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Education and Cross-Country Productivity Differences

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Abstract

In this paper, we study the effects of education on the total factor productivity (TFP) of a large number of countries. We estimate TFP using a variant of augmented Solow growth model in which health capital is one of the factors of production. We find that *quantity* of education significantly and positively affects TFP. This result is in contrast to the findings of the previous literature, that suggest that either the quantity of education does not matter for growth (e.g. Benhabib and Spiegel 1994, Caselli et al. 1996) or only the quality of education matters for growth (e.g. Hanushek and Kimko 2000). We also find that TFP differences explain about 1/3rd of per-capita real income differences across countries. This estimate is substantially lower than the existing estimates (e.g. Klenow and Rogriguez-Clare 1997, Hall and Jones 1999) which suggest that TFP differences are the dominant source of per-capita real income differences across countries.

Keywords: Augmented Solow Growth Model, TFP, Quantity and Quality of Education, Health

JEL Classifications: F43; E23; N10; N30; O47

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In this paper, we study the effects of education on the total factor productivity (TFP) of a large number countries. We estimate TFP using a variant of augmented Solow growth model in which health capital is one of the factors of production. We find that *quantity* of education significantly and positively affects TFP. This result is in contrast to the findings of the previous literature, that suggest that either the quantity of education does not matter for growth (e.g. Benhabib and Spiegel 1994, Caselli et al. 1996) or only the quality of education matters for growth (e.g. Hanushek and Kimko 2000). We also find that TFP differences explain about 1/3rd of per-capita real income differences across countries. This estimate is substantially lower than the existing estimates (e.g. Klenow and Rogriguez-Clare 1997, Hall and Jones 1999) which suggest that TFP differences are the dominant source of per-capita real income differences across countries.

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1 Introduction

It has long been stressed by the theoretical literature that educational attainment plays fundamental role in economic growth (e.g. Lucas 1988, Mankiw, Romer and Weil 1992, Aghion and Howitt 2009, Acemoglu et. al. 2006). Despite theoretical predictions, the empirical evidence on the effect of education on growth has been mixed. Most of the empirical literature treats education as an input in the production function and uses cross-country regression to identify the effects of education on growth. Using cross-country regression, Barro (1991, 1997) and Mankiw et. al. (1992) find that educational has a significant and positive effect on the per-capita income. But, there is a large number of empirical studies (e.g. Benhabib and Spiegel 1994, Knowles and Owen 1995, Islam 1995, Caselli et al. 1996, McDonald and Roberts 2002) which find that education has insignificant and in many specifications negative effect on per-capita income.

In response to weak empirical evidence of the effect of education on growth found by previous studies, the recent literature has developed in two directions. One strand of literature argues that measures of education capital such as enrollment ratios and average years of schooling used in the previous literature do not adequately measure educational capital (Hanusehk and Kimko 2000). In particular, these measures capture the quantity of education and not the quality of education.

These recent studies show that the quality of education as measured by student performance in the cognitive skills such as math and science have a significant and positive effect on growth (see Hanushek and WoBmann 2008 for a review of this literature). Similar to previous studies, they find that the quantity of schooling proxied by the enrollment ratios and the average years of schooling does not have significant effect on growth. One draw back of these studies is that the measure of cognitive skills of student is available only for few countries, mostly developed countries. For example, the analysis of Hanushek and Kimko (2000) is based on the data for only 31 countries. Given small sample of countries, it is difficult to generalize these results.

The other strand of literature argues that treating education capital as an input in the production function misspecifies its role in the growth process (Nelson and Phelps 1966, Benhabib and Spiegel 1994, Islam 1995). Education does not affect per-capita income directly. Rather it affects per-capita income indirectly through its effect on productivity. Education capital determines the ability of a nation to adopt, implement, and effectively utilize technologies. It affects the speed of technological catch-up and diffusion. The main aim of the paper is to investigate the effects of education capital on productivity of a country or its total factor productivity (TFP). In particular, it examines the effect of *quantity of education* on TFP.[1]

Understanding the role of quantity of education in the growth process is of fundamental importance. Removing illiteracy by 2015 is one of the main goals of Millennium Development goals (MDGs). Part of the reason for setting this goal is the belief that it will improve growth potential of poor countries. Given this ambitious target which involves rapid expansion of schooling system and the severe resource constraint faced by poor countries in terms of funding, well-trained teachers and other complementary inputs, most of the spread in education is likely to be of lower quality. In addition, if only quality of education matters for growth, poor countries may focus their resources in improving the quality of existing educational infrastructure rather than expanding them. Since, poorer and weaker sections of the society typically do not have access to schooling, narrow focus on increasing the quality of existing education infrastructure may aggravate inequalities within poor countries.

Secondly, it clarifies the role of different types of human capital in the growth process. There is a debate in the literature, whether human capital affects per-capita income directly or indirectly through their effects on TFP. Most of the empirical literature treats education and health capital as inputs in production. This literature finds that health capital is a significant determinant of cross-country differences in per-capita income (Knowles and Owen 1995; Caselli et al. 1996; McDonald and Roberts 2002; Weil 2007). However, as discussed above the empirical evidence on the effect of education on growth has been mixed.

Our analysis involves two steps. First, we estimate TFP of 100 countries using a variant of augmented Solow model of Mankiw et. al. (1992). We use panel data approach of Islam (1995) for this estimation. Our data spans the period 1960-2005 and we include health capital proxied by life-expectancy as one of the regressors. In the second step, we examine the determinants of TFP, especially the role of quantity of education capital. We proxy quantity of education capital by average years of schooling and primary and secondary school enrollment ratios.

The main findings of our paper with regard to the determinants of TFP are as follows. Firstly, we find that the quantity of education capital has a positive and significant effects on TFP. The significant and positive effect of quantity of education is robust to the inclusion of various measures of quality of education in the regression. Our results support the hypothesis of Nelson and Phelps (1966) and Benhabib and Spigel (1994) that education

[1]By quantity of education we do not mean education of zero quality rather education of low quality.

capital affects per-capita income indirectly through TFP. Secondly, apart from schooling variables, geographic location, ethnic composition and legal origin significantly affect TFP. In particular, latitude has a significant positive effect on TFP. Ethno-fractionalization and socialist system have a strong negative effect on TFP. Finally, oil-exporting countries have higher TFP.

