusual legal status in China, Ireland is a tax haven for companies in the European Union, and Norway's GDP is substantially affected by oil prices. These characteristics tended to raise growth rates beyond what can be explained by the variables in the model during the 1985-2005 period.

Columns 6 and 7 show the results when a dummy variable is included to control for the omitted factors contributing to higher growth rates in these three countries. In these two models the rate of investment in schooling is statistically significant at the 5 percent level, but the effect is relatively small and investment in physical capital still has no effect. In column 7 the effect of test scores on growth rates continues to be small and insignificant.

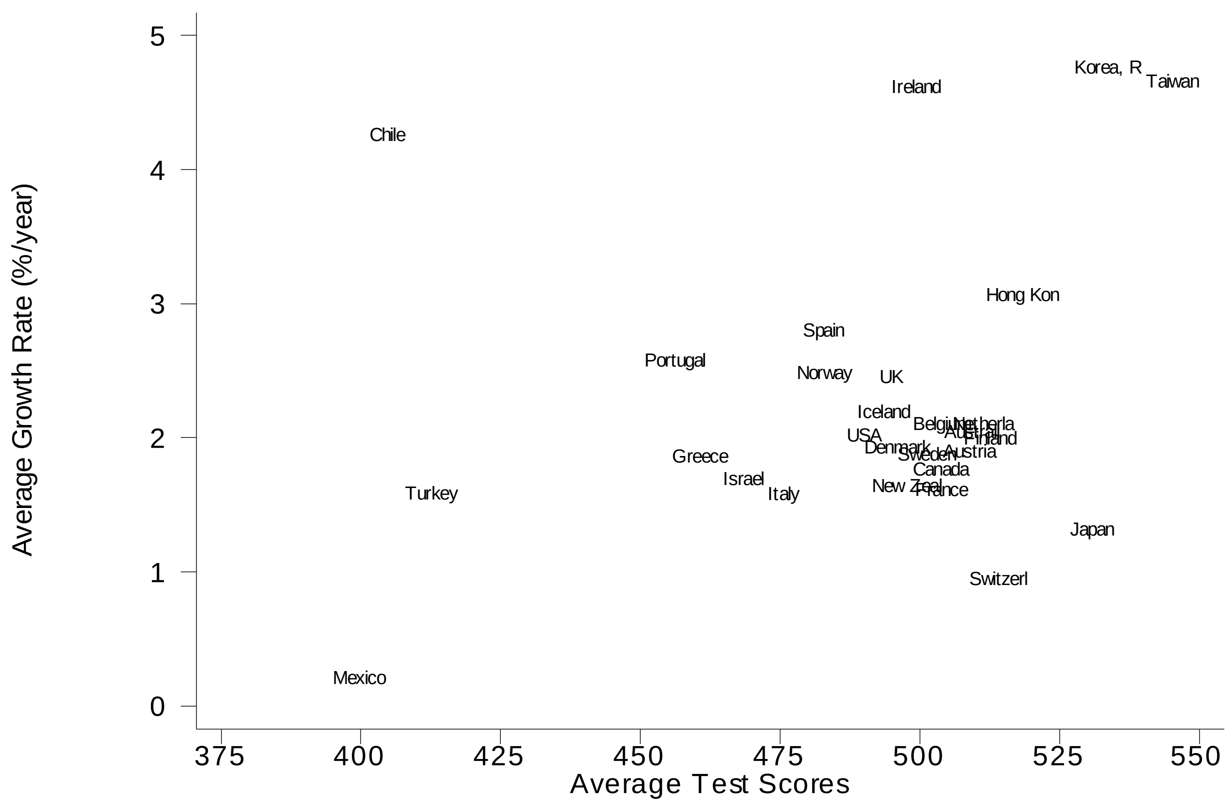
Column 8 shows the effect of test scores on growth in countries with average scores above 470. Again what we see in the results is absolute convergence in income levels, regardless of the level of test scores. Since the data sets for highly-educated countries are so small (20-24 countries), these results cannot be considered definitive, but they call into question HW's [2011b] claim that highly-educated OECD countries can raise their growth rates by raising their students' average test scores.

It is instructive to examine why HW [2011b] found a positive effect from test scores on growth in 24 OECD countries during 1960-2000, while this analysis does not find this effect during 1985-2005 in two slightly different sets of 24 countries. There are several reasons for the different results, but two stand out. First, two OECD countries with high test scores, Japan and Switzerland, had much lower growth rates during 1985-2005 than during 1960-2000. Second, Mexico and Turkey, two OECD countries with low test scores and low growth rates during 1960-2000, are not included in the current analysis, while one non-OECD country, Chile, which had low test scores and a high growth rate during 1985-2005, is included in this analysis. In such small data sets, these changes are sufficient to completely change the statistical relationships in the results.

