Economic Growth in the Long Run

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Abstract

We present new data on real output per worker, schooling per worker, human capital per worker, real physical capital per worker for 168 countries. Our major contribution is a new set of human capital per worker. With our preferred measure of human capital something on the order of 75-80 percent of all the variation in long run growth can be explained by variation in the growth of inputs per worker, and only 15-20 percent from variation in TFP growth.

INTRODUCTION

Using new data from Maddison, Mitchell, Lindert, and a variety of sources on literacy we have produced a new data set that dramatically expands the data available in Baier, Dwyer and Tamura (2006), hereafter BDT. The number of countries has expanded from 145 to 168, but more importantly, the length of coverage for all countries has dramatically increased. Table 1 below presents the increase in years for each of the 145 countries as well as the new countries added to the data. There has been an acceleration in the growth rates of output per worker in practically all regions. Even Sub-Saharan Africa has seen growth accelerate between 2000 to 2007 compared with the prior quarter century. The data contains the onset of the Industrial Revolution in every region of the world. Further we have the growth of formal schooling in every region from illiteracy to universal primary schooling, near universal secondary schooling and rising attendance in higher education. Consistent with results from BDT, we find that variations in growth rates of output per worker are mostly captured by variations in growth rates of TFP.

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NEW DATA

Table 1 shows that the data has greatly expanded in depth of coverage. In region 1, the *Western Countries*, the average initial year of observation is 1827, an increase of 67 years of coverage. We observe these 18 countries for approximately 180 years. In region 2, *Southern Europe*, the initial year of observation is 1859, an increase of 57 years. We now have data for these 7 countries for around 150 years. Although we now observe an initial year of 1940 for region 3, we have added 39 years of data per country. Region 3, Central and Eastern Europe is predominated by former Soviet republics, now independent. In BDT the initial year of observation was 1990. Now for all of these countries we observe them starting in 1970. Furthermore for the countries that were never Soviet republics, we have an average initial observation year of 1883, and an additional 64 years. All 5 countries in the Newly Industrialized Countries group, region 4, have an initial year of observation of 1820. We have extended an average of 113 years for these countries. Our new initial year of observation in Asia, region 5, is 1894, and average extension of 75 years! Some of this extension arises from the additional countries added to the sample, Aghanistan, Bhutan, Mongolia, North Korea. However the bulk of the extension arises from the additional years found for previously observed countries. We were able to start observations in 1820 for China (120 additional years), India (88 additional years), Indonesia (133 additional years), Malaysia (147 additional years), Myanmar (128 additional years), Philippines (126 additional years), Sri Lanka (133 additional years), and Thailand (124 additional years). Thus for the overwhelming bulk of Asian population, we have complete data for about 187 years. For region 6, Sub-Saharan Africa, our average initial year of observation is 1946, an additional 27 years of data. Hence even for the continent with the youngest independent countries, we now observe the typical Sub-Saharan African country for about 6 decades! The new initial year of observation in Latin America is 1908, bringing an additional 45 years of observations. Here we added 5 additional countries, Bahamas (1960), Barbados (1960), Belize (1960), Cuba (1930), Suriname (1950). However for the largest Latin American countries, Argentina (1870), Brazil (1820), Chile (1820), Mexico (1820), Uruguay (1870) and Venezuela (1820), we now typically observe them starting in 1837, for an additional 76 years. The Middle East has a new additional 68 years, and an average starting year of 1910. Finally we now observe all North African countries, except Libya, starting in 1820. This adds 107 years for the typical North African country.

To compute human capital, we use the same method as in Baier, Dwyer and Tamura (2006), Hall & Jones (1999) and Klenow & Rodriguez-Clare (1997). We use cross sectional evidence from

labor economists to compute human capital as a function of schooling and experience:

$$h_t = \exp(f(schooling) + g(\exp\text{erience})) \quad (1)$$

$$f(E) = .134\min(4, E) + .108\min(4, \max(0, E-4)) + .068\max(0, E-8) \quad (2)$$

$$g(\text{experience}) = .0495\text{experience-}.0007\text{experience}^2 \quad (3)$$

Notice that if all countries have reached the same schooling level, as well as the same average experience, then all countries will have the same human capital. This result is implies that human capital is bounded by the level of schooling. Since schooling cannot grow without bound, then eventually growth will cease, unless technological progress induces factor accumulation. Furthermore this convergence result predicts very rapid convergence in levels of income across countries as their schooling levels become more similar. Both of these assumptions will be relaxed in later sections in order to explain the distribution of income across the countries of the world.

GROWTH ACCOUNTING

Here we report the results of the growth accounting from the new data. We provide three ways of summarizing the data. In the first third of Table 2 we present the unweighted results. We allow each country to have the same weight as each other. In the unweighted world, the typical country had real output per worker growth of 1.33 percent per year. In BDT, the typical country had real output per worker growth of only 0.74 percent per year. Thus the augmented data has a much larger growth rate in output per worker, 80 percent larger, or 0.59 percent per year. Letting α be capital's share in production, the total growth rate of inputs, $\alpha g_k + (1-\alpha)g_h$, for the typical country in the world is 1.25 percent per year. By comparison, BDT had real input growth of 1.55 percent per year. Therefore the typical country in the world had annual TFP growth rate of only .09 percent per year. In BDT, the unweighted contribution of TFP growth was actually negative, -0.81. The additional years and additional countries have lowered the growth rate of inputs and raised the growth rate of output per worker. Hence we see that unweighted TFP growth is now positive.

A comparison of the different regions shows that all regions now have positive economic growth. They range from a high of 2.55 percent per year real output growth in Southern Europe to a low of 0.78 percent per year in Central & Eastern Europe. Only two regions, Sub-Saharan Africa and the Middle East have negative TFP growth. By contrast in the unweighted results of BDT, one region had negative real output per worker growth, Central & Eastern Europe, and 5 regions

had negative TFP growth rates, Central & Eastern Europe, Asia, Middle East, Sub-Saharan Africa and Latin America. Essentially the addition of earlier years as well as 2007 output per worker dramatically increased measured real output per worker growth. Central & Eastern Europe moved from -0.84 annual real output per worker growth to 0.78 percent per year growth. Measured Sub-Saharan African growth increases from 0.17 percent per year to 1.32 percent per year. The Middle Eastern countries also go from 0.09 percent per year growth to 0.99 percent per year growth. Finally Asia goes from 1.05 percent per year growth to 1.49 percent per year. North African countries had measured economic growth of 2.24 percent per year in BDT, and now it declines by a full percentage point to 1.24 percent per year. The N.I.C.'s saw a similar decline in their measured growth rates, from a spectacular 3.50 percent per year in BDT to 1.87 percent per year. Obviously these countries deserve their titles as Asian miracle economies, in that their growth is essentially a post World War II phenomena. The two remaining regions, Western Countries and Southern Europe are the least affected by the additional years. Real output per worker growth goes from 1.91 percent per year in the Western Countries to 1.69 percent per year, which indicates that growth has accelerated from 1820-1870 period to the 1870-2007 period. Southern Europe remains practically unchanged, 2.57 percent per year to 2.55 percent per year. Ignoring Cyprus and Malta, the remaining 5 countries are now observed starting in 1820, compared to an average observation of 1882. Hence the 6 decades prior to 1880 have real output per worker growth similar to the following century.

The population weighted results tend to reduce measured growth rates of output per worker, and measured inputs per worker growth. Thus TFP growth increases from 0.09 percent per year to 0.27 percent per year. The share of real output per worker growth is now 23 percent versus 7 percent in the unweighted case.

Finally we weight as in BDT by labor force and the number of years observed. Real output per worker growth becomes much more homogeneous across regions. Whereas in the unweighted case, real output per worker growth ranged from a low of 0.78 percent per year, Central & Eastern Europe, to a high of 2.55 percent per year, Southern Europe, in the weights with both 2007 labor force and length of observation, the range of real output per worker growth is 1.05 percent per year to 1.81 percent per year. Much of this can be attributed to the small variation in real output per capita in Maddison for 1820 starting years. Overall, only Sub-Saharan Africa displays negative TFP growth. Ignoring this one region, the remaining regions have TFP growth between 0.13 percent per year, Middle East, to 0.72 percent per year, N.I.C.'s. The share of real output growth accounted for by TFP growth is 29 percent for the world, with a range of 11 percent, Middle East, and 40

percent, N.I.C.'s, exclusive of Sub-Saharan Africa.

We summarize the data in graphical form in the following four graphs. We present regional average real output per worker, regional average real physical capital per worker, regional average schooling per worker, regional average human capital and regional average TFP. In computing these regional averages we depart from BDT and present the labor force weighted values for each region. We keep a region as long as the existing countries represent at least 50 percent of the labor force in 2007. Unlike BDT where the graphs represent the regional average growth rates, these figures allow for effects of changing country composition. These arriving countries, as time moves forward, can obviously change regional average levels if their initially observed real output per worker (real physical capital per worker, schooling per worker, TFP) differ from the regional average. However with the extension of data, many regions are dominated by countries that appear all at once, say 1820. Regions that have almost complete coverage in 1820 include: Western Countries, Southern Europe, N.I.C.'s, Asia and North Africa. In the case of the Western Countries, we observe France, Germany, Netherlands, Sweden, UK and the United States by 1800.[1] These six countries constitute 83 percent of the labor force in 2007. The five countries of the Southern Europe region that we observe in 1820 contain more than 99 percent of the labor force in 2007. All of the N.I.C.'s are observed in 1820. In the Asia region, we observe eight countries in 1820. These include China, India, Indonesia, Thailand. All eight of these countries constitute 87 percent of the labor force in 2007. Of the five countries in North Africa, four are observed in 1820. These constitute 96 percent of the labor force in 2007.

Figure 1 below contains the regional average real output per worker. Figure 1 shows that the the Western Countries have been the most productive countries of the world for nearly the last two centuries. In 1820 real output per worker in the Western Countries was 42 percent higher than in the Southern Europe region, 96 percent higher than in the N.I.C.'s, 106 percent higher than in Asia, and 155 percent higher than in North Africa. Fifty years later workers in the Western Countries were 115 percent more productive than their counterparts in Southern Europe, 233 percent higher than workers in the N.I.C.'s, 307 percent higher than workers in Asia and 228 percent higher than their counterparts in North Africa. In every region except Asia, real output per worker grew, however it is clear that the Industrial Revolution begins with Western Countries. Just before the onset of World War I, the relative per worker output gaps are: 108 percent (Southern Europe), 225 percent (N.I.C.'s), 491 percent (Asia), and 293 percent (North Africa). Thus it appears that the

[1] The UK we observe in 1801.

Industrial Revolution diffused to Southern Europe and the N.I.C.'s by 1910, which kept the relative productivity gap constant. However Asia and North Africa lag further behind. Right after World War II, 1950, the measured gaps are: 166 percent (Southern Europe), 279 percent (N.I.C.'s), 985 percent (Asia) and 379 percent (North Africa). Thus despite the damage done by World War II to France, Germany, and the UK, the Western Countries pulled further ahead of their 4 counterparts. Convergence becomes much more evident in 1980. With the exception of Asia, these thirty years reduced the productivity gap between Western Countries and these regions to: 57 percent (Southern Europe), 59 percent (N.I.C.'s), 1362 percent (Asia), 334 percent (North Africa). Finally in 2007 the gaps are: 85 percent (Southern Europe), 22 percent (N.I.C.'s), 474 percent (Asia) and 423 percent (North Africa). For reference the 1870, 1910, 1950, 1980 and 2007 gaps between Western Countries and Latin America and Central & Eastern Europe are: 182 percent (CE Europe), 175 percent (Latin America), 217 percent (CE Europe), 142 percent (Latin America), 260 percent (CE Europe), 120 percent (Latin America), 190 percent (CE Europe), 129 percent (Latin America) and 236 percent (CE Europe), 248 percent (Latin America).

Figure 2 below contains the regional average real physical capital per worker. Figure 3 below contains the regional average schooling per worker. Using the Klenow & Rodriguez-Clare (1999), Hall and Jones (1999) method for computing human capital based on schooling and average experience we construct human capital by region. These are presented in Figure 4: While there was a divergence from 1800 to 1850 between Western Countries and all other regions, and divergence between the group containing the Western Countries, Southern Europe, Newly Industrialized Countries and Central & Eastern Europe compared with the other regions prior to 1950, over the past half century there has been convergence in human capital levels across regions. Finally Figure 5 contains the regional average TFP.

VARIANCE DECOMPOSITION

In this section we present the results of the variance decomposition of growth rates. We construct plausible upper bounds on the share of real output per worker growth variance explained by variations in real input growth rates and variations in TFP growth rates. We proceed as in Baier, Dwyer and Tamura (2006). We aggregate inputs, physical capital per worker and human

capital per worker, into the single measure X_t. Thus output per worker is given as:

$$X_t = K_t^{\alpha} H_t^{1-\alpha} \tag{4}$$

$$Y_t = Z_t X_t \tag{5}$$

Taking logs and using lower case variables to represent growth rates produces:

$$y_t = z_t + x_t \tag{6}$$

Although our countries all are observed in 2007, some we observe as early as 1800, others as late as 1990. However the log difference between the 2007 observation and the first observation of the country divided by the number of years between first and last observation produces estimates of growth rates of output per worker for all countries on an annualized basis. The variance of the growth rate of output per worker across these countries is given by:

$$var(y) = var(z) + 2cov(x, z) + var(x) \tag{7}$$

Dividing by the variance of growth rate of output per worker produces:

$$1 = \frac{var(z)}{var(y)} + \frac{var(x)}{var(y)} + 2\rho_{x,z}\frac{sd(x)sd(z)}{var(y)} \tag{8}$$

Now it is standard in much of the empirical development literature to allocate one of the covariance terms to the inputs and one of the covariance terms to the residual, TFP, term, see Klenow & Rodriguez-Clare (1999) and Weil (2009). This "egalitarian" assignment is then used to discuss the proportion of the variance of growth rates in output per worker "explained" or "accounted" for by inputs and the remained allocated to TFP. However the correlation of growth rates of inputs and total factor productivity growth is not 0. This atheoretical analysis is lacking. There are two sets of theories that imply that the correlation between input growth and TFP growth is caused by one of the other. For example neoclassical growth models with exogenous technological progress implies that factor accumulation is induced by the growth in TFP. Further Romer (1990) has the same implication that technological progress drives all capital accumulation and growth in the economy. On the opposite end of the theoretical divide, Romer (1986), Lucas (1988), Tamura (2002,2006) construct theories that show that physical capital accumulation or human capital accumulation produces endogenous TFP growth. Thus these sets of theories imply that the correlation between TFP growth and input growth are due to input growth and hence the correlated or predictable component should be assigned to input growth.