A large part of growth accounting literature is devoted to estimating the contribution of TFP in explaining cross-country income differences and the speed with which countries converge to their steady state (conditional convergence). This literature suggests that TFP differences are the dominant source of cross-country income differences (e.g. Klenow and Rogriguez-Clare 1997, Hall and Jones 1999). In contrast to the previous literature, we find that TFP differences account for just about one-third of cross-country income differences. The main reason for this significant difference in the estimates is that growth accounting approach typically ignores the health capital as an input in the production function. Thus, their measure of TFP includes health capital as well. The income differences arising out of differences in health capital is attributed to differences in TFP. The inclusion of health capital in the production function also affects the estimated speed of convergence. We find that speed of convergence to be 0.09 which is roughly double the estimate of Islam (1995) and four times the estimate of Makiw et. al. (1992).

Our paper relates to Islam (1995) and McDonald and Roberts (2002) who use panel data method in growth regression. There are two important differences from Islam (1995). Firstly, he does not include health capital as a factor of production. Since, health capital significantly affects per-capita income and is also positively and significantly associated with investment rate his regression suffers from mis-specification bias. Secondly, his estimation method does not account for the presence of lagged dependent variable. McDonald and Roberts (2002) include health capital as a factor of production. However, their estimation method does not account for the presence of lagged dependent variable. None of these studies examine the determinants of TFP which is the main focus of our paper.

Our paper also relates to the voluminous empirical literature which examines the determinants of TFP (see Isaksson 2007 for a review). In particular, our paper relates to Miller and Upadhyay (2000) who study the effects of quantity of education on TFP. They find that the quantity of education has either insignificant or negative effect on TFP. In contrast, we find that education capital has a positive and significant effect on TFP.

2 Methodology

Let the production function be

$$Y_{it} = [A_{it}L_{it}]^{1-\alpha-\beta}K_{it}^{\alpha}H_{it}^{\beta} \tag{1}$$

where Y is output, A is technology, L, K, and H are labor, physical and health capital respectively, α and β are the elasticities of output with respect to physical and health capital respectively, and the subscripts denote country (i) and time (t).[2] Letting lower case letters with ˆ denoting variables per "effective" labor unit (e.g. $\hat{y}_{it} = \frac{Y_{it}}{A_{it}L_{it}}$) the production function can be written in the intensive form as

$$\hat{y}_{it} = \hat{k}_{it}^{\alpha}\hat{h}_{it}^{\beta}. \tag{2}$$

Assume that the labor force in country i grows at the country specific rate, n_i, and technology advances at the common rate, g, across all countries and that the physical and human capital stocks depreciate at the rate, δ. Thus, $L_{it} = L_{i0}\exp^{n_i t}$, and $A_{it} = A_{i0}\exp^{gt}$.

Let $\hat{k}_i^*$ and $\hat{h}_i^*$ denote the steady state levels of physical and health capital *per-effective labor unit* respectively in country i. Also let s_i^K and s_i^H denote the investment rates for physical and health capitals respectively in country i. Then, $\hat{k}_i^*$ and $\hat{h}_i^*$ are given by

$$\hat{k}_i^* = \left[\frac{(s_i^K)^{1-\beta}(s_i^H)^{\beta}}{n_i + g + \delta}\right]^{\frac{1}{1-\alpha-\beta}}; \tag{3}$$

$$\hat{h}_i^* = \left[\frac{(s_i^K)^{\alpha}(s_i^H)^{1-\alpha}}{n_i + g + \delta}\right]^{\frac{1}{1-\alpha-\beta}}. \tag{4}$$

Let lower case letters denote variables per worker (e.g. $y_{it} = \frac{Y_{it}}{L_{it}}$), then, using (2), (3) and (4) following the steps given in Mankiw et. al. (1992), one can derive,

$$\ln y_{it} = \ln A_{i0} + gt - \frac{\alpha}{1-\alpha}\ln(n_i + g + \delta) + \frac{\alpha}{1-\alpha}\ln s_i^K + \frac{\beta}{1-\alpha}\ln \hat{h}_i^*. \tag{5}$$

[2] We do not include education as a factor of production. In the growth regression, none of the indicators of education either of quality or quantity turned out to be significant. These results are similar to previous studies, which show that either when fixed-effects (e.g. Islam 1995) or health indicators (Knowles and Owen 1995) or both (e.g. McDonald and Roberts 2002) are included in the growth regression, education has insignificant effect on real per-capita income.

(5) is a steady state relationship. Let t_1 and t_2 denote the initial period and the current period respectively. Let τ denote the difference between the current and initial periods, i.e. $\tau = t_2 - t_1$. Then by linearizing (5) around the steady state, one can derive (see Mankiw et. al. 1992, Islam 1995)

$$\ln y_{it_2} = \frac{(1-\exp^{-\lambda\tau})\alpha}{1-\alpha}\ln s^K_{i\tau} - \frac{(1-\exp^{-\lambda\tau})\alpha}{1-\alpha}\ln(n_{i\tau}+g+\delta) +$$

$$\frac{(1-\exp^{-\lambda\tau})\beta}{1-\alpha}\ln h^*_{i\tau} + \exp^{-\lambda\tau}\ln y_{it_1} + g(t_2 - \exp^{\lambda\tau} t_1) + (1-\exp^{-\lambda\tau})\ln A_{i0} \quad (6)$$

where $\lambda = (1-\alpha-\beta)(n+g+\delta)$. y_{it_1} and y_{it_2} refer to per-worker real income in periods t_1 and t_2 respectively. $s^K_{i\tau}$, $h^*_{i\tau}$, and $n_{i\tau}$ refer to average savings rate, health capital, and labor force growth rate respectively over the period $\tau = t_2 - t_1$ in country i.