Figure 8 shows the relationship between growth rates in 1985-2005 and test scores for the 28 countries included in either of the analyses. An examination of the data in this figure reveals that the more educated OECD countries, excluding South Korea, had similar growth rates during this period, which were not related to their average test scores. This same pattern is evident in Figure 2 in HW [2011b] during the 1960-2000 period. In both analyses the statistical relationship between growth rates and test scores is very sensitive to the inclusion or exclusion of certain countries that are outliers relative to the traditional group of highly-educated countries.

Figure 8

Economic Growth Rates vs. Average Test Scores During 1985-2005



There is a possible explanation for the lack of correlation between test scores and growth rates in countries with scores above 470. Experiments with groups of students in the highly-educated countries show that average scores on the same international tests rise by about 32 points after students complete an additional year of schooling [Fuchs and Woessmann, 2006, Juerges and Schneider, 2004, and Woessmann, 2003]. The implication is that intensive efforts to raise students' scores in highly-educated countries accelerate by 1-2 years the increase in students' skills that otherwise occurs as students continue their schooling. It is not clear whether the skill advantage at ages 9 to 15 in countries with higher average scores continues later, or whether it diminishes with time. Since there is no noticeable effect of scores above 470 on economic growth in the empirical results, the skill advantage in countries with scores above 470 may be temporary. Alternatively, it may be that in countries with average scores of at least 470, there are enough students with high skills to meet the economy's requirement for highly-skilled workers.

The lack of any effect from test scores on growth rates in the more educated countries is not surprising given the data patterns in Figures 3, 4, and 5, but the small or negligible effect of investment in physical capital and human capital is unexpected. It appears that in these countries differences in other factors not included in the model had a larger effect on reported growth rates during the 1985-2005 period than differences in capital investment rates.

VI. Conclusions

Hanushek and Woessmann [2008, 2011a, 2011b, 2012a, and 2012b] argue that students' cognitive skills at ages 9 to 15, as measured on international tests, determine a nation's rate of economic growth, and HW [2008 and 2012b] show that increased schooling attainment explains only one third of the variation in growth rates explained by higher average test scores. Breton [2011] argues that their results are severely biased because their methodology is flawed.

In this paper I re-examine the effects of higher test scores and more schooling on growth rates using a structural growth model, conceptually-appropriate measures of schooling, and a time period more appropriate for the vintage of their test scores. I find that in the complete data set, either average test scores or more investment in schooling can explain growth rates over the 1985-2005 period. Test scores explain more of the variation in growth rates, but the variation explained by the two measures is similar once the effect of private tutoring is taken into account. Results using an instrumental variable provide evidence that increased investment in schooling causes growth. These results are consistent with HW's finding that increases in students' test scores cause growth, but they reject their finding that increases in schooling do not reliably cause growth.

When I examine the effect of higher test scores and more investment in schooling in subsets of countries with high and low levels of average schooling, I find that the effect of these measures during 1985-2005 occurs almost entirely in countries that had schooling attainment below eight years at the beginning of the growth period. In these countries either higher test scores or more investment in schooling and private tutoring explain a very high share of the variation in economic growth rates.

I find that countries that expend considerable resources on private tutoring have higher growth rates. These results indicate that investment in schooling and private tutoring are substitutes for raising students' cognitive skills and for increasing growth rates in countries with average schooling attainment below eight years. More research should be undertaken to determine whether it is the substantial private tutoring or the greater focus on testing (or both) in these countries that raises the scores.

In contrast, I find no evidence that increases in international test scores affect growth rates in countries with more than eight years of schooling or in countries with test scores above 470. These results call into question HW's [2011b] argument that OECD countries can raise their growth rates by increasing students' cognitive skills at ages 9 to 15.

I find evidence that more investment in schooling continues to raise growth rates in countries with more than eight years of schooling, but the effect is smaller than in the less-educated countries. The results show that over the 1985-2005 period growth rates in these countries were determined primarily by their level of income in 1985. Countries with lower incomes grew faster, regardless of their rates of investment in schooling or their level of test scores.

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World Bank, 2013, *World Bank Data*, School Enrollment, Primary (% gross), Secondary (% gross), and Tertiary (% gross)