Under the view that TFP growth induces factor accumulation, and that the predictable or correlated portion of input growth should be assigned to TFP growth, the share of growth of output per worker can be written as:

$$1 = \frac{(sd(z) + sd(x)\rho_{x,z})^2}{var(y)} + \frac{(1-\rho_{x,z}^2)var(x)}{var(y)} \tag{9}$$

where the first term is now a plausible upper bound on the proportion of the variation in growth rates of output per worker caused by variation in growth rates of TFP.[2] At the other end of the theoretical spectrum, the predictable or correlated component of TFP growth arises from endogenous factor accumulation. Assigning this predicatble component to factor accumulation produces the following variance decomposition:

$$1 = \frac{(sd(x) + sd(z)\rho_{x,z})^2}{var(y)} + \frac{(1-\rho_{x,z}^2)var(z)}{var(y)} \tag{10}$$

Tthe first term is now the proportion of the variation of growth rates of output per worker that explained by variation in input growth.[3]

The results of these plausible upper bound calcuations are contained in Table 3.[4] The results from Baier, Dwyer and Tamura (2006) are contained in the columns labeled with BDT. Notice, somewhat surprisingly that the addition of more countries and in particular extending the number of years of observation has not improved the plausible upper bound and in fact has lowered it for

[2] One way of seeing that the least squares decomposition holds for this representation is to note that the variance decomposition is $var(y) = \beta_{y,a}^2 var(a) + var(e_{y|x})$, where $\beta_{y,a}$ is the regression coefficient from a regression of y on a and $e_{y|a}$ is the regression residual.

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[4] Both of these calculations assumes that the correlation between growth of inputs and growth of TFP is positive. A negative correlation has several possible explanations. One that does not make economic sense is forgetting. While it is possible to forget technology, and it has happened to peoples in Europe after the fall of the Roman Empire, as well in China after the fall of the XXX Dynasty, over the 1800-2007 period there is much less of sense of forgetting. It is possible that the conversion of economies toward central planning after World War II in Central and Eastern Europe and the switch back from central planning to market based economies after the fall of the Soviet Union can be captured as forgetting. More likely there is accumulation of inputs that have extremely low returns, building zero value public roads, investing in "critical" private sector industries that no profit making investor would ever authorize, spending on "education," but failing to provide the basics such as textbooks, blackboard an chalk, qualified teachers, etc. All of these would be measured as productive factor accumulations, that have 0 or possibly negative returns. Of course institutional change the reduces property rights, that fosters corruption, etc. can produce large neagtive TFP shocks.

factor accumulation in most of the regions and the world as a whole. In the lower panel we examine the effects of aggregating to larger regions, for example combining Western Countries with Southern Europe and Newly Industrialized Countries.

NEW HUMAN CAPITAL CALCULATION

The surprising conclusion from above is that despite adding many additional years of observations, and a nontrivial number of new countries, the variation in growth rates of output per worker is still mostly captured by variations in growth rates of TFP. To address this, we return to some theories of endogenous growth. In particular we examine the role of human capital accumulation in promoting growth of output per worker. The original Lucas (1988), as well as Becker, Murphy and Tamura (1990) papers introduce the idea that time spent away from production can be used to accumulation human capital. In Lucas infinite lived agents perpetually accumulate human capital, whereas in Becker, Murphy and Tamura parents spend time away from production and educate their children. In both of these models human capital builds off of the existing human capital, hence accumulation has the property of standing on the shoulders of giants. Allowing for human capital spillovers across borders as in Tamura (1991, 2002, 2006) produces the following specification for country i between generations t and $t+1$:

$$h_{it+1} = \mathrm{A}\overline{h}_t^{\rho} h_{it}^{1-\rho} \exp(f(schooling) + g(\exp\mathrm{erience})) \tag{11}$$

where the two functions in the exponential are defined as in (2) and (3). The key innovation here is that we allow for intergenerational accumulation in human capital. [5] That is we initialized human capital in the first year of observation for 25-34 year olds in the economy to 1.[6] The virtues of this method are twofold: (1) it allows for human capital across generations to accumulate without bound, while allowing for the possibility of late developers to converge to the human capital level of early developers via the spillover effect, (2) it keeps a demographic age structure of human capital in the population that incorporates the Mincer age earnings quadratice profile. That is to say, if we compare individuals in a country of the same age, but different schooling levels, their earnings would differ by () and be consistent with Mincerian wage regressions on returns to schooling. Second if we

[5] This is similar to the specification in Bils and Klenow (2000), although in their model they do not allow for spillovers across countries.

[6] For those countries that we observe much later, say 1970 and are much richer than the typically observed country in the 19th century, we choose an initial human capital value for that generation to be closer to historically observed values for the US.

compare individuals in a country over their life cycle, their human capital has the standard inverted U-shape age earnings profile consistent with Mincerian wage regressions. The human capital in the economy is therefore a population weighted average of human capital of 5 age groups, 15-24, 25-34, 35-44, 45-54, 55-64. Thus human capital in country i in year t is:

$$H_{it} = s_{15-24,t}h_{15-24,t} + s_{25-34,t}h_{25-34,t} + s_{35-44,t}h_{35-44,t} + s_{45-54,t}h_{45-54,t} + s_{55-64,t}h_{55-64,t} \quad (12)$$

where s_i is the share of the population 15-64 in age category i, and human capital accumulates via the age earnings profile from above, for example:

$$h_{35-44,t+1} = h_{25-34,t} \exp(g(\text{experience}+10) - g(\text{experience})) \quad (13)$$

where each generation is assumed to have an average schooling and hence their first set of expected experience in the age group 15-24 is given by:

$$\text{experience}_{15-24} = \max(0, \text{average age - 6 - average schooling}) \quad (14)$$

and from then on, every observation they age 10 years. For the new generation, represented by h_{15-24} we assume that the parents are between the ages of 35-54 today. That is to say we use the arithmetic average human capital of adults 25-34 and 35-44 in the prior observation to produce human capital for current 15-24 children. Thus parents had their children between the ages of 20-39. Thus our intergenerational human capital accumulation equation is:

$$h_{15-24,t} = \mathrm{A}\overline{h}_{t-1}^{\rho}\left(\frac{h_{25-34,t-1} + h_{35-44,t-1}}{2}\right)^{1-\rho} \exp(f(schooling) + g(\exp\text{erience})) \quad (15)$$

where, $f(schooling)$ and g(experience) are given by (2) and (3), and where initial experience is max(0,average age - 6 - expected schooling of cohort born in period t-1). In these calculations the time subscripts refer to birth cohort, and typically are spaced 10 years apart. Thus for the US where birth cohorts are exactly 10 years apart until the last one in 2007, the human capital of 15-24 year olds in 1860 use the enrollment rates of schooling in 1850 to produce an estimate of expected years of schooling.

What is left is a determination of values for ρ, the spillover, the determination of $\overline{h}$, and A. We assume that human capital spillover arises from the US. The importance of this human capital spillover is dependent on the schooling of the population. As a country becomes more educated, it can better draw on the body of knowledge in the world. This is similar to Tamura (1996), however instead of a step function, we assume a continuous function of child schooling, S:.

$$\rho = \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\}$$

In this specification the lower bound for ρ is .1 and an upper bound of .475. In the former case, with a generation of 20 (40) years, human capital converges at a rate of .5 (.25) percent per year. At the upper extreme, human capital converges at a rate of 2.375 (1.1875) percent per year. The lower bound rate of convergence is sufficiently slow that it would take roughly 140 (280) years for a country to close the gap by 50 percent! In the upper bound case, it would take a country 29.5 (59) years to close the gap by 50 percent. With the data at hand, the more rapid convergence can be seen by the Newly Industrialized Countries, as well as China and India recently. The slow convergence, would just as likely appear to be non convergence.

We follow Tamura (2002,2006) and assume that $\overline{h}$ is international in scope, typically the maximum human capital in the panel in year t, and thus is the human capital of the United States. For ρ we assumed that it has increased over time as globalization and the rise of the service-knowledge economy has made diffusion of knowledge easier. We generally assume that it starts at the value of .1, and rises with the level of schooling in a step function manner. It goes from .1 to .33 if schooling of the young generation equals or exceeds 5 years. Finally we assumed that A is a declining function of parental schooling. This is so that growth rates do not accelerate unreasonably over time. Since schooling rises from roughly 0 or 1 year of schooling to 14 in almost every rich country, the implied growth rate differential for constant A would be given by:

$$\frac{\gamma(14)}{\gamma(1)} = \exp(.134 * 3 + .108 * 4 + .068 * 6 - .0495 * 13 + .0007 * 13^2) \approx 2$$

Thus the gross growth rate of human capital at the end would be 2 times bigger than in 1800. So if human capital grew roughly 30 percent per generation, a gross growth rate of 1.3, then at the end the gross growth rate of human capital would be 160 percent per generation. So clearly this would be counterfactual. We chose a smoothly declining function for A, that declines as parental schooling increases. We chose the following functional form:

$$\mathrm{A} = \begin{cases} .375 & \text{if } E < 4 \\ \max\{.24, (.375^4 .24^{E-4})^{1/E}\} & \text{if } 4 \leq E < 8 \\ \max\{.24, (.375^4 .24^{E-4} .15^{E-8})^{1/E}\} & \text{if } 8 \leq E \end{cases}$$

The results of this new calculation for human capital are contained in Figure 6. We plot the weighted average human capital by region.

Unlike the previous human capital accumulation, there is less evidence of convergence. Outside of the Newly Industrialized Countries and Southern Europe, prior to 1950 there was much stronger evidence of divergence in human capital levels. Today the gap between Sub-Saharan Africa and

the Western Countries is not much different than the gap in 1950,. In 1950 under the original calculation of human capital, the Western Countries average human capital was 5.4, and the Sub Saharan African average was 2.3. Under the new method of computing human capital, the 1950 average human capital in the Western Countries was 6.1 and the Sub-Saharan African average was 1.0. So whereas the gap in the first case was 2.3 the new gap is 6.1. The relative output gap between these two regions in 1950 was 8.2. So the new method allows for more chance for human capital to capture the difference in productivity based on input variations than before.

In Figure 6 we plot the new TFP levels for regions. In contrast to the previous graph, there is almost no long term trend in TFP across regions. While some regions have had sustained TFP growth, Latin America from 1870-1970, others are almost trendless, for example Western Countries.

Table 4 presents the results for growth accounting using the new measure of human capital. The new method increases the share of output growth that is explained by input accumulation relative to TFP growth. Using *Econonic Inquriy* weights, population in 2007 times the number of years of observations per country, 23 percent of real output growth per worker is captured by TFP growth. Under the new method of computing human capital, only 2 percent of real output growth per worker comes from growth in TFP.

Table 5 presents the results in the variance decomposition of growth rates. While the new method increases the share of growth that is captured by factor accumulation, it does little to explain the variation in growth rates of output per worker across countries! In fact it appears to have no effect at all! However this can be checked more carefully

ADJUSTMENTS TO HUMAN CAPITAL ACCUMULATION

Finally we adjust our hiuman capital spillover function to see what effect this does for expalining growth in the means as well as the variance of growth rates. We find that allowing for minor changes in the accumulation function to account for things like a switch from a centrally planned economy to a market economy, as well as differential rates of human capital diffusion, can explain roughly all of the variation in output per worker growth in our data. We take from this exercise that the model can be used for quantitative identification of institutional changes. We find that the model has the ability to allow for sudden depreciation of human capital in these institutional switches, which captures the change in productivity of inputs, specifically human capital, quite well.

Some of the changes were simply to alter the initial conditions of human capital. Those

changes are listed in the Appendix table. For example 9 of the 18 countries in the Western Countries Region had changes in their initial human capital. Three of the seven countries in the Southern Europe Region had changes in initial human capital. All five of the countries in the Newly Industrialized Countries Region had different initial human capital. In these three regions, our spillover function remains as in the previous section. All but one of the 24 Central and Eastern European Countries Region had changed initial human capital distributions. We changed 16 of 20 initial human capital distributions in the Asia Region All of the 48 countries in Sub-Saharan Africa Region have new initial human capital conditions. For Latin America, we changed 26 of 28 initial human capital distributions. For the Middle East we changed 8 of 13 countries, and all 5 of the North African Countries have new initial conditions.