(6) represents a dynamic panel data model with $(1-\exp^{-\lambda\tau})\ln A_{i0}$ as the time-invariant country-effect term. (6) can be written in the following conventional form of the panel data literature:

$$y_{i,t} = \gamma y_{i,t-1} + \sum_{j=1}^{3}\phi_j x^j_{it} + \eta_t + \mu_i + v_{it} \quad (7)$$

with

$$y_{i,t} = \ln y_{it_2};\ y_{i,t-1} = \ln y_{it_1};\ x^1_{it} = \ln s^K_{i\tau};\ x^2_{it} = \ln(n_{i\tau}+g+\delta);$$

$$x^3_{it} = \ln h^*_{i\tau};\ \eta_t = g(t_2 - \exp^{\lambda\tau} t_1)\ \&\ \mu_i = (1-\exp^{-\lambda\tau})\ln A_{i0} \quad (8)$$

where v_{it} is the idiosyncratic error term with mean zero. Note that Solow model puts the restriction that $\phi_1 = -\phi_2$. Also we expect ϕ_1 & $\phi_3 > 0$ and $\phi_2 < 0$. In the first step, we use (7) and (8) to derive estimates of α, β, and A_{i0}. A_{i0} can be recovered from the following relation

$$\ln A_{i0} = \frac{\mu_i}{1-\exp^{\lambda\tau}}. \quad (9)$$

In the second step, we analyze determinants of cross-country TFP differences. For this analysis, we run following regression:

$$\ln A_{i0} = \Xi X + u_i \quad (10)$$

where Ξ is the vector of coefficients, X is the matrix of explanatory variables including constant term, and u_i is the idiosyncratic term with mean zero.

The Cross-section versus the Panel Approach

At this point it is instructive to compare the cross-section growth accounting approach and the panel regression approach to estimate TFP. Let the production function be as in (1): $Y_{it} = [A_{it}L_{it}]^{1-\alpha-\beta}K_{it}^{\alpha}H_{it}^{\beta}$. In the cross-section accounting approach, researchers assume specific values of α and β and then use observations of Y_{it}, L_{it}, K_{it}, and H_{it} to construct implied values of A_{it}. This approach has three problems.

Firstly, the values of α and β are chosen arbitrarily. For example, Hall and Jones (1999) take $\alpha = 0.33$ and $\beta = 0$. They do not consider health capital. On the other hand, Weil (2007) who incorporates health capital in the production function takes $\alpha = 0.33$ and $\beta = 0.67$. In general, given that health capital and physical capital are highly correlated, the values of α are likely to be sensitive to the inclusion or the exclusion of health capital in the production function. In the panel regression approach, α and β are econometrically estimated and the econometric procedure takes into account any correlation among independent variables.

Secondly, since TFP is estimated as a residual, its estimate is sensitive to country-specific and time-specific shocks. TFP includes not only the productivity level, but also the effects of all the other variables not included in the production function. For example, if there is a negative demand shock in a country at time t and the capacity utilization falls, the estimated TFP of the country will be lower. The panel regression approach provides a direct estimate of TFP and also includes country-specific and time-specific shocks. Thus, its estimate of TFP is not sensitive to country-specific and time-specific shocks.

Finally, the cross-section approach uses data on capital stock. Usually, capital stock data is not available for many countries. Researchers have to construct capital-stock data which requires assumptions regarding initial capital stock and depreciation rates. This introduces additional noise in the data. The panel regression approach uses data on investment rates which are readily available.

There is also a subtle difference in the interpretation of TFP estimated by these two approaches. The panel regression approach estimates TFP for the entire sample period. Strictly speaking, it estimates the initial value of TFP, A_{i0}. On the other hand, the cross-section approach estimates TFP of a particular year, t, A_{it}. This can be interpreted as the end of the period TFP. One advantage of the cross-section approach is that it can be implemented for any year. Thus, it is more suitable to analyze short and medium term dynamics of TFP. By design, panel regression approach cannot be used to study short and medium term dynamics of TFP. Therefore, one should take these two approaches of estimating TFP to be complementary.

3 Estimation Method and Data

3.1 Estimation

We first use Breusch-Pagan (BP) test to assess the need for country fixed effects with null, $H_0 : \mu_i = 0 \; \forall \; i$. If BP test rejects the null, then we test whether fixed or random effects model is more appropriate using Hausman (H) test. In the case, H test rejects the null hypothesis that both fixed effects and random effects estimates of the model are consistent, we use fixed effects model.

In the case of fixed effects model, we use the Arellano and Bond (1991) generalize method of moment method (AB method) to estimate parameters of (7). This method is widely used to estimate dynamic panel models with relatively short number of time-periods. For the comparison purpose we also estimate (7) using least squares dummy variable (LSDV) method. However, in the presence of lagged dependent variable LSDV estimator is not consistent.

In the AB method, the first difference is used to eliminate fixed country effects. First differencing produces an equation that is estimable using instrument variables. This method uses a matrix of instruments to produce a consistent estimator. The lagged dependent variable in the first difference is instrumented using level values of dependent variable lagged two or more periods, level values of predetermined variables lagged one period and more and the differences of strictly exogenous variable.

The AB estimator has been shown to perform well in cross-country panels (Judson and Owen 1999). Arellano and Bond (1991) suggest that the Sargan test of over-identifying restrictions be applied to test that the model is identified. Also, the error term in the first difference may not have an autocorrelation of order two. If this is violated, then the AB estimator is not consistent.

The AB estimator does not directly estimate country effects, μ_i. The estimated country effects are obtained as follows:

$$\hat{\mu}_i = \overline{y}_{i,T} - \hat{\gamma}\overline{y}_{i,T-1} - \sum_{j=1}^{3} \hat{\phi}_j \overline{x}_i^j - \overline{\hat{\eta}} \quad (11)$$

where

$$\overline{y}_{i,T} = \frac{1}{T}\sum_{t=1}^{T} y_{it},\ \overline{y}_{i,T-1} = \frac{1}{T}\sum_{t=1}^{T-1} y_{it},\ \overline{x}_i^j = \frac{1}{T}\sum_{t=1}^{T} x_{it}^j,\ \overline{\hat{\eta}} = \frac{1}{T}\sum_{t=1}^{T} \eta_t$$

with $\hat{\eta}_t$ being the estimates of the time effects. Using the estimates of μ_i, the implied values of $\ln A_{i0}$ can be recovered from equation (9). Once we generate $\ln A_{i0}$, we estimate (10) using ordinary least squares (OLS) method.

3.2 Data

In this section, we describe data pertaining to the first stage (growth) regression. Our main sources of data are Penn World Tables 6.3 and World Development Indicators. Income, savings, and labor force growth rate data are from Penn World Tables. The income data are real GDP per-worker adjusted for purchasing power parity (PPP). For savings rate we use the ratio of real investment to real GDP (series ki in Penn World Tables). The labor force growth rate, n_i, is calculated as follows. Using real GDP per capita and real GDP per worker adjusted for PPP (GDPPOP and GDPWOK in Penn World Tables), we generate labor force participation rate (LFPR) for each country. Then, using LFPR and population we calculate labor force and its growth. Following MRW, we set $(g + \delta)$ to be equal to 0.05 and assume this value to be the same for all countries and years.