Appendix

Data Used in the Analysis

country	dlnya	lskngdk	testngdh	lnshngdh	lnya85	attain80	attain85	score
Argentina	0.211622	0.6711522	6.912739	0.7860799	9.612741	7.52101	7.61	392
Australia	0.396962	1.247324	8.084021	1.497115	10.26628	12.19525	12.48	509.4
Austria	0.368271	1.312362	8.299737	1.416677	10.224	10.30848	10.63	508.9
Belgium	0.409782	1.299402	8.298145		10.14377	9.240252	9.64	504.1
Bolivia	0.130157	0.1006966	5.434231	0.8415295	8.517889	5.956885	6.65	264
Brazil	0.035391	0.4415107	6.492191	0.8346702	9.391448	4.266083	5.4	363.8
Canada	0.340935	1.123917	8.065067	1.580733	10.30438	11.58783	11.98	503.8
Chile	0.839829	0.940259	6.986868	1.218808	9.189778	8.179819	8.66	404.9
Colombia	0.182909	0.3991878	6.988955	0.6091493	9.054819	4.885788	5.46	415.2
Costa Rica	0.289506	0.8208812	7.269486	0.9066864	9.328547	4.676545	5.3	448.6
Cyprus	0.652849	1.36316	7.584034		9.634167	7.140444	7.57	454.2
Denmark	0.374158	1.299627	8.23687	1.809866	10.2123	11.02921	11.29	496.2
Ecuador	-0.04642	0.75372	5.613191	0.6579229	9.104218	6.255825	6.73	285.2
Egypt	0.424047	-0.113491	6.794591	0.842262	8.538795	2.924729	3.94	403
El Salvador	0.115936	0.5337584	6.031528	0.3590154	8.912055	3.591599	4.07	324.3
Finland	0.387336	1.339292	8.359121	1.45835	10.10438	9.488171	10.11	512.6
France	0.310768	1.166422	8.206151	1.552194	10.1602	9.342874	11.46	504
Ghana	0.131105	-0.398806	6.314626	0.3442843	7.700253	4.356027	4.59	360.3
Greece	0.360711	1.217776	7.763773	0.6351646	9.939602	7.723573	8.22	460.8
Guatemala	0.075137	0.6498438	5.634293	0.0352167	9.121902	2.645101	3.29	285.5
Honduras	-0.07126	0.8883988	5.119307		8.711511	4.099012	4.37	245.3
Hong Kong	0.601303	1.12039	8.131552	0.5685213	10.09681	8.98219	9.78	518.5
Iceland	0.427654	1.292013	7.970513		10.37112	8.85822	9.35	493.6
India	0.627966	0.491327	7.141128	0.5420531	7.885294	2.608793	2.88	428.1
Indonesia	0.532384	0.7449951	6.724748		8.308831	3.796606	4.89	388
Iran	0.195858	0.9779859	6.968876	0.581405	9.25999	2.284063	3.01	421.9
Ireland	0.911686	1.23938	8.050796	1.247178	9.882119	8.941803	9.24	499.5
Israel	0.328039	1.102149	7.433621		10.01751	11.32635	11.68	468.6
Italy	0.305141	1.350426	8.023483	1.280706	10.08097	7.958135	8.53	475.8
Japan	0.251243	1.50906	8.468986	1.235483	10.19843	11.20305	11.57	531
Korea, Rep	0.940977	1.583808	8.323191	0.9366603	9.273177	9.111204	9.52	533.8
Malaysia	0.791451	1.011615	7.619553	0.9176932	9.31857	6.218179	7.1	483.8
Mexico	0.030595	0.8584217	6.828609	0.707304	9.608402	5.895277	6.48	399.8
Morocco	0.053906	0.4238231	6.077518	0.9414557	8.868413	1.513718	1.96	332.7
Netherlands	0.409392	1.182184	8.287357	1.445797	10.18674	10.28168	10.5	511.5
N. Zealand	0.317142	1.098914	8.036728	1.441234	10.03382	10.71778	10.87	497.8
Norway	0.485743	1.441099	8.041743	1.658423	10.46266	11.55776	11.94	483

Panama	0.215948	0.8374761	5.804248	1.004044	9.127715	6.8584	7.37	298.5
Paraguay	-0.11603	0.3775947	5.750821	0.1999077	9.022554	5.207469	5.59	303.1
Peru	0.03867	0.6740683	5.941034	0.6279016	8.993235	6.390708	6.93	312.5
Philippines	0.183507	0.4642704	6.418061	0.4230506	8.577427	6.256843	6.72	364.7
Portugal	0.503985	1.403134	7.707759	1.15521	9.547281	5.573224	5.74	456.4
Singapore	0.805824	1.463391	8.09957	0.7043145	9.925726	5.788505	6.12	533
South Africa	0.025918	-0.053913	5.905856		9.513802	5.12932	5.4	308.9
Spain	0.548758	1.388587	7.982292	1.070956	9.888076	7.446527	7.95	482.9
Sweden	0.363447	1.045869	8.252322	1.765506	10.15845	11.25779	11.65	501.3
Switzerland	0.177696	1.411867	8.309451	1.346727	10.47382	12.47633	12.72	514.2
Taiwan	0.920408	0.9159113	8.431703		9.398903	8.57647	9.19	545.2
Thailand	0.69	1.338312	7.479619	0.771515	8.631466	3.873258	5.19	456.5
Tunisia	0.404183	0.4778444	6.583171	0.9767635	9.023318	2.73074	3.03	379.5
Turkey	0.306232	0.8485879	6.942647	0.0458697	8.900937	4.160105	4.69	412.8
UK	0.479316	1.021637	8.192791	1.392623	10.03668	11.56917	11.93	495
Uruguay	0.385536	0.5587678	7.439269	0.749364	9.201221	6.847013	7.26	430
USA	0.391984	1.070665	7.970561	1.520401	10.47981	12.18986	12.37	490.3