We specify the following modifications to the spillover function. With the exception of Luxembourg, Cyprus and Malta (all countries that we only observe from 1950 onward), we did not change ρ for the Western Countries, Southern Europe. For these three exceptions, we set ρ to be:

$$\rho = \min\{.75, \left(.65^{\min(S,1)}.5^{\max(0,S-1)}\right)^{1/S}\}|\text{Luxembourg, Cyprus, Malta}$$

For countries of Central & Eastern Europe we modified the ρ function.

$$\rho = \begin{cases} \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Bulgaria, Hungary, Poland, Romania, Yugoslavia \& } t < 1950 \\ \min\left\{.475, \left(.1^{\min(S,5)}.5^{\max(0,S-5)}\right)^{1/S}\right\} & \text{Bulgaria, Hungary, Poland, Romania, Yugoslavia \& } 1949 \leq t \leq 1969 \\ \min\left\{.75, \left(.7^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Bulgaria, Hungary, Poland, Yugoslavia \& } t > 1969 \\ \min\left\{.475, \left(.1^{\min(S,5)}.5^{\max(0,S-5)}\right)^{1/S}\right\} & \text{Romania \& } 1970 \leq t < 1980 \\ \min\left\{.75, \left(.6^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Romania \& } t > 1979 \\ \min\left\{.475, \left(.1^{\min(S,5)}.5^{\max(0,S-5)}\right)^{1/S}\right\} & \text{Russia \& } 1949 \leq t \leq 1988 \\ \min\left\{.75, \left(.6^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Russia \& } t > 1988 \end{cases}$$

For those countries that we observed only from 1970 onward, essentially the former Soviet Re-

publics,

$$\rho = \begin{cases} \min\left\{.475, \left(.1^{\min(S,5)}.5^{\max(0,S-5)}\right)^{1/S}\right\} & 1949 \ \leq t \leq 1989 \\ \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & t > 1990 \\ \min\left\{.75, \left(.6^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Albania \& } t > 1979 \\ \min\left\{.475, \left(.01^{\min(S,10)}.5^{\max(0,S-10)}\right)^{1/S}\right\} & \text{Moldova \& Tajik.\& } t < 1990 \\ \min\{.475, \left(.1^{\min(S,5)}.5^{\max(0,S-5)}\right)^{1/S}\} & \text{Georgia, Kyrg., Moldova, Tajik., Turk. \& } t > 1989 \\ \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Lithuania \& } t > 1989 \\ \min\left\{.70, \left(.5^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Armenia, Azerbaijan, Belarus \& } t > 1979 \\ \min\left\{.475, \left(.375^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Estonia, Kazak., Latvia, Slovakia, Ukraine, Uzbek.\& } t > 1989 \end{cases}$$

For the Newly Industrialied Countries, we changed ρ to:

$$\rho = \begin{cases} \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & t < 1951 \\ \min\left\{.65, \left(.45^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & t > 1950 \end{cases}$$

For Asia we made changes for seven countries:

$$\rho = \begin{cases} .75 & \text{Bhu tan} \\ \min\left\{.475, \left(.15^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Cambodia \& } t > 1990 \\ \min\left\{.475, \left(.01^{\min(S,10)}.5^{\max(0,S-10)}\right)^{1/S}\right\} & \text{Fiji, Mongolia, Papua New Guinea} \\ .05 & \text{North Korea} \\ \min\left\{.475, \left(.45^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Vietnam \& } t > 1980 \end{cases}$$

For Sub-Saharan Africa we changed ρ to

$$\rho = \min\left\{.475, \left(.05^{\min(S,10)}.5^{\max(0,S-10)}\right)^{1/S}\right\} | \text{Sub-Saharan Africa, except}$$

$$\rho = \begin{cases} \min\left\{.75, \left(.65^{\min(S,..5)}.75^{\max(0,S-.5)}\right)^{1/S}\right\} & \text{Botswana} \\ \min\left\{.475, \left(.45^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Swaziland} \\ \min\left\{.475, \left(.4^{\min(S,2)}.5^{\max(0,S-2)}\right)^{1/S}\right\} & \text{Mali, Mauritania} \\ \min\left\{.475, \left(.4^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Cape Verde, Equitorial Guinea} \\ \min\left\{.475, \left(.25^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Guinea-Bissau} \\ \min\left\{.475, \left(.15^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Malawi, Mauritius, Namibia, Sudan} \\ \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Congo, Liberia} \\ \min\left\{.475, \left(.1^{\min(S,9)}.5^{\max(0,S-9)}\right)^{1/S}\right\} & \text{Kenya} \\ \min\left\{.475, \left(.1^{\min(S,2)}.5^{\max(0,S-2)}\right)^{1/S}\right\} & \text{South Africa} \end{cases}$$

and

$$\rho = \min\left\{.475, \left(.01^{\min(S,10)}.5^{\max(0,S-10)}\right)^{1/S}\right\} \mid \begin{array}{c}\text{Burdundi, Cameroon, Central African Republic, Chad,}\\ \text{Comoros, Eritrea,Gabon, Gambia, IvoryCoast,}\\ \text{Lesotho, Madagascar, Mozambique, Niger,}\\ \text{Seychelles, Sierra Leone, Somalia, Togo}\\ \text{Uganda, Zaire, \& Zimbabwe}\end{array}$$

Of the 28 countries in Latin America four kept the base ρ function and the other 24 required eight different branches forρ:

$$\rho = \begin{cases} \min\left\{.475, \left(.1^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Cuba, El Salvador, Jamaica, Peru}\\ \min\left\{.75, \left(.7^{\min(S,.25)}.75^{\max(0,S-.25)}\right)^{1/S}\right\} & \text{Argentina, Chile, Mexico, P. R., Trinidad}\\ \min\left\{.475, \left(.35^{\min(S,1)}.5^{\max(0,S-1)}\right)^{1/S}\right\} & \text{Barbados, Venezuela}\\ \min\left\{.475, \left(.25^{\min(S,1)}.5^{\max(0,S-1)}\right)^{1/S}\right\} & \text{Bolivia, \& Costa Rica}\\ \min\left\{.475, \left(.2^{\min(S,1)}.5^{\max(0,S-1)}\right)^{1/S}\right\} & \text{Brazil, Colombia, Guatemala, Suriname}\\ \min\left\{.475, \left(.1^{\min(S,1)}.5^{\max(0,S-1)}\right)^{1/S}\right\} & \text{Dominican Republic}\\ \min\left\{.475, \left(.1^{\min(S,4)}.5^{\max(0,S-4)}\right)^{1/S}\right\} & \text{Panama, Uruguay}\end{cases}$$

and

$$\rho = \min\left\{.475, \left(.05^{\min(S,11)}.5^{\max(0,S-11)}\right)^{1/S}\right\} \mid \begin{array}{c}\text{Bahamas, Belize, Ecuador, Guyana,}\\ \text{Haiti, Honduras, Nicaragua, Paraguay}\end{array}$$

There are three specificationst for the Middle East:

$$\rho = \begin{cases} \min\left\{.475, \left(.1^{\min(S,10)}.5^{\max(0,S-10)}\right)^{1/S}\right\} & \text{Middle East, except}\\ \min\left\{.475, \left(.25^{\min(S,3)}.75^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Iran, Oman, Yemen}\\ \min\left\{.75, \left(.6^{\min(S,.2)}.75^{\max(0,S-2)}\right)^{1/S}\right\} & \text{Israel}\end{cases}$$

Finally for North Africa there are three functional forms for ρ:

$$\rho = \begin{cases} \min\left\{.475, \left(.2^{\min(S,3)}.5^{\max(0,S-3)}\right)^{1/S}\right\} & \text{Algeria}\\ \min\left\{.75, \left(.6^{\min(S,2)}.75^{\max(0,S-2)}\right)^{1/S}\right\} & \text{Egypt, Morroco, Tunisia}\\ \min\left\{.475, \left(.05^{\min(S,14)}.5^{\max(0,S-14)}\right)^{1/S}\right\} & \text{Libya}\end{cases}$$

In terms of the human capital of Central and Eastern Europe we generally kept their schooling human capital atttained prior to the fall of the communist system. However after 1989 we zeroed out all gains from experience, and restarted their experience clock at 0 in year 1990. As a result we

graph the new measures of human capital by region as well as the new measures of TFP by region. These are contained in Figures 8 and 9.

Tables 6 and 7 contain the new growth accounting and variance decomposition results for these new calculations. We see that these new adjustments increase the ability of factors, physical capital and human capital for explaining average growth across countries, as well as the variation in growth rates of output per worker across countries. We find that the model is capable of explaining all of the output per worker growth in the data, and roughly 75 percent of the variation in growth rates of output per worker across countries. We do not claim a structural interpretation of these parameters in that they are independent of policy. In particular we view this as an exercise in quantitative identification.[7] That is given a specific model, what must parameters be in order to fit the data. In theory we could use a search algorithm for the best fitting parameters that minimizes a loss function. We leave that to future research. Furthermore we view the differences in parameters in the spillover function to be a direct result of different institutional protections for private property.[8]

Our work also identifies the ending value of human capital across countries. How would one get an independent measure of human capital, separate from the macro approach here? This is exactly answered in the work of Hendricks (2002) and Schoellman (2008). In their work these authors attempt to measure relative human capital of individuals educated from different countries working in the same labor market and having the same observable characteristics, i.e. years of schooling, years of work experience, marital status, sex, etc. We leave it to future research to see if in fact our terminal values of human capital are correlated with the results from these two papers.

EVIDENCE FROM MICRO LITERATURE

In this section we take our estimates of human capital in 2000 & 2007 and compare the implications of these with micro evidence. Table 8, taken from Hendricks (2002), contains the 1990

[7] This exercise is conducted similar to Simon and Tamura (2008), Murphy, Simon and Tamura (2008) and Tamura (2006). There models are forced to fit actual time series, and the forcing variables, such as price of space, or efficiency of schooling time, are allowed to be whatever they need to be to fit the series.

[8] While this may seem odd, we assume that greater degrees of spillover, higher values of ρ, are consistent with greater protection of private property. Thus agents have increased incentives to learn best practices from others because while their increased human capital comes at the "expense" of the world leader, the world leader behaves as if there are no external benefits to their accumulation. Closed economies are particularly bad in that they imply very small and possibly 0 value for ρ.

values of relative earnings of immigrants to the US, controlling for age, education and sex. The first column lists the country of origin. The second column presents his adjusted relative earnings (100 base), and the third column presents the human capital from this paper relative to the US in 1990. The fourth column presents the year 2000 relative human capital of countries from Schoellman (2008) and the fifth column presents our relative human capital for these countries. It is evident that our new estimates are closer to those of Schoellman than Hendricks. In particular we find much lower human capital for Central, Eastern European and Western Countries than Hendricks. Whereas Hendricks typically reports human capital in these countries exceeds that in the US, we find that only the Netherlands in 1990 and 2000 had higher human capital per worker than the US. Furthermore our estimates of Asian, Sub-Saharan Africa and Latin American countries are on average only about 30 percent of the US, one sixth of the US and 45 percent of the US, respectively. Our Middle Eastern countries typically have only a quarter of the US human capital per worker. Thus we find that human capital typically can help explain more the differences in cross country income productivity than either Schoellman or Hendricks.

A final manner in which to test the data is to to do a development decomposition exercise, similar to the growth decomposition. Once again we can combine the factors of production per worker into the variable x. Assuming a Cobb-Douglas production function produces the following result:

$$\ln y_{it} = \ln z_{it} + \ln x_{it}$$

Under the view that TFP induces factor accumulation, and that the predictable or correlated portion of inputs should be assigned to TFP, the share of output per worker can be written as:

$$1 = \frac{(sd(\ln z) + sd(\ln x)\rho_{\ln x,\ln z})^2}{var(\ln y)} + \frac{(1-\rho^2_{\ln x,\ln z})var(\ln x)}{var(\ln y)} \tag{16}$$

where the first term is now a plausible upper bound on the proportion of the variation in output per worker explained by variation in TFP.[9] At the other end of the theoretical spectrum, the predictable or correlated component of TFP arises from endogenous factor accumulation. Assigning this predicatble component to factors produces the following variance decomposition:

$$1 = \frac{(sd(\ln x) + sd(\ln z)\rho_{\ln x,\ln z})^2}{var(\ln y)} + \frac{(1-\rho^2_{\ln x,\ln z})var(\ln z)}{var(\ln y)} \tag{17}$$

[9] One way of seeing that the least squares decomposition holds for this representation is to note that the variance decomposition is $var(\ln y) = \beta^2_{\ln y,\ln z} var(\ln z) + var(e_{y|x})$, where $\beta_{\ln y,\ln z}$ is the regression coefficient from a regression of $\ln y$ on $\ln z$ and $e_{\ln y|\ln z}$ is the regression residual.

Tthe first term is now the proportion of the variation of output per worker that explained by variation in inputs.[10] We examine these for the initial conditions as well as the terminal observation.[11] Table 9 contains these results. We find that the variation in inputs typically explains about two thirds of output differences in the terminal year and around three quarters of the variation in the initial year. Thus inputs seem to have an edge in capturing output differences across countries compared to TFP differences.

CONCLUSION

The paper presents a simple model of human capital accumulation and physical capital accumulation within the framework of a standard Cobb-Douglas aggregate production function. We use the new data created here to estimate new values of country specific human capital. Using a method standard in the labor literature we allow for Mincerian age-earnings relationships to hold within each country, but allow for human capital to accumulate across generations. This accumulation technology is similar to Bils and Klenow (2000), Lucas (1988), Tamura (1991). We allow human capital to build on the shoulders of the previous generation. We find that this model can explain all of the long term growth of output per worker, and about 80 percent of the cross sectional variation in output per worker growth.

[10] One way of seeing that the least squares decomposition holds for this representation is to note that the variance decomposition is $var(\ln y) = \beta^2_{\ln y, \ln x} var(\ln x) + var(e_{\ln y | \ln x})$, where $\beta_{\ln y, \ln x}$ is the regression coefficient from a regression of $\ln y$ on $\ln x$ and $e_{\ln y | \ln x}$ is the regression residual.

[11] All terminal years are 2007, except for East Germany, which has a terminal observation in 1990.