We use proxy for health capital based on life-expectancy (LE). Adopting the transformation used by Anand and Ravallion (1993), we proxy $\ln h$ by $-\ln(90 - LE)$, where $(90 - LE)$ is the shortfall of the average life expectancy at birth from 90 years. This proxy for health capital is widely used in the literature (Knowles and Owen 1995 2008, McDonlad and Roberts 2002).[3] The data for life expectancy are taken from the World Development Indicators.

Our sample includes 100 countries and covers the period 1960-2005. In the sample, we include only those countries for which data is available for the entire period. Also we exclude countries with population of less than one million at the end of 2005. The summary statistics of data is given in Table 1.

For panel analysis, similar to Islam (1995) we divide the total period into several shorter time spans, each consisting of five years. Thus, we have ten data (time) points for each country: 1960, 1965, 1970, 1975, 1980, 1985, 1990,

[3]Infant mortality rate is another commonly used indicator of health capital. However, data for the infant mortality rate is available for only 60 countries for the entire period. Due to data constraint, we use only life-expectancy as an indicator of health capital.

1995, 2000, 2005. When $t = 1965$ for example, then $t-1 = 1960$, and savings rate, $s^K_{i\tau}$, labor force growth rate, $n_{i\tau}$, and health capital, $\hat{h}^*_{i\tau}$, are averages over $1961 - 1965$. However, the real income per worker for time t, y_{it}, is the real income per worker for year 1965 and y_{it-1} is the real income per worker for year 1960. The v_{it}'s pertain to five year spans and hence less likely to be serially correlated and less influenced by business cycle fluctuations than they would be in a yearly data setup.

4 Estimated Results: Growth Regression

Table 2 presents the results of the first stage regression. First, we perform BP and H tests. The results of these tests suggest that fixed effects model is the appropriate model for estimating (7). The upper panel presents the unrestricted version of (7) and the lower panel restricted version. To test for the restriction implied by the Solow model ($\phi_1 = -\phi_2$), we use Wald test.The implied restriction is not rejected for any of the estimated equations.

The first two columns report results from AB method. The third column reports results from the LSDV estimation method. Standard errors are reported in the parentheses. The AB method provides for one-step and two-step estimators. Before proceeding to discuss the results, we clarify their interpretations. The one-step method assumes the absence of heteroskedasticity and the Sargan test over-rejects when this is not true. The two-step estimator uses the differenced residuals from the first-step estimator for additional information. The standard errors of the two-step estimator tend to be biased downward in the case of small samples (Baltagi 2005, StataCorp 2003).

In what follows, we take two-step specification as our preferred model, though it exaggerates the efficiency of estimates. This is done for variety of reasons. Firstly, Sargan test results support a two-step specification in place of the one-step estimates. Secondly, we have a large sample size. Thirdly, the size and the sign of the one-step estimates and two-step estimates are mostly the same. Finally, the one-step estimate of coefficients for key explanatory variables such as lagged dependent variable, health capital, and investment rate are all statistically significant.

The regression results show that all the explanatory variables have expected signs. Health capital proxy and investment rate are highly significant in all specifications. The labor force growth rate variable, $\ln(n_{i\tau} + g + \delta)$, has expected negative sign in all specifications. But, it is significant only in the AB two-step and LSDV specifications.

We also report implied values of α, β, and λ using the co-efficient estimates of the restricted version of the model. The implied values of these parameters derived from AB one-step and two-step estimates are quite close to each other. But, there is large divergence in the AB and LSDV estimates. The AB two-step estimates of $\alpha (= .18)$ is about half as large and that of $\lambda (= .09)$ is twice as large of LSDV estimates. However, the LSDV and AB estimates of β are quite close.

The reason for the divergence between LSDV and AB estimates is that LSDV estimator overestimates the coefficients of lagged dependent variable, γ, and underestimates the co-efficient on health capita, ϕ_3.[4] This can be seen from following expressions: $\lambda = -\ln \gamma / \tau$ and $\alpha = \frac{\phi_1}{1-\gamma+\phi_1}$. The overestimation of γ leads to underestimation of λ and overestimation of α. Since, $\beta = \frac{\phi_3}{1-\gamma+\phi_1}$, its estimate is not much affected as overestimation of γ and underestimation ϕ_3 largely cancel them out.

The implied values of λ and α are also quite different from Islam (1995). In Islam (1995) λ varies between $0.035 - .05$ and α varies between $0.43 - 0.50$. There are two main reasons for these divergence. Firstly, Islam (1995) does not include health capital. Given the strong positive association between physical and health capital, he overestimates α. In addition, his econometric methodology does not account for the presence of the lagged dependent variable.

5 Cross-Country Productivity Differentials: Preliminary Analysis

Once we have estimated the growth regression, using (9) we derive the estimate of productivity levels of various countries, $\ln A_i$. For the estimation of $\ln A_i$, we use parameter estimates generated by the AD two-steps method. The estimates of $\ln A_i$ is reported in Appendix 2. We have arranged countries in the descending order of productivity. Our estimate suggests that the United States has the highest productivity level with $\ln A_i = 11.68$, and Guinea-Bissau the lowest with $\ln A_i = 8.68$. Table 3 provides the summary statistics of the productivity levels. It shows that the mean and the median productivity levels are 10.44 and 10.51 respectively with the standard deviation of 0.75.

Appendix 2 (column 3) provides the relative position of various countries in terms of productivity (A_i) relative to the United States. The relative productivity of country i is calculated as $\frac{A_i}{A_{US}} * 100$. Column 3 shows that countries vary enormously in terms of productivity. The productivity level of

[4]Since, we are using the restricted version of the model ϕ_1=-ϕ_2.

Guinea-Bissau is just 4.95 percent of the United States. In general, we find bottom heavy distribution of productivity levels, with most of the countries clustered in the lower end of the TFP distribution.

To throw more light on the dispersion in TFP, we classify countries according to whether their TFP relative to the United States is 75 percent or more, between 75 percent and 50 percent, 50 percent and 25 percent, and less than 25 percent. We call the corresponding groups as I (Very High Productivity countries), II (High Productivity countries), III (Medium Productivity countries) and IV (Low Productivity countries). Appendix 2 shows that only 9 countries belonged to group I (very high productivity) and 40 countries belonged to group IV (low productivity). Majority of countries (67) belonged to either group III or IV.