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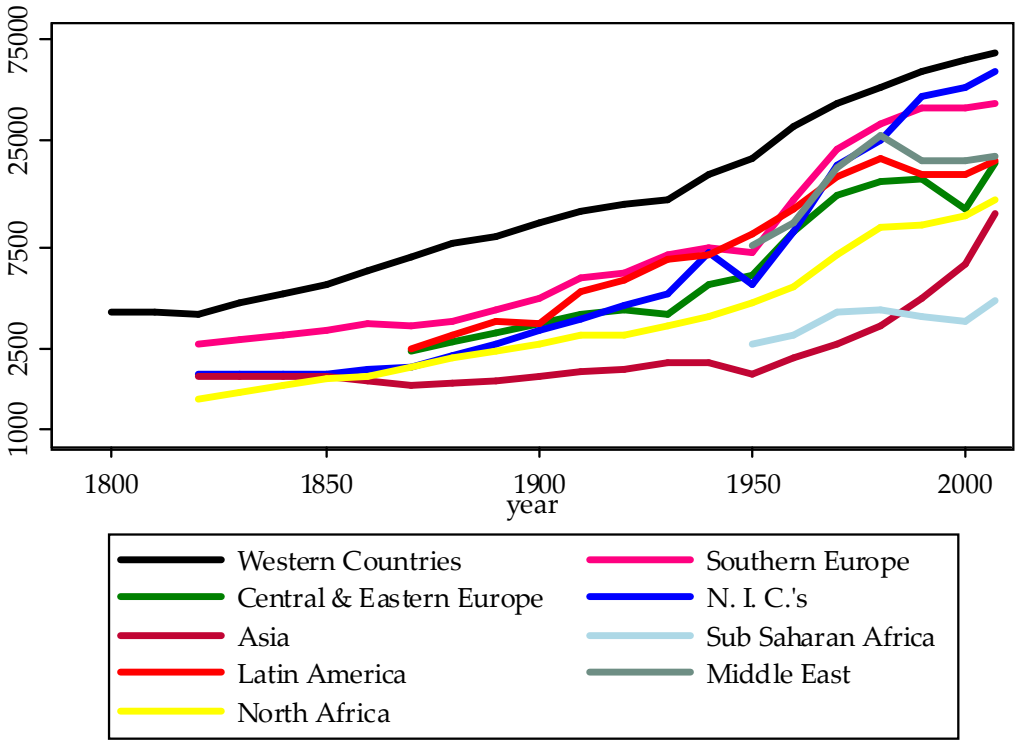

FIG. 1. Real Output Per Worker: By Region

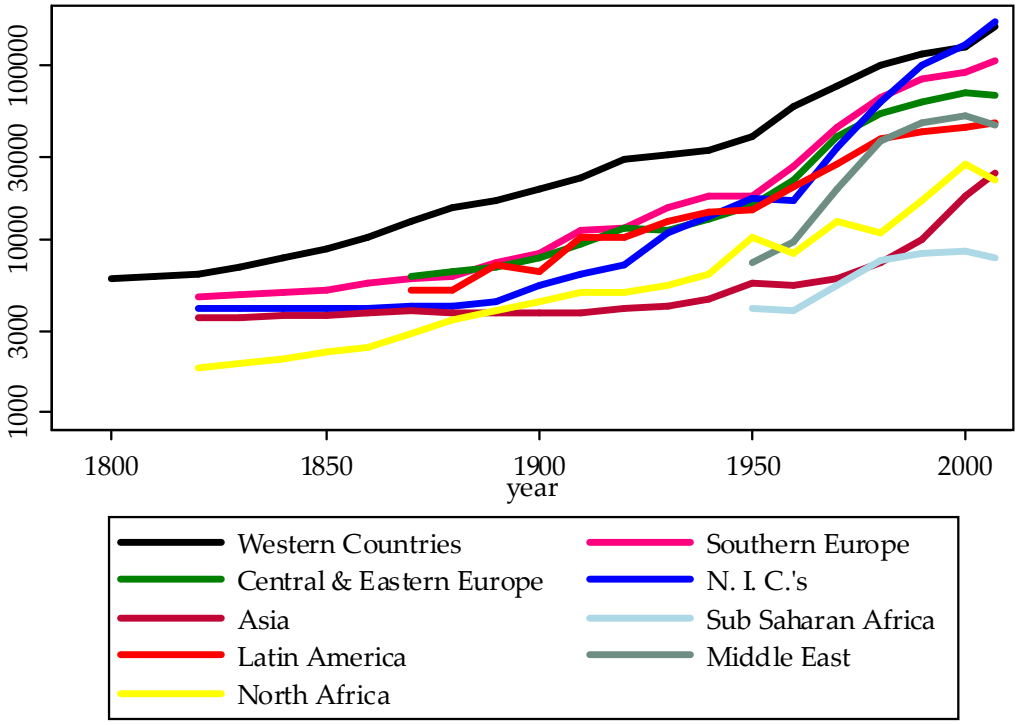

FIG. 2. Real Physical Capital Per Worker: By Region

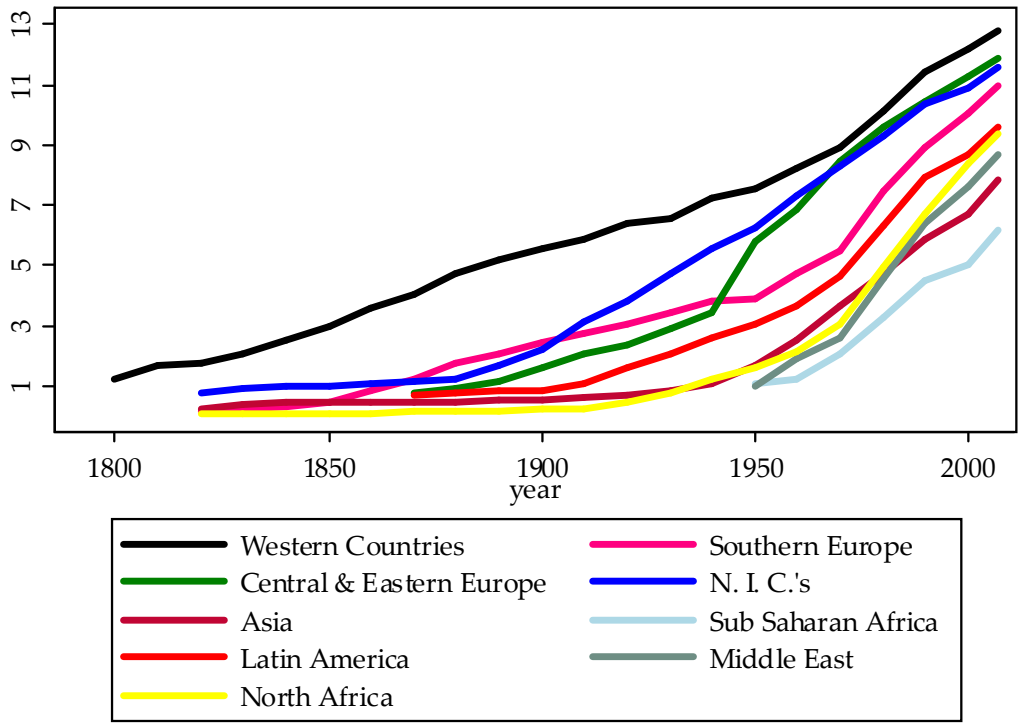

FIG. 3. Average Schooling Per Worker: By Region

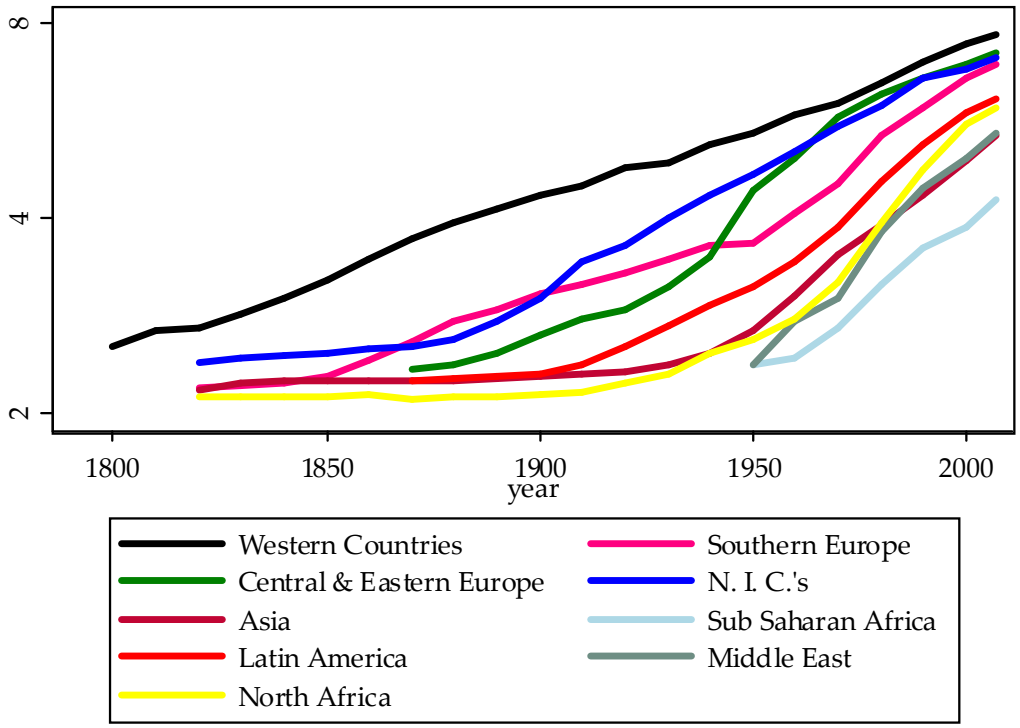

FIG. 4. Average Human Capital Per Worker (Old): By Region

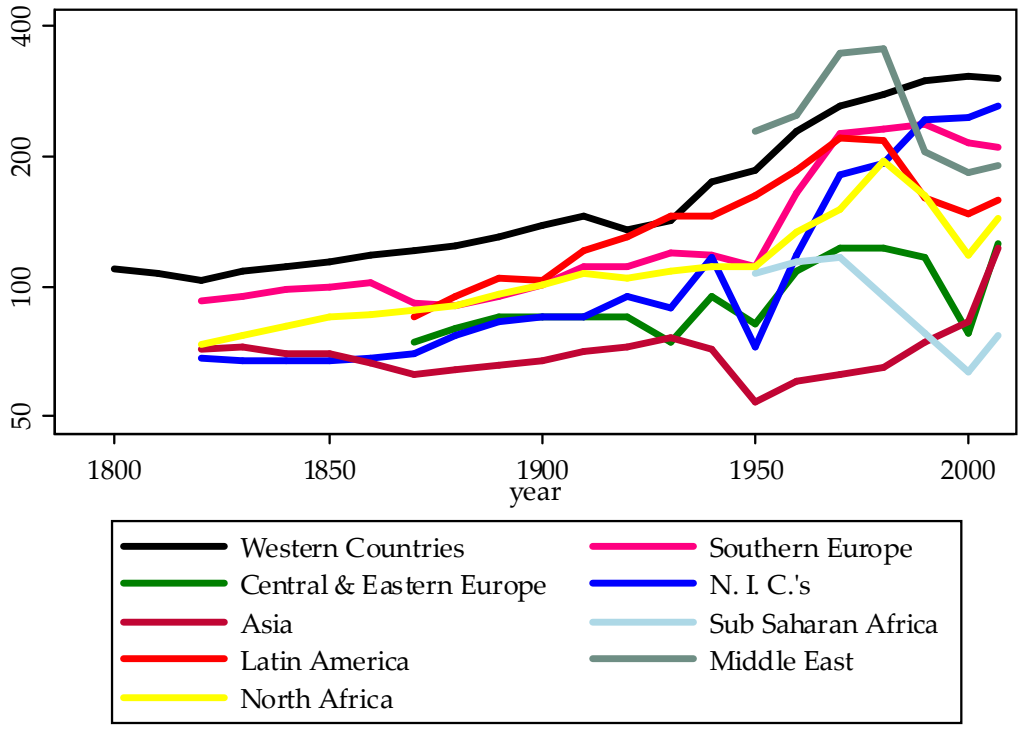

FIG. 5. Average TFP: By Region

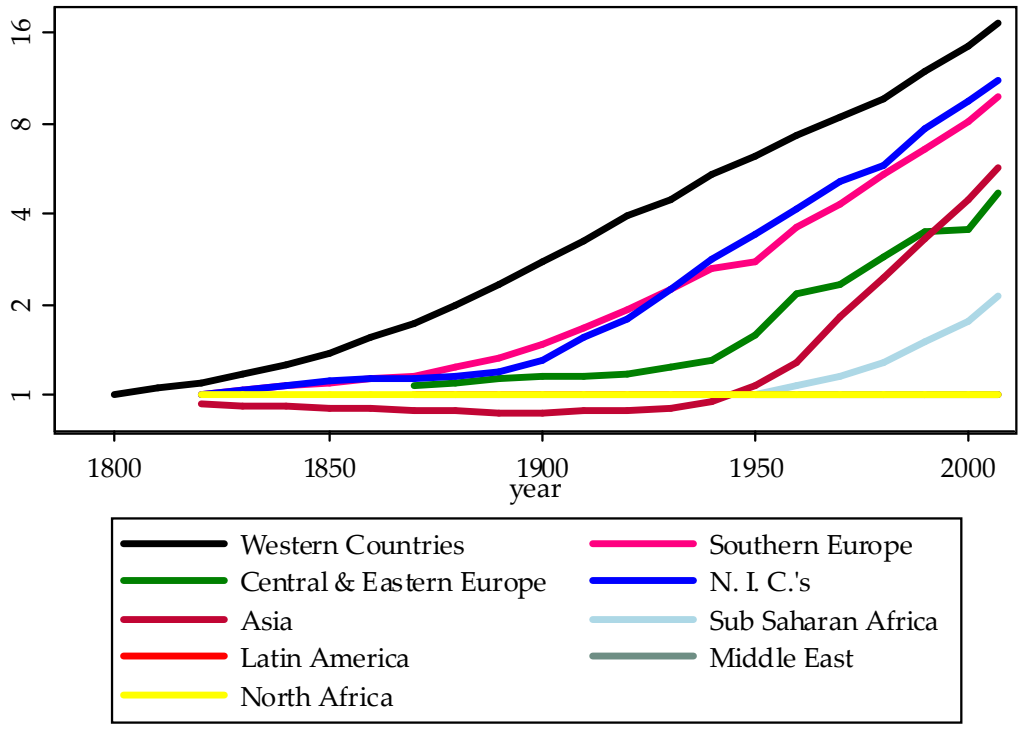

FIG. 6. Average Human Capital (New): By Region

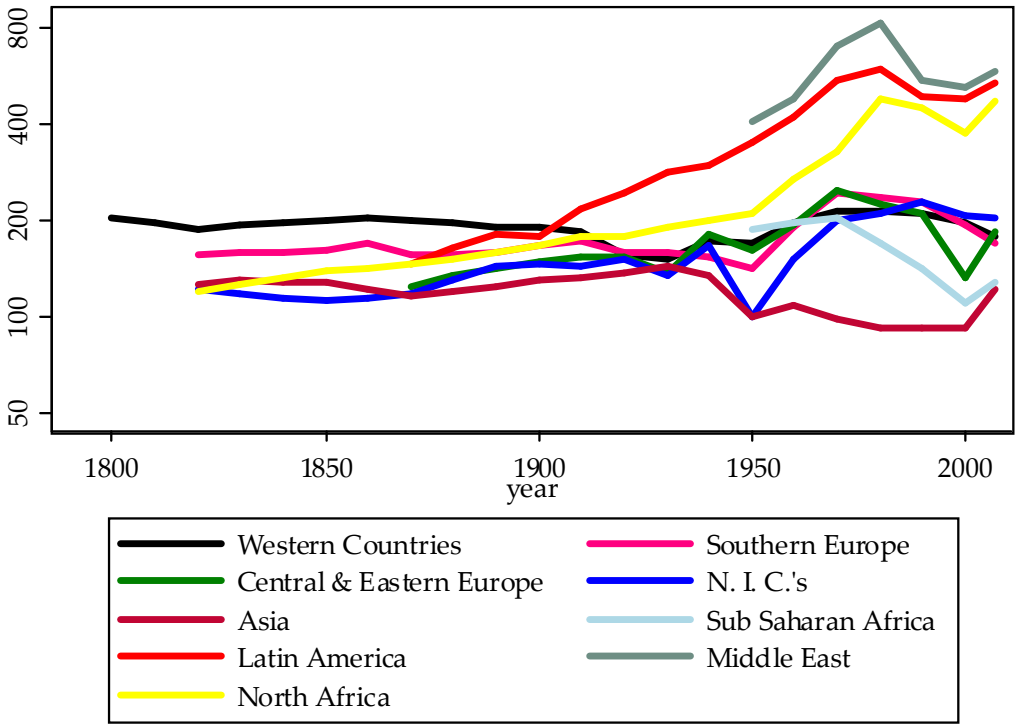

FIG. 7. Average TFP (New): By Region

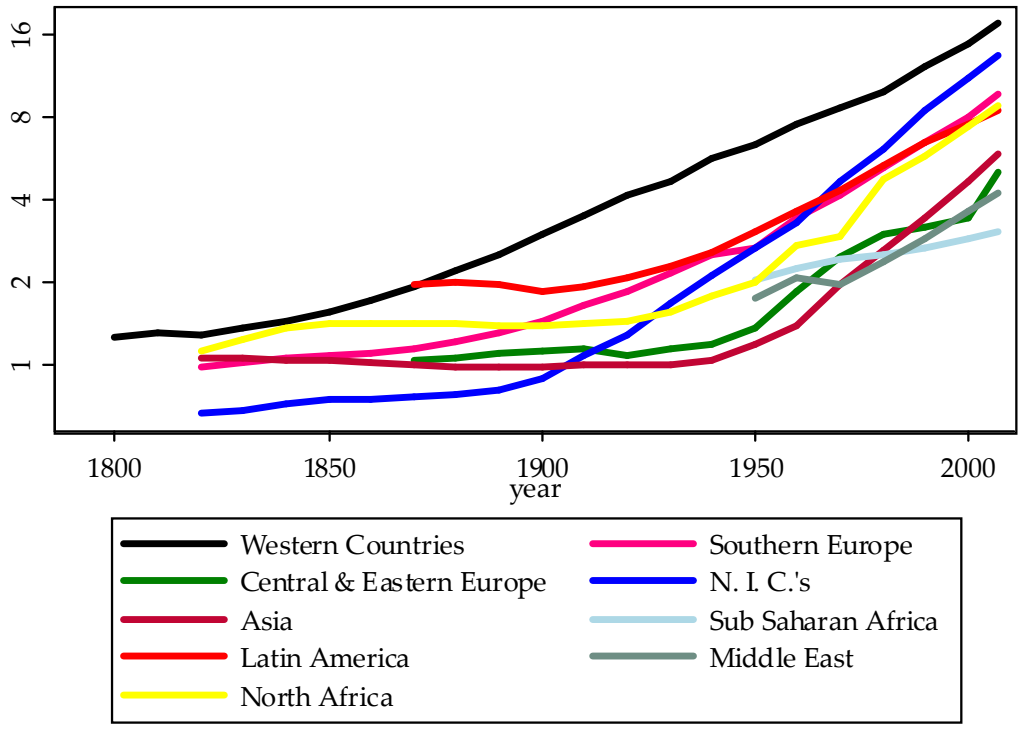

FIG. 8. Average Human Capital (Modified): By Region

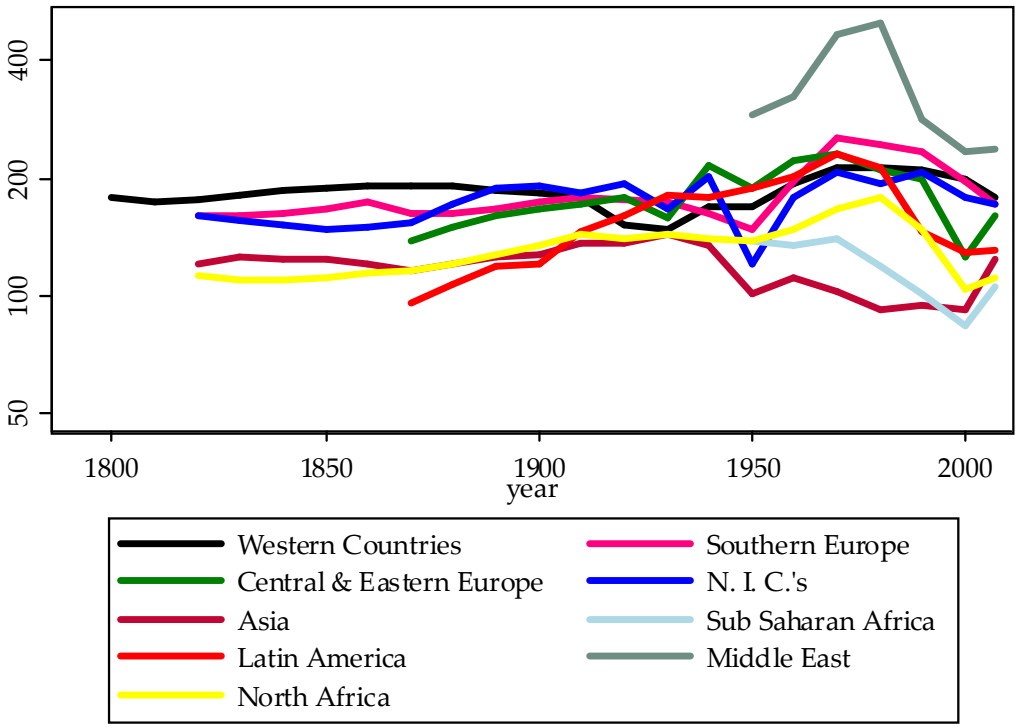

FIG. 9. Average TFP (Modified) : By Region

Country	New	Old	Add. Yrs	Central & Eastern Europe	New	Old	Add. Yrs.
Western Countries				Armenia	1970	1990	27
Australia	1820	1861	48	Azerbaijan	1970	1990	27
Austria	1820	1880	67	Belarus	1970	1990	27
Belgium	1820	1846	33	Bulgaria	1870	1934	71
Canada	1820	1871	58	Czech Republic	1820	1921	108
Denmark	1820	1870	57	East Germany	1964	1964	-
Finland	1820	1850	37	Estonia	1970	1990	27
France	1800	1850	57	Georgia	1970	1990	27
Germany	1800	1880	87	Hungary	1869	1890	28
Iceland	1950	-	57	Kazakhstan	1970	1990	27
Ireland	1820	1926	113	Kyrgyzstan	1970	1990	27
Luxembourg	1950	-	57	Latvia	1970	1990	27
Netherlands	1800	1849	56	Lithuania	1970	1990	27
New Zealand	1820	1911	98	Moldova	1970	1990	27
Norway	1820	1855	42	Poland	1870	1931	68
Sweden	1800	1860	67	Romania	1870	1930	67
Switzerland	1820	1888	75	Russia	1820	1917	104
United Kingdom	1801	1831	37	Slovak Republic	1990	1990	7
United States	1790	1870	87	Tajikistan	1970	1990	27
avg. Western Countries	1827	1869	63	Turkmenistan	1970	1990	27
Southern Europe				Ukraine	1970	1990	27
Cyprus	1950	1950	7	Uzbekistan	1970	1990	27
Greece	1820	1910	97	Yugoslavia	1910	1920	17
Italy	1820	1861	48	avg. Central & Eastern Europe	1940	1969	37
Malta	1960	-	47	N.I.C.'s			
Portugal	1820	1849	36	Hong Kong	1820	1960	147
Spain	1820	1857	44	Japan	1820	1890	77
Turkey	1820	1935	122	Singapore	1820	1963	150
avg Southern Europe	1859	1894	57	South Korea	1820	1910	97
Central & Eastern Europe				Taiwan	1820	1905	92
Albania	1950	1990	47	avg. N.I.C.'s	1820	1926	113

Table 1: New Initial Years & Additional Years by Region

Country	New	Old	Add. Yrs	Country	New	Old	Add. Yrs
Asia				Latin America			
Afghanistan	1950	-	57	Argentina	1870	1895	32
Bangladesh	1950	1970	27	Bahamas	1960	-	47
Bhutan	1980	-	27	Barbados	1960	-	47
Cambodia	1950	1980	37	Belize	1960	-	47
China	1820	1933	120	Bolivia	1880	1950	77
Fiji	1960	1960	7	Brazil	1820	1872	59
India	1820	1901	88	Chile	1820	1895	82
Indonesia	1820	1951	138	Colombia	1890	1917	34
Laos	1950	1980	37	Costa Rica	1920	1951	38
Malaysia	1820	1960	147	Cuba	1930	-	77
Mongolia	1950	-	57	Domincan Republic	1950	1950	7
Myanmar	1820	1941	128	Ecuador	1940	1950	17
Nepal	1950	1960	17	El Salvador	1920	1950	37
North Korea	1820	-	187	Guatemala	1921	1950	36
Pakistan	1950	1951	8	Guyana	1946	1946	7
Papua New Guinea	1960	1960	7	Haiti	1945	1950	12
Philippines	1820	1939	126	Honduras	1920	1930	17
Sri Lanka	1820	1946	133	Jamaica	1820	1953	140
Thailand	1820	1937	124	Mexico	1820	1895	82
Vietnam	1950	1980	37	Nicaragua	1920	1950	37
avg. Asia	1894	1953	75	Panama	1945	1950	12
				Paraguay	1939	1939	7
North Africa				Peru	1900	1908	15
Algeria	1820	1948	135	Puerto Rico	1950	1960	17
Egypt	1820	1917	104	Suriname	1950	-	57
Libya	1950	1960	17	Trinidad & Tobago	1946	1960	21
Morocco	1820	1951	138	Uruguay	1870	1939	76
Tunisia	1820	1956	143	Venezuela	1820	1936	123
avg. North Africa	1846	1946	107	avg. Latin America	1908	1935	45

Table 1: New Initial Years & Additional Years by Region

Country	New	Old	Add. Yrs	Country	New	Old	Add. Yrs
Angola	1950	1960	17	Madagascar	1950	1960	17
Benin	1950	1960	17	Malawi	1950	1960	17
Botswana	1950	1960	17	Mali	1950	1960	17
Burkina Faso	1950	1960	17	Mauritania	1950	1960	17
Burundi	1950	1960	17	Mauritius	1950	1960	17
Cameroon	1950	1960	17	Mozambique	1950	1960	17
Cape Verde	1950	-	57	Namibia	1950	1960	17
Central African Republic	1950	1960	17	Niger	1950	1960	17
Chad	1950	1960	17	Nigeria	1950	1952	19
Comoros	1950	-	57	Reunion	1950	-	57
Congo	1950	1960	17	Rwanda	1950	1960	17
Djibouti	1950	-	57	Senegal	1950	1970	27
Equitorial Guinea	1950	-	57	Seychelles	1950	-	57
Eritrea	1990	-	57	Sierra Leone	1950	1961	18
Ethiopia	1950	1950	7	Somalia	1950	1960	17
Gabon	1950	1960	17	South Africa	1820	1946	133
Gambia	1950	1960	17	Sudan	1950	1970	27
Ghana	1870	1960	97	Swaziland	1950	-	57
Guinea	1950	1960	17	Tanzania	1950	1960	17
Guinea Bissau	1950	1960	17	Togo	1950	1960	17
Ivory Coast	1950	1960	17	Uganda	1950	1959	16
Kenya	1950	1962	19	Zaire	1950	1950	7
Lesotho	1950	1960	17	Zambia	1950	1950	7
Liberia	1950	1960	17	Zimbabwe	1950	1950	7
				avg. *Sub-Saharan Africa*	1946	1959	27