Regarding geographical distribution, as expected the North American and the Western European countries belong to groups I and II. On the other hand, groups III and IV are mainly dominated by the Asian and the African countries. Most of the Latin American countries are in group II (high productivity countries) or III (medium productivity countries). Most of the Asia-Pacific countries are in group II. All the South Asian countries are in group IV. There are some notable oil rich countries (e.g. Venezuela, Iran) which are in groups I and II. Both China and India, two of the largest countries in terms of population, despite their very high per-capita income growth in the last two decades are in group IV.

Productivity Differentials and Cross-Country Income Difference

Now we examine the contribution of differences in TFP, health, and physical capital to differences in income among countries. To do this we use variance decomposition method as in Klenow and Rodriguez-Clare (1997), Hall and Jones (1999) and Weil (2007). Using the production function, real income per worker at time t, y_{it}, can be written as

$$\ln y_{it} = \alpha \ln k_{it} + \beta \ln h_{it} + (1 - \alpha - \beta) \ln A_i. \tag{12}$$

Then, the variance of real income per-worker can be written as

$$var(\ln y_{it}) = \sum_{j=1}^{3} \mu_j^2 var(\ln x_{ijt}) + 2 \sum_{j \neq m} cov(\mu_j \ln x_{ijt}, \mu_m \ln x_{mjt}) \tag{13}$$

where $\mu_1 = \alpha$, $\mu_2 = \beta$, $\mu_3 = 1 - \alpha - \beta$, $\ln x_{i1t} = k_{it}$, $\ln x_{i2t} = h_{it}$, and $\ln x_{i3t} = \ln A_i$.

We can directly observe y_{it} and h_{it}. We have estimate of A_i. We can back out physical capital stock per-worker as a residual. Using (13) the fraction of variance in $\ln y_i$ attributable to productivity differentials can be estimated as the sum of $var(\ln A_i)$ along with two times all the covariance terms involving $\ln A_i$ divided by $var(\ln y_i)$. Similarly, we can calculate the fraction of variance in $\ln y_i$ attributable to health and physical capital.

Table 4a below reports the results of variance decomposition for year 2005. The data for both real income per-worker and health capital are for 2005. The first part of the table reports estimates of variance and covariance. Table 4b reports the fraction of variance of income attributable to various factors.

Table 4b shows that TFP differences account for about 31 percent of the variance in the log real income per worker. On the other hand, health capital and physical capital account for 34 percent and 35 percent of the variance in the log real income per worker.

Our estimate shows that the contribution of TFP differences in explaining differences in real income per worker is considerably smaller than what has been found in other studies. For example, Islam (1995) and Hall and Jones (1997) attribute most of the differences in the income differential to TFP. Part of the reason for this difference is that Islam (1995) and Hall and Jones (1997) do not take into account health capital.

Weil (2007) extends the analysis of Hall and Jones and explicitly includes health capital in his growth accounting. In his analysis, TFP differences account for about 42-50 percent of the variation in incomes depending on the health indicator used. While Weil's estimate of contribution of TFP differences is much closer to our estimate. They are still substantially different. The main reason for the difference between these two estimates is that in Weil (2007) TFP is estimated as residual. Thus, it may not only capture productivity differences, but also other kinds of country-specific and time-specific shocks. Secondly, our estimate of TFP captures initial year differences in TFP, while Weil's estimate captures the end of the period TFP differentials. If there has been divergence in the contribution of TFP over time, our estimate may not capture it.

Table 5 shows association between TFP and real income per worker and physical and human capital for year 2005. It shows that TFP levels are strongly correlated with real income as well as physical and health capital.

6 Determinants of Cross-Country Productivity Differentials: Data

In this section, we analyze the determinants of TFP. We estimate the following regression model

$$\ln A_{i0} = \Pi_1 S + \Pi_2 Q + \Pi_3 Z + u_i \quad (14)$$

where S is the matrix of variables measuring quantity of education capital, Π_1 is the associated vector of coefficients, Q is the matrix of variables measuring quality of education capital, Π_2 is the associated vector of coefficients, Z is matrix of other explanatory variables including constant term, Π_3 is the associated vector of coefficients, and u_i is the idiosyncratic term with mean zero. The description of independent variables used to estimate equation (14) and their data sources is given in Appendix 1.

Quantity of Education

We proxy the quantity of education capital by the the average number of years of schooling by adults (LAVYEAR) in 1960 and the fraction of population aged 15 years and above completing primary (LPCOMP60) and secondary education (LSCOMP60) in 1960. These variables are widely used in the literature. All data are taken from Barro and Lee (2001). In the regression, we use logarithmic values of these variables.

Quality of Education

The direct way to capture the quality of education is to use the cognitive skills of students as in Hanusehek and Knimko (2000). The main problem is that this data is available only for few countries (mainly developed countries). To capture the effects of quality of education, we use the determinants of quality of education. We hypothesize that the quality of education depends on resources available to schools, morbidity rate, and the quality of institutions.

We proxy resources available to schools by the pupil-teacher ratio in the primary (LTEAP60) and the secondary schools (LTEAS60) in 1960. Data are taken from Barro and Lee (2001). In the regression, we use logarithmic values of these variables. Apart from resources available, morbidity rate and quality of institutions are important determinants of quality of education. Relatively high disease burden and low quality of institutions reduce the return from education and thus incentives of individuals to acquire education. There is also large number of studies which suggest that healthier children have better cognitive ability.

Morbidity and quality of institutions also directly affect TFP in many ways. Health influences TFP directly through labor productivity and technology adoption. Healthier workers are more productive because of their larger capacity to work. In addition, higher disease burden reduces the availability of workers. It also works as disincentive for acquiring and adopting newer technologies. Indicators of morbidity and quality of institutions will be part of both Q and Z matrices. Thus, in the present exercise the coefficients of indicators of morbidity and the quality of institutions will incorporate their direct and indirect effects (through the quality of education) on TFP.

Since our measure of productivity relates to 1960, we need data for indicators of morbidity and the quality of institution for 1960 or before. However, such data is not available. As an alternative, instead of using the direct measures of morbidity rate and quality of institutions, we use their determinants. We hypothesize that the morbidity rate and the quality of institutions depend on geographical, cultural, ethnic, and political factors. These determinants are discussed below. One advantage of these determinants are that they are exogenous.

Geography and TFP

There is a large literature which suggests that the geographical factors are important determinants of per-capita income, TFP, and health capital (Bloom and Sachs 1998, Gallup et. al. 1999, Sachs 2003, Hall and Jones 1998, Acemoglu, Johnson, and Robinson 2001). Geographical factors affect TFP both directly and indirectly through their effects on quality of institutions and human capital. Among the geographical factors, the effects of three variables latitude, mean temperature, and access to coastal areas on TFP and per-capita income have received a great deal of attention.

Bloom and Sachs (1998) and Gallup et. al. (1999) argue that the extreme heat and humidity in tropical countries contributes to low soil fertility and agricultural productivity. On the other hand, temperate zones have high soil fertility and agriculture productivity.

Tropical countries also have higher disease burden leading to higher mortality rate, morbidity rate, and lower health capital. Higher disease burden not only directly reduces TFP, but also reduces TFP indirectly. Acemoglu, Johnson, and Robinson (2001) argue that higher mortality rate of European settlers in tropical countries induced them to develop exploitative institutions in these countries (see also Hall and Jones 1999). Latitude also affects diffusion of technology. It is also argued that technological diffusion works most effectively within ecological zones and therefore in an east-west direction along a common latitude rather than in a north-south direction.

Easy access to coasts enhances the extent of market (both internal and external) and thereby increases the opportunity of specialization. In addition, Gallup et. al. (1999) argue that coastal areas are conducive for urban growth and thus countries with access to ocean are more likely to reap the benefit of agglomeration economies. Transport cost has historically played important role in the diffusion of technology, ideas, and new products. Coastal areas with lower transportation costs compared to the land-locked countries are likely to be more exposed to newer products, ideas and technical advancements. Gallup et. al. (1999) also suggest that a coastal economy may face a higher elasticity of output response with respect to trade taxes, whereas an inland economy does not. This may induce governments in inland economies to impose harsh taxes on trade.

Finally, some countries may be endowed with high value natural resources such as hydro-carbons. These countries are likely to have higher TFP. To capture geographical factors, we use average latitude of a country (LATI), and average temperature in a country (MEANTEM). These variables are commonly used in the literature. The data for LATI is from La Porta et. al. and for MEANTEM are from Gallup et. al. (1999). We also use dummy for land-locked (LAND) and dummy for oil exporting countries (OILEXPO). We expect the coefficients of latitude and oil exporting countries to be positive. On the other hand, we expect coefficients of dummy for land-locked and mean temperature to be negative.

Legal Origin and TFP

There is a large literature which suggests that legal origin of a country have significant effect on per-capita income and productivity. Legal system of a country determines the security and enforcement of private property rights, rights of the states, and also quality of governance (La Porta et. al. 1999). All these factors are crucial for technological innovation and adoption. Other things remaining the same, a society in which private property rights are more secure and the government is less intrusive is likely to be more friendly to private innovations. To capture the effects of legal origin, we use dummy for the socialist countries (SOCIALIST). The data are from La Porta et. al. 1999. We expect socialist laws to have negative effect on TFP.

Ethnic Heterogeneity and TFP

Recently the effects of ethnic diversity on investment, growth, quality of government, civil wars, political instability etc. have received a great deal of attention (Easterly and Levine 1997, Alesina et. al. 1997). Ethnic diversity can affect TFP in many ways. Firstly, some authors have argued that ethnically diverse societies have tendency of ethnic conflicts, civil wars, and political instability. Such conflicts and instabilities have a negative impact on investment. Also in heterogeneous societies the adoption and the diffusion of technological innovations are more difficult, particularly, when there is ethnic conflict among groups in a country. Ethnic conflicts and political instability may generate a high level of corruption, private property may not be secure, and in general lead to lower quality of governance. To control for the effect of ethic heterogeneity, we use the index of ethno-linguistic fractionalization (ETHNO) taken from La Porta (1999). We expect the coefficient of this variable to be negative.

7 Determinants of Cross-Country Productivity Differentials: Estimated Results

Table 6, 7, and 8 provide variety of estimations based on equation 14. Tables 6 and 7 present the estimated relationship between TFP and the quantity of education capital and between TFP and the quality of education capital respectively. Table 8 gives the estimated results for both the quality and the quantity of education capital.

Model (1) begins by estimating TFP as a function of the average number of years of schooling and geographical, cultural, and institutional factors. It shows that the quantity of education capital as measured by the average number of years has a positive and highly significant effect on TFP. In models 2 and 3, we use the fraction of population completing primary education and secondary education as indicators of the quantity of education capital respectively. In model 4, we use the fraction of population completing primary education and secondary education together. We find that in all the specifications, both these variables have a positive and highly significant effect on TFP.

These results also show that other factors have expected signs. Among geographical factors, latitude seems to be the most important. It has significant and positive effects on TFP in three of the four models. Average temperature and landlocked have expected negative signs. However, they are not significant in all cases. The ethno-fractionalization has expected negative impact on TFP. Its coefficient is significant in all cases except one. These results suggest that the relationship between TFP and the quantity of education capital is not caused by some third factor. In all the regressions, socialist system has a negative and significant effect on TFP as hypothesized. Oil export has positive effect on TFP. This effect is significant in all cases except one.

Table 7 summarizes the results for the effects of quality of education capital on TFP. Models (5) and (6), we use the pupil-teacher ratio in the primary schools and the pupil-teacher ratio in the secondary schools as an indicators of quality of education capital respectively. Model (5) shows that the pupil-teacher ratio in the primary schools has a significant and negative effect on TFP. However, model (6) shows that the pupil-teacher ratio in the secondary schools has a negative, but insignificant effect on TFP. In model (7) we use both the indicators of quality of education capital and find that the pupil-teacher ratio in the primary schools still has a significant and negative effect on TFP. The effect of the pupil-teacher ratio in the secondary schools remains insignificant.

In table 8, we use both indicators of the quantity and the quality of education jointly. Results show that the quantity of education capital has a strong and positive impact on TFP. The quality variable has a negative effect. However, it is significant only in one case. There are two reasons for the weak effects of the quality variables. One is that the pupil-teacher ratio is quite crude measure of quality. The second is a high degree of collinearity between both types of indicators.

These results show that education capital, particularly the quantity of education capital, has a significant and positive effect on TFP. These results also show that the association between the two are robust to the inclusion of variety of geographical and other variables.