Table 1: New Initial Years & Additional Years by Region

Country	New	Old	Add. Yrs
Middle East			
Bahrain	1950	-	57
Iran	1820	1956	143
Iraq	1820	1950	137
Israel	1948	1948	7
Jordan	1950	1960	17
Kuwait	1950	1980	37
Lebanon	1820	-	187
Oman	1950	1970	27
Qatar	1950	-	57
Saudi Arabia	1950	1960	17
Syria	1820	1953	140
U.A.E.	1950	1980	37
Yemen	1950	1970	27
avg. Middle East	1910	1963	68

Table 2: Growth Accounting:

region	N	g_y	g_k	g_h	g_x	g_{tfp}	share$_{tfp}$	share$_x$
world	168	1.33	2.04	0.85	1.25	0.09	0.07	0.93
Western Countries	18	1.69	1.84	0.55	0.98	0.72	0.42	0.58
Southern Europe	7	2.55	2.72	0.74	1.40	1.16	0.45	0.55
Central & Eastern Europe	24	0.78	0.93	0.62	0.72	0.06	0.08	0.92
New Industrialized Countries	5	1.87	2.20	0.57	1.12	0.76	0.41	0.59
Asia	20	1.49	1.82	0.83	1.16	0.33	0.22	0.78
Sub-Saharan Africa	48	1.32	0.29	1.08	1.69	-0.36	-0.27	1.27
Latin America	28	1.26	1.58	0.84	1.08	0.17	0.14	0.86
Middle East	13	0.99	2.20	1.07	1.44	-0.45	-0.46	1.46
North Africa	5	1.24	1.90	0.76	1.14	0.10	0.08	0.92
population weighted								
world	168	1.18	1.45	0.64	0.91	0.27	0.23	0.77
Western Countries	18	1.46	1.67	0.57	0.94	0.52	0.36	0.64
Southern Europe	7	1.45	1.62	0.61	0.95	0.50	0.35	0.65
Central & Eastern Europe	24	0.89	1.13	0.65	0.81	0.09	0.10	0.90
New Industrialized Countries	5	1.81	2.09	0.59	1.09	0.72	0.40	0.60
Asia	20	1.12	1.16	0.57	0.77	0.35	0.31	0.69
Sub-Saharan Africa	48	1.02	2.66	1.02	1.57	-0.54	-0.53	1.53
Latin America	28	1.19	1.30	0.70	0.90	0.29	0.25	0.75
Middle East	13	1.32	2.33	0.83	1.33	-0.01	0.04	0.96
North Africa	5	1.18	1.48	0.59	0.89	0.29	0.25	0.75

Table 2: *Economic Inquiry* weights

region	N	gy	gk	gh	gx	gtfp	share$_{tfp}$	share$_{x}$
world	168	1.17	1.34	0.58	0.83	0.34	0.29	0.71
Western Countries	18	1.45	1.67	0.57	0.94	0.52	0.36	0.64
Southern Europe	7	1.43	1.60	0.61	0.94	0.49	0.35	0.65
Central & Eastern Europe	24	1.26	1.41	0.69	0.93	0.33	0.26	0.74
New Industrialized Countries	5	1.81	2.09	0.59	1.09	0.72	0.40	0.60
Asia	20	1.05	1.11	0.53	0.72	0.33	0.31	0.69
Sub-Saharan Africa	48	1.05	2.43	0.96	1.45	-0.39	-0.37	1.37
Latin America	28	1.19	1.28	0.65	0.86	0.33	0.28	0.72
Middle East	13	1.15	1.77	0.65	1.02	0.13	0.11	0.89
North Africa	5	1.17	1.41	0.56	0.84	0.33	0.28	0.72

Table 3: Plausible Upper Bounds on Variance Decomposition

region	N	share$_x$	share$_{tfp}$
world	168	0.3703	0.6609
Western Countries	18	0.4854	0.9340
Southern Europe	7	0.9845	0.9919
Central & Eastern Europe	24	0.3134	0.8196
non "Stans"	8	0.7948	0.2379
"Stans"	16	0.1353	0.8649
New Industrialized Countries	5	0.1453	0.9471
Asia	20	0.2918	0.7918
Sub-Saharan Africa	48	0.5963	0.5401
Latin America	28	0.3814	0.7725
observe longer than 69 years	16	0.4152	0.5848
observe fewer than 70 years	12	0.4510	0.8873
Middle East	13	0.5226	0.8007
observe longer than 57 years	5	0.9821	0.9385
observe fewer than 58 years	8	0.7427	0.9037
North Africa	5	0.6531	0.4855
larger regions			
W.C. & S.E.	25	0.8963	0.9550
W.C., S.E. & N.I.C.	30	0.8900	0.9527
W.C., S.E., N.I.C., & N.A.	35	0.5999	0.8097
W.C., S.E., N.I.C., N.A, Asia	55	0.4125	0.7947
Central & Eastern Europe	24	0.3134	0.8196
Central & Eastern Europe, L.A.	52	0.3620	0.7903
Central & Eastern Europe, L.A., M.E.	65	0.3647	0.7578
Central & Eastern Europe, L.A., M.E, Sub-Saharan Africa	113	0.4364	0.6007

Table 4: Growth Accounting New Human Capital

region	N	g_y	g_k	g_h	g_x	g_{tfp}	share$_{tfp}$	share$_x$
world	168	1.33	2.04	1.10	1.41	-0.08	-0.06	1.06
Western Countries	18	1.69	1.85	1.61	1.69	0.01	0.005	0.995
Southern Europe	7	2.55	2.72	1.71	2.05	0.51	0.20	0.80
Central & Eastern Europe	24	0.78	0.93	1.96	1.61	-0.83	-1.07	2.07
New Industrialized Countries	5	1.87	2.20	1.19	1.52	0.35	0.19	0.81
Asia	20	1.49	1.82	1.38	1.53	-0.03	-0.02	1.02
Sub-Saharan Africa	48	1.32	2.89	1.32	1.84	-0.53	-0.40	1.40
Latin America	28	1.26	1.58	1.61	1.60	-0.34	-0.27	1.27
Middle East	13	0.99	2.20	1.62	1.82	-0.83	-0.84	1.84
North Africa	5	1.24	1.90	0.94	1.26	-0.01	-0.01	1.01
population weighted								
world	168	1.18	1.47	1.00	1.16	0.02	0.02	0.98
Western Countries	18	1.46	1.67	1.36	1.47	-0.01	-0.01	1.01
Southern Europe	7	1.47	1.65	1.21	1.36	0.11	0.07	0.93
Central & Eastern Europe	24	0.88	1.08	1.61	1.43	-0.55	-0.63	1.63
New Industrialized Countries	5	1.81	2.10	1.27	1.55	0.26	0.14	0.86
Asia	20	1.12	1.13	1.07	1.09	0.04	0.03	0.97
Sub-Saharan Africa	48	1.03	2.68	1.17	1.67	-0.64	-0.62	1.62
Latin America	28	1.22	1.35	1.01	1.12	0.10	0.08	0.92
Middle East	13	1.39	2.42	1.04	1.50	-0.11	-0.08	1.08
North Africa	5	1.18	1.46	0.66	0.93	0.25	0.22	0.78

Table 4: Growth Accounting, New Human Capital *Economic Inquiry* weights

region	N	gy	gk	gh	gx	gtfp	share$_{tfp}$	share$_{x}$
world	168	1.17	1.33	0.96	1.08	0.09	0.08	0.92
Western Countries	18	1.45	1.67	1.36	1.46	-0.01	-0.01	1.01
Southern Europe	7	1.45	1.63	1.20	1.35	0.10	0.07	0.93
Central & Eastern Europe	24	1.25	1.41	1.27	1.31	-0.06	-0.05	1.05
New Industrialized Countries	5	1.81	2.10	1.27	1.55	0.26	0.14	0.86
Asia	20	1.05	1.06	1.03	1.04	0.01	0.01	0.99
Sub-Saharan Africa	48	1.06	2.45	1.11	1.56	-0.50	-0.47	1.47
Latin America	28	1.22	1.32	0.90	1.04	0.18	0.15	0.85
Middle East	13	1.17	1.81	0.77	1.12	0.05	0.04	0.96
North Africa	5	1.17	1.40	0.62	0.88	0.30	0.25	0.75

Table 5: Plausible Upper Bounds on Variance Decomposition (New Human Capital)

region		N	share$_x$	share$_{tfp}$
world		168	0.4800	0.6750
Western Countries		18	0.8245	0.1771
Southern Europe		7	0.9772	0.9276
Central & Eastern Europe		24	0.2321	0.9251
	non "Stans"	8	0.9053	0.3381
	"Stans"	16	0.4035	0.9354
New Industrialized Countries		5	0.3723	0.7460
Asia		20	0.2744	0.7256
Sub-Saharan Africa		48	0.6184	0.4508
Latin America		28	0.5402	0.7493
	observe longer than 69 years	16	0.4183	0.6098
	observe fewer than 70 years	12	0.4889	0.9351
Middle East		13	0.2286	0.8296
	observe longer than 57 years	5	0.9807	0.9640
	observe fewer than 58 years	8	0.7293	0.9147
North Africa		5	0.6893	0.5654
larger regions				
W.C. & S.E.		25	0.9046	0.7348
W.C., S.E. & N.I.C.		30	0.8898	0.7005
W.C., S.E., N.I.C., & N.A.		35	0.7669	0.4464
W.C., S.E., N.I.C., N.A, Asia		55	0.4998	0.5818
Central & Eastern Europe		24	0.2321	0.9251
Central & Eastern Europe	, L.A.	52	0.0136	0.9864
Central & Eastern Europe	, L.A., M.E.	65	0.2674	0.9009
Central & Eastern Europe	, L.A., M.E, Sub-Saharan Africa	113	0.4998	0.7401

Table 6: Growth Accounting: Modified Human Capital

region	N	g_y	g_k	g_h	g_x	g_{tfp}	share$_{tfp}$	share$_x$
world	168	1.33	2.04	1.20	1.48	-0.15	-0.11	1.11
Western Countries	18	1.69	1.85	1.57	1.66	0.03	0.02	0.98
Southern Europe	7	2.55	2.72	2.47	2.55	0.00	0.00	1.00
Central & Eastern Europe	24	0.78	0.93	0.93	0.93	-0.15	-0.19	1.19
New Industrialized Countries	5	1.87	2.20	1.70	1.86	0.01	0.01	0.99
Asia	20	1.49	1.82	1.42	1.56	-0.06	-0.04	1.04
Sub-Saharan Africa	48	1.32	2.89	0.94	1.59	-0.27	-0.21	1.21
Latin America	28	1.26	1.58	1.15	1.29	-0.04	-0.03	1.03
Middle East	13	0.99	2.20	1.13	1.49	-0.50	-0.51	1.51
North Africa	5	1.24	1.90	1.05	1.33	-0.10	-0.07	1.07
population weighted								
world	168	1.18	1.47	1.06	1.19	-0.01	-0.01	1.01
Western Countries	18	1.46	1.67	1.34	1.45	0.01	0.004	0.996
Southern Europe	7	1.47	1.65	1.25	1.39	0.08	0.05	0.95
Central & Eastern Europe	24	0.88	1.08	0.87	0.94	-0.06	-0.07	1.07
New Industrialized Countries	5	1.81	2.10	1.64	1.79	0.01	0.01	0.99
Asia	20	1.12	1.13	1.08	1.10	0.03	0.02	0.98
Sub-Saharan Africa	48	1.03	2.68	0.62	1.31	-0.28	-0.27	1.27
Latin America	28	1.22	1.35	1.07	1.16	0.06	0.05	0.95
Middle East	13	1.39	2.42	0.83	1.36	0.03	0.02	0.98
North Africa	5	1.18	1.46	1.06	1.19	-0.01	-0.01	1.01

Tab le 6: Growth Accounting Modified Human Capital *Economic Inquiry* weights

region	N	gy	gk	gh	gx	gtfp	share$_{tfp}$	share$_{x}$
world	168	1.17	1.33	1.08	1.17	0.01	0.01	0.99
Western Countries	18	1.45	1.67	1.34	1.45	0.01	0.005	0.995
Southern Europe	7	1.45	1.63	1.24	1.37	0.08	0.06	0.94
Central & Eastern Europe	24	1.25	1.41	1.05	1.17	0.08	0.07	0.93
New Industrialized Countries	5	1.81	2.10	1.64	1.79	0.01	0.01	0.99
Asia	20	1.05	1.06	1.04	1.05	0.00	0.00	1.00
Sub-Saharan Africa	48	1.06	2.45	0.67	1.27	-0.21	-0.19	1.19
Latin America	28	1.22	1.32	1.03	1.12	0.10	0.08	0.92
Middle East	13	1.17	1.81	0.66	1.04	0.13	0.11	0.89
North Africa	5	1.17	1.40	1.06	1.17	0.00	0.001	0.999

Table 7: Plausible Upper Bounds on Variance Decomposition (Modified Human Capital)

region				N	share_x	share_{tfp}
world				168	0.7466	0.3354
Western Countries				18	0.9916	0.6935
Southern Europe				7	0.9856	0.1288
Central & Eastern Europe				24	0.7061	0.3308
	non "Stans"			8	0.9946	0.3672
	"Stans"			16	0.7547	0.3807
New Industrialized Countries				5	0.9927	0.4102
Asia				20	0.9158	0.5210
Sub-Saharan Africa				48	0.8344	0.2722
Latin America				28	0.5892	0.4681
	observe longer than 69 years			16	0.8055	0.5438
	observe fewer than 70 years			12	0.5040	0.5280
Middle East				13	0.4728	0.7892
	observe longer than 57 years			5	0.9821	0.7782
	observe fewer than 58 years			8	0.7621	0.9294
North Africa				5	0.8786	0.6347
larger regions						
W.C. & S.E.				25	0.9843	0.0156
W.C., S.E. & N.I.C.				30	0.9843	0.0159
W.C., S.E., N.I.C., & N.A.				35	0.9965	0.0222
W.C., S.E., N.I.C., N.A, Asia				55	0.9361	0.2136
W.C., S.E., N.I.C., N.A, Asia,	Sub-Saharan Africa			103	0.8753	0.2586
W.C., S.E., N.I.C., N.A, Asia,	Sub-Saharan Africa	, L.A.		131	0.8347	0.2538
W.C., S.E., N.I.C., N.A, Asia,	Sub-Saharan Africa	, L.A.,	Central & Eastern Europe	155	0.8065	0.2514

Table 8: Cross Country Evidence of Human Capital

Country	Lutz (1990)	Relative HC (1990)	Schoellman (2000)	Relative HC (2000)
Australia	131.3	69.6	95.2	68.5
Austria	126.3	54.3	60.8	54.8
Belgium	126.5	84.4	94.8	83.0
Canada	125.8	83.6	92.7	81.8
Denmark	131.4	87.2	56.1	86.0
Finland			53.2	54.0
France	126.5	70.4	54.6	67.6
Germany	117.0	65.5	79.6	67.0
Ireland	119.3	62.8	63.3	63.4
Netherlands	110.2	106.6	87.1	102.9
New Zealand	126.2	68.4	114.7	67.3
Norway	131.0	77.0	116.5	74.9
Sweden	129.2	93.0	136.9	90.4
Switzerland	131.4	85.0	84.4	82.7
United Kingdom	130.5	97.3	82.2	93.7
average	125.9	78.9	84.8	75.9
Cyprus			15.7	52.1
Greece	102.6	34.5	37.4	37.8
Italy	119.1	59.8	34.0	60.6
Portugal	109.4	37.3	21.3	40.2
Spain	105.5	65.3	40.9	66.1
Turkey	107.0	22.9	30.3	26.2
average	108.7	44.0	29.9	47.2
Bulgaria			41.8	23.4
Czechoslavkia	100.5	30.5		
Hungary	100.4	21.7	65.4	23.2
Poland	92.3	23.2	33.5	24.7
Romania	97.8	15.7	45.9	17.7
Russia (U.S.S.R.)	93.0	23.0		
Yugoslavia	111.4	17.1		
average	99.2	21.9	46.6	22.2

Table 8: Cross Country Evidence of Human Capital

Country	Lutz (1990)	Relative HC (1990)	Schoellman (2000)	Relative HC (2000)
Hong Kong	98.3	52.1	60.9	63.4
Japan	136.4	65.6	85.9	70.5
Singapore			71.2	55.0
South Korea	77.6	53.8	35.6	60.1
Taiwan	99.4	50.4		57.4
average	102.9	55.5	63.4	62.2
Bangladesh	78.8	10.7	19.8	10.5
China	77.3	34.0	33.3	39.4
Fiji	81.4	29.0	28.0	26.2
India	97.5	14.5	33.0	17.9
Indonesia	96.7	29.9	32.1	30.7
Malaysia	93.5	34.6	49.8	40.6
Nepal			17.8	14.9
Pakistan	81.9	14.0	24.0	12.4
Philippines	76.4	40.0	40.9	38.2
Sri Lanka	100	49.9	40.8	44.2
Thailand	83	23.5	26.6	24.8
average	86.6	28.0	31.5	27.3
Cameroon			27.6	19.2
Ethiopia	73.8	27.4		22.9
Ghana	70.4	5.5	25.6	5.1
Kenya	99.0	15.8	33.2	15.5
Nigeria	67.1	16.3		13.8
Senegal			20.0	10.0
Sierra Leone			20.1	16.6
South Africa	135.9	17.3	74.5	19.8
Sudan			18.7	7.9
Uganda			23.2	17.4
Zimbabwe			36.4	21.3
average	89.2	16.5	31.5	15.0
Argentina	78.6	68.8	52.8	62.6
Barbados	95.5	52.0		48.6
Belize	84.6	51.3		45.0
Bolivia	78.6	40.0	18.1	39.9
Brazil	94.1	36.3	28.0	37.5

Table 8: Cross Country Evidence of Human Capital

Country	Lutz (1990)	Relative HC (1990)	Schoellman (2000)	Relative HC (2000)
Chile	90.7	62.3	44.2	59.6
Colombia	83.9	35.5	24.8	35.8
Costa Rica	86.4	43.8	23.3	42.5
Dominican Republic	79.1	56.6	20.5	52.6
Ecuador	82.2	68.9	20.4	60.0
El Salvador	74.7	50.4	18.6	47.2
Guatemala	75.9	33.9	17.2	34.6
Guyana	88.7	34.1	34.1	29.7
Haiti	72.7	44.1	20.5	38.9
Honduras	73.0	69.1	18.7	60.6
Jamaica	90.4	20.9	33.8	20.1
Mexico	76.5	62.2	19.2	59.2
Nicaragua	66.5	71.1	21.8	62.3
Panama	90.6	35.3	43.0	32.5
Paraguay			27.9	65.8
Peru	77.3	17.3	30.4	18.1
Puerto Rico	85.3	61.3		57.2
Trinidad & Tobago	91.9	63.7	39.3	57.4
Uruguay	96.3	29.9	29.5	24.3
Venezuela	89.2	36.8	32.4	37.7
average	83.4	47.7	28.1	45.2
Iran	91.2	21.1	35.6	24.0
Iraq	88.3	15.3		15.6
Israel	109.7	61.4	59.4	56.4
Jordan	91.3	22.5	25.9	19.8
Kuwait			72.7	24.1
Syria	106.2	12.7	27.8	11.8
average	97.3	26.6	44.3	25.3
Algeria			29.7	19.3
Egypt	93.7	52.5	33.2	55.2

Table 9: Importance of Factors and TFP at Initial and Final Year

Region	Initial Year ln(X)	Initial Year ln(TFP)	Terminal Year ln(X)	Terminal Year ln(TFP)
World	0.7198	0.4228	0.8456	0.6338
Western Countries	0.9215	0.3240	0.2729	0.7271
Sourthern Europe	0.5401	0.8888	0.7933	0.2424
Central & Eastern Europe	0.9326	0.5656	0.6502	0.4923
Newly Industrialized Countries	0.7183	0.3063	0.4817	0.9039
Asia	0.8261	0.2488	0.7982	0.2311
Sub-Saharan Africa	0.5579	0.4537	0.7224	0.7278
Latin America	0.7590	0.3467	0.6151	0.8221
Middle East	0.7309	0.8874	0.6760	0.3774
North Africa	0.9739	0.7210	0.6385	0.7920

APPENDIX

In this appendix we report the starting year for each country, initial real output per worker, 2007 real output per worker, initial schooling per worker, 2007 schooling per worker, and initial physical capital per worker, and 2007 real physical capital. We present the data by region

country	initial year	y_i	y_{2007}	$H_{initial}^{new}$	$H_{initial}^{\text{modified}}$	H_{2007}^{new}	$H_{2007}^{\text{modified}}$	E_i	E_{2007}	k_i	k_{2007}
Australia	1820	1426	58219	0.9975	0.4914	14.746	13.261	1.2	11.8	1757	165008
Austria	1820	3027	57260	0.9918	0.9918	11.536	11.536	0.4	12.1	6490	176495
Belgium	1820	3488	62561	0.9920	0.9920	16.186	16.186	0.7	11.6	7627	175712
Canada	1820	3335	57774	0.9971	0.9971	15.719	15.719	0.5	13.0	6109	158087
Denmark	1820	3356	57829	0.9930	0.9930	17.069	17.069	3.4	12.9	11173	171874
Finland	1820	3344	57453	0.9923	0.9923	11.306	11.306	0.1	13.0	5723	157852
France	1800	3198	59434	0.9903	0.9903	13.144	13.144	1.0	11.5	6354	172575
Germany	1800	3166	50905	0.9922	0.9922	13.652	13.652	1.5	11.8	4175	147761
Iceland	1950	14604	56104	0.9918	2.9754	6.7086	11.131	7.2	11.7	38943	140119
Ireland	1820	2269	67201	0.9932	0.4893	14.108	12.275	0.6	11.4	3411	145875
Luxembourg	1950	21635	161558	0.9879	1.9758	6.1015	14.463	6.9	10.4	70323	331446
Netherlands	1800	5644	50079	1.0077	2.0154	18.447	19.912	2.7	13.8	15226	138301
New Zealand	1820	1140	43217	0.9945	0.7348	13.973	13.182	0.7	12.6	1084	127413
Norway	1820	2200	68134	0.9920	0.7330	15.859	15.148	3.9	12.0	3866	186420
Sweden	1800	4225	56463	0.9912	1.4648	16.580	17.483	2.5	11.5	7353	145068
Switzerland	1820	2957	53953	0.9907	0.9907	15.933	15.933	1.7	11.0	7688	184552
United Kingdom	1801	4660	57195	0.9986	1.9676	15.749	17.561	1.2	12.5	5553	139496
United States	1790	2931	76083	0.9962	0.9962	19.960	19.960	0.5	13.5	4982	180766
Cyprus	1950	2195	46136	0.9608	0.6153	4.5779	10.410	3.0	9.9	3890	83466
Greece	1820	2107	43620	0.9942	0.2449	12.069	8.0979	0.0	11.3	12733	122334
Italy	1820	2967	57195	0.9922	0.9922	12.321	12.321	0.1	12.3	3737	172249
Malta	1960	4144	46810	4.2701	0.7117	9.4356	9.7749	5.0	10.5	6609	103582
Portugal	1820	2387	33554	0.9910	0.9910	8.6482	8.6482	0.0	10.4	5789	114273
Spain	1820	2794	42103	0.9919	0.9919	13.559	13.559	0.2	12.6	6394	131087
Turkey	1820	1603	18125	0.9931	0.9931	5.8262	5.8262	0.2	9.0	3168	39962
			2								
Albania	1950	2775	10471	0.9478	1.8676	2.7597	5.7108	3.2	9.7	7196	45170
Armenia	1970	19132	28255	0.9353	3.6860	1.9078	5.0277	9.0	10.4	73856	77231
Azerbaijan	1970	11829	18205	0.9398	2.7780	2.2739	5.2328	7.7	11.1	47441	51324
Belarus	1970	13398	26022	0.9317	2.7538	2.2452	5.2644	9.7	12.3	52712	83120
Bulgaria	1870	1965	25099	0.9413	0.9274	4.6078	6.0535	0.4	11.7	5106	87249
Czech Republic	1820	2189	30060	0.9433	0.5576	7.0960	6.2077	0.8	11.4	5034	125165
East Germany[1]	1964	16742	12113	5.3633	5.3633	8.6521	8.5847	5.2	9.1	43000	96412
Estonia	1970	20095	46814	0.9343	3.6818	2.4214	8.7318	7.7	12.0	79849	133373
Georgia	1970	15813	13723	0.9356	3.6873	2.2485	2.5925	8.5	11.6	64208	65073
Hungary	1869	3030	26659	0.9462	1.6314	7.1164	5.8177	2.7	11.2	6430	84886
Kazakhstan	1970	19297	24969	0.9405	2.3165	2.4100	3.3766	7.8	12.4	85765	73260
Kyrgyzstan	1970	10316	7311	0.9467	2.7514	2.1134	1.9868	5.2	10.6	41929	31950