8 Conclusion

In this paper, we studied the effects of education on the total factor productivity (TFP) of a large number countries. We estimated TFP using a variant of augmented Solow growth model in which health capital is one of the factors of production. We find that the quantity of education significantly and positively affects TFP. This result is in contrast to findings of the previous literature, which suggests that either education does not matter for growth (e.g. Benhabib and Spiegel 1994, Caselli et al. 1996) or only the quality of education matters for growth and not the quantity of education (e.g. Hanushek and Kimko 2000, Hanushek and Wobmann 2008). We also find that TFP differences explain about 1/3rd of per-capita real income differences across countries. This estimate is substantially lower than existing estimates (e.g. Hall and Jone 1999) which suggest that TFP differences are the dominant source of per-capita real income differences across countries.

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Table 1
Summary Statistics (1960-2005)

Variables	Mean	Std. Dev.	Max	Min
$y_{i,t}$	9.27	1.10	11.39	6.71
$\ln(s_{i\tau}^K)$	2.76	0.70	4.06	0.21
$\ln(n_{i\tau} + g + \delta)$	-2.64	0.27	-1.92	-8.51
$\ln(\hat{h}_{i\tau}^*)$	-3.27	0.45	-4.12	-2.11

Table 2
Growth Regression Results

Explanatory Variables	AB One-Step (1)	AB Two-Step (2)	LSDV (3)
Unrestricted			
Constant			1.6335(0.474)*
$y_{i,t-1}$	0.6589(0.055)*	0.6647(0.03)*	0.8203 (0.035)*
$ln(s^K_{i\tau})$	0.107(0.027)*	0.0961(0.019)*	0.1173(0.012)*
$\ln(n_{i\tau} + g + \delta)$	-0.039(0.041)	-0.0688(0.038)**	-0.0561(0.024)*
$\ln(\hat{h}^*_{i\tau})$	0.1902 (0.066)*	0.2133 (0.037)*	0.1133 (0.064)**
Restricted			
Constant			1.7375(0.54)*
$y_{i,t-1}$	0.6415(0.057)*	0.652(0.03)*	0.8135 (0.035)*
$\ln(s^K_{i\tau}) - \ln(n_{i\tau} + g + \delta)$	0.0715(0.038)**	0.0785(0.018)*	0.0922(0.012)*
$\ln(\hat{h}^*_{i\tau})$	0.1968 (0.074)*	0.2151 (0.037)*	0.1337 (0.076)**
Implied α	0.17	0.184	0.33
Implied β	0.46	0.504	0.48
Implied λ	0.09	0.086	0.04
BP Test (p value)			0.00
H Test (p value)			0.00
Wald Test (p value)	0.15	0.47	0.14
Sargan Test (p value)	0.003	0.13	NA
H(0): AR(2) is absent (p value)	0.16	0.19	NA
R^2	NA	NA	0.99
No. of Observations	900	900	900
No. of Countries	100	100	100

Note:

(1) $*$ and $**$ indicate significance levels of 1% and 5% respectively against one-sided alternatives for the t-tests.

(2) All specifications included time specific effects if significant at 5% level (two-tailed tests). Time specific effects are not reported here.

(3) Implied values of α, β and λ have been derived using the restricted model.

Table 3
Summary Statistics of TFP Level ($\ln A_i$)

Mean	Median	Std. Dev.	Max	Min
10.44	10.51	0.75	11.68	8.68

Table 4a
Variance Decomposition of Per-Capita Income $\ln y_i$ (year 2005)

$var(\ln y_i)$	1.44
$var((1-\alpha-\beta)\ln A_i)$	0.557
$var(\beta \ln h_i)$	0.278
$var(\alpha \ln k_i)$	17.36
$cov((1-\alpha-\beta)\ln A_i, \beta \ln h_i)$	0.0445
$cov((1-\alpha-\beta)\ln A_i, \alpha \ln k_i)$	0.149
$cov(\alpha \ln k_i, \beta \ln h_i)$	0.168

Table 4b
Fraction of variance in $\ln y_i$ attributable to:

$\ln A_i$	0.306
$\ln h_i$	0.343
$\ln k_i$	0.351

Table 5
Correlation Coefficients

Variable	$\ln y_i$	$\ln A_i$	$\ln k_i$	$\ln h_i$
$\ln y_i$	1	0.89	0.98	0.89
$\ln A_i$	0.89	1	0.84	0.73
$\ln k_i$	0.98	0.84	1	0.83
$\ln h_i$	0.89	0.73	0.83	1

Table 6
TFP (lnA_i) and the Quantity of Education Capital

Variable	(1)	(2)	(3)	(4)
LAVYEAR	0.214*			
	(0.04)			
LPCOMP60		0.168*		0.109***
		(0.05)		(0.06)
LSCOMP60			0.157*	0.137*
			(0.04)	(0.04)
LATI	0.756**	0.554	0.52***	0.57***
	(0.33)	(0.39)	(0.31)	(0.34)
MEANTEM	−0.012	−0.019***	−0.022**	−0.014
	(0.01)	(0.01)	(0.01)	(0.01)
LAND	−0.13	−0.104	−0.234***	−0.182
	(0.16)	(0.17)	(0.14)	(0.16)
ETHNO	−0.498**	−0.503***	−0.419**	−0.233
	(0.23)	(0.28)	(0.21)	(0.21)
SOCIALIST	−1.257***	−1.13*	−1.355*	−1.235*
	(0.07)	(0.10)	(0.08)	(0.11)
OILEXPO	0.219***	0.195*	0.162*	0.165
	(0.13)	(0.14)	(0.14	(0.14))
R^2	0.68	0.64	0.69	0.70
N	78	77	74	72

Note: Numbers in parentheses are White Heteroskedasticity-Consistent standard errors.

Table 7
TFP (lnA_i) and the Quality of Education Capital

Variable	(5)	(6)	(7)
LTEAP60	-0.447^{*}		-0.52^{**}
	(0.20)		(0.23)
LTEAS60		-0.034	0.097
		(0.16)	(0.15)
LATI	0.432	0.67	0.561
	(0.43)	(0.43)	(0.42)
MEANTEM	-0.038^{**}	-0.035^{**}	-0.031^{**}
	(0.01)	(0.01)	(0.01)
LAND	-0.404^{**}	-0.362^{**}	-0.422^{**}
	(0.18)	(0.18)	(0.19)
ETHNO	-0.519^{**}	-0.636^{**}	-0.637^{**}
	(0.24)	(0.26)	(0.26)
OILEXPO	0.204	0.239^{***}	0.225
	(0.15)	(0.14)	(0.14)
R^2	0.58	0.56	0.60
N	88	85	84

Note: Numbers in parentheses are White Heteroskedasticity-Consistent standard errors.

Table 8
TFP (lnA_i) and the Quantity and the Quality of Education Capital

Variable	(8)	(9)	(10)	(11)
LAVYEAR	0.188*			
	(0.05)			
LPCOMP60		0.127**		0.097***
		(0.06)		(0.06)
LSCOMP60			0.141*	0.129*
			(0.04)	(0.04)
LTEAP60	-0.246	−0.393**	-0.237	-0.143
	(0.19)	(0.19)	(0.17)	(0.19)
LATI	0.759**	0.589	0.585**	0.602**
	(0.34)	(0.39)	(0.29)	(0.32)
MEANTEM	−0.011	−0.016	−0.018***	−0.013
	(0.01)	(0.01)	(0.01)	(0.01)
LAND	−0.156	−0.141	−0.232	−0.187
	(0.16)	(0.16)	(0.14)	(0.16)
ETHNO	−0.492**	−0.512***	−0.445**	−0.258
	(0.24)	(0.28)	(0.22)	(0.22)
OILEXPO	0.219***	0.198	0.175	0.170
	(0.06)	(0.14)	(0.14)	(0.14)
R^2	0.68	0.65	0.69	0.70
N	76	75	72	70

Note: Numbers in parentheses are White Heteroskedasticity-Consistent standard errors.

Appendix 1
Data Description and Data Sources

- y: Real income per worker in 2005 constant price PWT 6.3
- s^K: Investment share of real GDP per capita *PWT 6.3*
- n: Calculated using LFPR and population *PWT 6.3*
- LE: Life Expectancy *World Development Indicators*
- LAVYEAR: The average years of school for adults *Barro and Lee (2001)*
- LPCOMP60: The fraction of population aged 15 years and above completing primary schooling *Barro and Lee (2001)*
- LSCOMP60: The fraction of population aged 15 years and above completing secondary schooling *Barro and Lee (2001)*
- LTEAP60: The pupil-teacher ratio in the primary school *Barro and Lee (2001)*
- LTEAS60: The pupil-teacher ratio in the secondary schooling *Barro and Lee (2001)*
- LATI: The absolute distance from equator *La Porta et. al. (1999)*
- MEANTEM: Average temperature *Gallup et. al. (1999)*
- LAND: Dummy for land-locked countries
- SOCIALIST: Countries with socialist legal system *La Porta et. al. (1999)*
- ETHNO: Index of ethno-linguistic fractionalization *La Porta et. al. (1999)*
- OIL: Dummy for oil exporting countries

Appendix 2

Country	LN A_i	Productivity Index (TFPi/TFPus)*100 Life-Expectancy
1	2	3
Group I Countries		
United States	11.68	100.00
Puerto Rico	11.51	84.12
Netherlands	11.45	79.54
Norway	11.43	77.92
Canada	11.43	77.72
South Africa	11.42	77.25
Venezuela, RB	11.41	75.83
Switzerland	11.40	75.21
Belgium	11.40	75.10
Group II Countries		
Austria	11.37	72.86
Australia	11.35	71.96
Israel	11.31	69.11
New Zealand	11.30	68.38
France	11.29	67.38
Gabon	11.26	65.29
Denmark	11.25	64.91
United Kingdom	11.25	64.84
Italy	11.23	63.75
Jordan	11.20	61.78
Ireland	11.20	61.56
Argentina	11.18	60.59
Sweden	11.18	60.32
Trinidad and Tobagc	11.16	59.57
Iran, Islamic Rep.	11.16	59.06
Spain	11.12	56.92
Greece	11.11	56.51
Mexico	11.11	56.29
Finland	11.09	55.03
Hong Kong SAR, Chir	11.05	53.05
Singapore	11.03	52.32
Namibia	11.02	51.75
Mauritius	11.02	51.40
Chile	11.01	51.09

Group III Counries

Japan	10.94	47.71
Brazil	10.89	45.21
Portugal	10.80	41.37
Guatemala	10.79	40.92
Costa Rica	10.78	40.58
Algeria	10.77	40.33
Tunisia	10.77	40.28
Malaysia	10.75	39.44
Uruguay	10.75	39.36
Peru	10.66	35.96
Colombia	10.65	35.65
Korea, Rep.	10.63	34.85
El Salvador	10.62	34.50
Dominican Republic	10.61	34.21
Guinea	10.60	33.73
Morocco	10.59	33.63
Jamaica	10.52	31.36
Zimbabwe	10.50	30.69
Egypt, Arab Rep.	10.48	29.95
Ecuador	10.47	29.69
Sierra Leone	10.45	29.11
Bolivia	10.44	29.01
Turkey	10.42	28.40
Congo, Rep.	10.42	28.25
Panama	10.38	27.11
Cote d'Ivoire	10.38	27.09
Cameroon	10.34	26.06

Group IV Countries

Paraguay	10.29	24.90
Honduras	10.21	23.04
Senegal	10.19	22.50
Philippines	10.19	22.47
Syrian Arab Republic	10.19	22.44
Nicaragua	10.17	22.11
Chad	10.14	21.45
Nigeria	10.12	20.89
Pakistan	10.07	20.03
Romania	9.95	17.71
Zambia	9.93	17.34
Indonesia	9.92	17.17
Kenya	9.87	16.33
Haiti	9.85	16.01
Sri Lanka	9.80	15.25

Bangladesh	9.74	14.27	30
Mozambique	9.73	14.25	
Thailand	9.73	14.15	
Mauritania	9.71	13.95	
India	9.70	13.73	
Gambia, The	9.69	13.66	
Papua New Guinea	9.66	13.27	
Niger	9.65	13.12	
Mali	9.65	13.09	
Congo, Dem. Rep.	9.64	12.94	
Nepal	9.60	12.46	
Benin	9.52	11.53	
Rwanda	9.51	11.35	
Uganda	9.46	10.78	
Central African Repu	9.44	10.57	
Ethiopia	9.41	10.33	
Madagascar	9.39	10.10	
Togo	9.33	9.49	
Ghana	9.31	9.35	
Burkina Faso	9.20	8.36	
Burundi	9.16	7.99	
Malawi	9.09	7.48	
China	8.83	5.77	
Tanzania	8.71	5.11	
Guinea-Bissau	8.68	4.95	