country	initial year	y_i	y_{2007}	$H_{initial}^{new}$	$H_{initial}^{\text{modified}}$	H_{2007}^{new}	$H_{2007}^{\text{modified}}$	E_i	E_{2007}	k_i	k_{2007}
Latvia	1970	17518	37751	0.9224	3.1806	2.0957	7.4710	9.6	11.9	71247	106004
Lithuania	1970	18598	28852	0.9310	3.4395	2.3362	7.6454	10	12.2	79698	94677
Moldova	1970	13015	8133	0.9388	3.6997	2.0271	2.2620	8.5	10.9	53524	60365
Poland	1870	2102	26448	0.9552	1.8821	6.1577	6.2203	0.5	11.8	6988	74254
Romania	1870	1853	11804	0.9457	1.1646	6.2284	4.6780	0.4	10.7	3545	47130
Russia	1820	1686	20465	0.9476	0.6535	6.2400	5.9250	0.2	12.7	4564	67179
Slovak Republic	1990	20238	31841	4.3162	2.8055	6.2604	4.8851	9.6	11.1	62533	94822
Tajikistan	1970	14427	5552	0.9503	3.2770	2.2283	2.2962	9.7	11.2	60243	30984
Turkmenistan	1970	13781	10026	0.9459	3.2619	2.3033	2.5111	7.7	11.3	58055	46676
Ukraine	1970	11829	12492	0.9323	3.6740	2.2772	3.5639	10.0	12.0	51725	67380
Uzbekistan	1970	17323	13539	0.9463	3.7294	2.1952	3.5448	9.2	11.5	66411	34151
Yugoslavia	1910	2610	16412	0.9456	1.0713	2.6845	4.6884	0.2	9.2	12943	151214
Hong Kong	1820	1675	73162	0.9887	0.4140	11.226	13.600	0.6	9.9	2576	184024
Japan	1820	1783	54457	0.9918	0.5863	13.426	14.142	1.1	11.8	4596	202351
Singapore	1820	1779	66158	0.9920	0.4496	7.7384	11.641	0.2	10.4	2466	188295
South Korea	1820	2176	47572	0.9910	0.9519	6.9916	12.537	0.0	11.7	2248	144565
Taiwan	1820	1503	55657	0.9954	0.4168	7.8720	11.955	0.1	10.7	1908	102266
Afghanistan	1950	2482	2171	0.9370	1.4055	1.2942	1.7832	0.3	2.8	2975	2155
Bangladesh	1950	1190	2007	0.9255	0.9255	2.3356	2.3356	1.6	6.2	2243	5324
Bhutan	1980	1416	7000	0.9789	0.9789	1.4509	4.9048	0.6	1.4	3214	7991
Cambodia	1950	1120	4542	0.9416	0.4708	2.7793	2.1220	0.8	7.1	1479	4786
China	1820	2006	14558	0.9288	1.3932	7.2356	8.3639	0.3	8.5	2890	34071
Fiji	1960	11757	9529	0.9820	2.9461	3.2779	4.3603	3.8	8.8	26247	37052
India	1820	1388	8845	0.9373	0.4686	5.1374	3.8625	0.0	7.5	4852	15819
Indonesia	1820	2208	105973	0.9360	1.4039	5.5082	6.5789	0.0	8.7	3588	24243
Laos	1950	1649	4862	0.9337	0.9337	2.3907	2.3907	0.4	6.6	2801	11431
Malaysia	1820	1991	28061	0.9429	0.9429	8.1480	8.1480	0.1	9.0	2438	70801
Mongolia	1950	1162	3825	0.9353	1.4029	3.7785	2.6164	1.9	10.7	1242	17617
Myanmar	1820	1103	6063	0.9394	0.9394	3.9737	3.9737	0.3	6.4	2440	7554
Nepal	1950	1123	3451	0.9381	1.4071	2.2099	3.0293	0.0	6.7	743	7794
North Korea	1820	1628	3125	0.9315	0.9315	5.9911	2.5446	0.0	8.7	464	23825
Pakistan	1950	2796	7753	0.9379	1.4068	1.6981	2.3670	0.7	4.5	5957	13445
Papua New Guinea	1960	2655	4792	0.9802	2.9407	2.2118	4.1669	2.1	5.5	2948	12151
Philippines	1820	1875	8032	0.9420	0.9420	7.5122	7.5122	0.1	10.2	4608	21129
Sri Lanka	1820	1717	13512	0.9391	1.1739	8.2343	8.7010	0.3	9.7	2470	24954
Thailand	1820	1465	18890	0.9390	0.4695	7.7123	6.0470	0.1	8.9	3134	52496
Vietnam	1950	1370	6442	0.9792	0.9792	2.7850	3.6789	0.5	8.3	2257	9661

country	initial year	y_i	y_{2007}	$H_{initial}^{new}$	$H_{initial}^{\text{modified}}$	H_{2007}^{new}	$H_{2007}^{\text{modified}}$	E_i	E_{2007}	k_i	k_{2007}
Angola	1950	2553	4160	0.9525	2.3461	1.4670	2.8313	0.0	4.6	1116	3351
Benin	1950	2485	4360	0.9589	1.4170	1.8873	1.8167	0.5	6.0	2816	6403
Botswana	1950	975	22499	0.9616	1.4211	3.0327	10.539	0.9	9.4	695	43040
Burkina Faso	1950	1008	3086	0.9590	3.3069	1.1182	3.7587	0.3	2.9	179	5584
Burundi	1950	728	1229	0.9548	2.3518	1.3925	2.7416	0.7	4.1	147	1717
Cameroon	1950	1757	3811	0.9466	2.3315	2.7796	3.3508	0.5	7.4	800	6241
Cape Verde	1950	1663	6793	0.9405	0.9266	2.1943	4.3037	1.0	7.6	3477	12620
Central African Republic	1950	1638	1832	0.9524	2.3458	1.6025	2.8284	0.3	4.7	979	2303
Chad	1950	1142	1622	0.9525	2.3460	1.3620	2.7372	0.1	4.4	733	3024
Comoros	1950	1512	2094	0.9513	2.3431	1.9384	2.9882	0.2	5.6	837	4514
Congo	1950	3130	6817	0.9580	1.4157	3.2206	4.0456	1.1	8.5	6798	18117
Djibouti	1950	3081	3483	0.9507	3.2781	1.1334	3.9082	0.4	3.0	4077	6483
Equitorial Guinea	1950	1628	31388	0.9443	0.9302	2.6410	4.9567	1.0	6.7	340	79248
Eritrea	1990	1410	2288	0.9513	2.8118	1.3304	3.5208	1.7	3.5	727	3933
Ethiopia	1950	885	2265	0.9572	3.3006	1.3596	3.8284	0.1	4.0	125	2085
Gabon	1950	6336	10763	0.9462	2.3305	3.3915	3.7120	1.3	8.3	17365	40625
Gambia	1950	1425	2706	0.9519	2.3446	1.6420	2.8738	0.4	5.3	209	4288
Ghana	1870	1111	4298	0.9546	0.4703	2.9010	0.8844	0.1	7.6	2259	7216
Guinea	1950	883	1523	0.9508	3.2788	1.3396	3.8319	0.6	4.2	498	2027
Guinea Bissau	1950	657	1962	0.9353	0.9353	1.4881	2.2086	0.7	4.6	1487	7071
Ivory Coast	1950	2925	3969	0.9600	2.3646	1.7983	2.7806	0.2	5.6	3621	7311
Kenya	1950	1586	3156	0.9571	1.4115	3.6250	2.9722	1.0	8.8	4004	6978
Lesotho	1950	975	6920	0.9547	2.3515	3.3317	3.5701	1.6	8.3	79	31250
Liberia	1950	2829	4018	0.9343	1.8685	1.7539	3.0156	0.6	7.0	8261	8742
Madagascar	1950	2254	2215	0.9489	2.3372	2.4117	3.1378	3.9	5.2	1637	3292
Malawi	1950	806	1907	0.9335	0.9335	2.1058	2.4383	1.5	7.4	1663	3444
Mali	1950	993	3345	0.9572	0.9430	1.2303	2.6458	0.1	3.9	1639	6748
Mauritania	1950	1201	3876	0.9526	1.4078	1.4546	3.6457	0.1	4.8	1668	7574
Mauritius	1950	10480	32824	0.9566	1.4137	3.6535	5.0211	2.2	9.8	19183	64596
Mozambique	1950	2887	5417	0.9470	2.3324	1.5222	2.8558	0.4	4.8	600	5627
Namibia	1950	6814	18015	0.9375	1.8750	2.5123	4.4667	1.6	9.4	13104	40467
Niger	1950	1541	1541	0.9561	2.3549	1.0877	2.6791	0.1	2.3	838	2337
Nigeria	1950	2274	5360	0.9662	1.9038	2.1041	2.4354	0.7	7.3	1258	10055
Reunion	1950	4829	10563	0.9460	2.3299	3.8944	4.5276	2.0	9.2	9435	28590
Rwanda	1950	1201	2777	0.9536	2.3487	2.5217	3.3207	0.8	7.3	715	3942
Senegal	1950	3256	4805	0.9486	1.4019	1.5667	1.7443	0.8	5.2	4871	8748
Seychelles	1950	5571	18317	0.9328	2.2975	3.9640	4.1614	2.2	9.6	3516	66601
Sierra Leone	1950	1949	1939	0.9523	2.3457	1.9222	3.0190	0.3	6.5	1276	2295
Somalia	1950	2331	1207	0.9601	2.3648	1.0956	2.6984	0.2	1.8	1977	5022

country	initial year	y_i	y_{2007}	$H^{new}_{initial}$	$H^{\text{modified}}_{initial}$	H^{new}_{2007}	$H^{\text{modified}}_{2007}$	E_i	E_{2007}	k_i	k_{2007}
South Africa	1820	1162	14826	0.9508	0.4684	3.8456	4.0745	0.1	9.6	2054	33387
Sudan	1950	2523	5710	0.9582	0.9440	1.4103	1.5858	0.4	4.6	2210	8246
Swaziland	1950	2220	12671	0.9487	1.4020	3.1476	6.5055	1.1	9.3	6212	33005
Tanzania	1950	924	1812	0.9579	3.3030	2.0260	4.2268	0.5	5.7	755	2816
Togo	1950	1522	1924	0.9588	2.3616	2.7183	3.4679	0.7	7.9	1284	5843
Uganda	1950	1590	2756	0.9507	2.3415	1.8954	3.0024	1.0	7.4	573	2128
Zaire	1950	1306	746	0.9583	2.3602	2.1911	3.2433	1.4	5.4	471	1212
Zambia	1950	1730	2271	0.9473	2.3333	3.0441	3.8264	1.0	7.6	3958	6677
Zimbabwe	1950	1839	2424	0.9553	2.3529	3.1746	3.7421	2.2	9.2	6568	10588
Argentina	1870	2996	47029	0.9983	2.4588	5.7691	11.531	0.7	11.5	3039	93660
Bahamas	1960	38359	31675	0.9933	8.807	3.2853	13.164	5.6	10.5	36554	95202
Barbados	1960	10464	30966	0.9904	4.8786	3.2806	8.8921	5.4	10.9	16332	48726
Belize	1960	7913	14582	0.9933	5.3824	3.2039	7.4445	4.9	9.6	9634	34887
Bolivia	1880	1570	7622	0.9939	2.2032	3.6934	8.2117	0.4	9.9	2460	16788
Brazil	1820	2387	15845	0.9956	1.2261	3.8947	7.4597	0.3	9.7	4254	37831
Chile	1820	2468	39093	0.9958	2.9433	5.1438	10.791	0.4	11.1	4428	91416
Colombia	1890	4797	15420	0.9952	1.4708	3.4996	7.1943	0.4	8.5	27090	28436
Costa Rica	1920	5118	20274	0.9961	1.4721	4.3586	7.8009	1.5	9.1	17551	36655
Cuba	1930	5218	7367	0.9946	2.9397	4.1695	7.4620	2.7	10.2	31887	13113
Domincan Republic	1950	3362	13422	0.9969	0.9969	3.5947	9.3143	1.1	9.3	4116	26310
Ecuador	1940	4413	9797	0.9952	5.8829	3.7277	10.184	2.5	9.8	4711	28522
El Salvador	1920	3419	8754	0.9963	3.9265	4.7441	8.4098	1.5	10.0	5245	18115
Guatemala	1921	4969	15905	0.9963	2.4541	2.7643	7.0880	1.1	8.0	7048	25533
Guyana	1946	3905	7705	0.9936	2.9368	3.7610	5.1416	5.5	8.9	9255	28347
Haiti	1945	2362	2012	0.9947	4.8999	1.9660	6.8832	0.8	5.4	2659	4518
Honduras	1920	4667	6430	0.9965	6.8724	3.2745	10.346	1.4	8.1	4832	19891
Jamaica	1820	2149	10589	0.9960	0.6786	5.0234	4.0121	0.0	10.8	14535	39865
Mexico	1820	1906	24467	0.9979	1.7205	3.9386	10.814	0.1	9.5	5674	66480
Nicaragua	1920	4240	5341	0.9976	6.8800	3.4158	10.431	1.0	8.6	9524	17397
Panama	1945	7089	19612	0.9956	2.4523	3.9971	5.8657	2.9	10.4	14291	44235
Paraguay	1939	7627	8460	0.9953	6.8640	3.9748	11.334	4.1	8.4	21180	22606
Peru	1900	2105	12785	0.9949	0.9949	4.0459	3.5069	0.6	9.8	1611	29508
Puerto Rico	1950	8654	43086	0.9932	4.8926	3.6957	10.337	5.4	11.5	22750	95420
Suriname	1950	6724	19929	0.9931	2.3313	3.4269	7.7343	2.1	9.7	20114	51460
Trinidad & Tobago	1946	10455	61656	0.9940	4.8965	3.5031	10.246	6.4	10.3	10447	103422
Uruguay	1870	6938	23364	0.9969	1.4161	4.6348	4.8494	0.8	10.7	17238	46253
Venezuela	1820	1761	25453	0.9959	0.9408	3.6878	7.4121	0.3	9.1	3815	61194

country	initial year	y_i	y_{2007}	H_i^{new}	H_i^{modified}	H_{2007}^{new}	$H_{2007}^{\text{modified}}$	E_i	E_{2007}	k_i	k_{2007}
Bahrain	1950	6001	16457	0.9959	0.9959	4.6855	2.7087	1.0	9.1	6290	28307
Iran	1820	2312	19484	0.9931	1.4676	2.8766	5.0785	0.0	9.4	3161	54393
Iraq	1820	2685	9831	0.9924	1.4666	2.9318	2.7529	0.0	8.7	3458	29310
Israel	1948	10409	53057	4.9320	5.5515	7.7462	10.256	5.4	11.8	9226	132108
Jordan	1950	11026	18841	0.9963	1.9631	3.8478	4.0076	2.5	10.1	18890	35901
Kuwait	1950	69625	23238	0.9989	1.9683	4.1202	4.4230	1.3	7.7	79123	44959
Lebanon	1820	2823	11852	0.9919	0.9772	3.7134	2.1155	0.1	10.5	5758	35656
Oman	1950	2860	26662	0.9920	1.9548	2.4381	4.8063	0.1	6.8	1319	30187
Qatar	1950	102853	36275	0.9944	1.9593	4.7508	5.0050	1.7	7.8	118559	70782
Saudi Arabia	1950	9157	31330	0.9976	1.9657	2.7882	3.4603	0.3	7.2	1827	52257
Syria	1820	3347	24549	0.9942	0.9795	3.2839	2.0464	0.0	8.9	3879	39115
U.A.E.	1950	81144	40150	0.9956	1.9618	4.1553	4.6952	1.3	5.3	23525	95403
Yemen	1950	2636	11789	0.9952	1.9609	2.5201	5.1030	0.2	7.6	2078	15399
Algeria	1820	1312	10294	0.9946	0.9779	2.9506	3.9533	0.0	10.0	1140	32288
Egypt	1820	1394	13809	0.9944	1.2246	3.4791	10.633	0.0	10.3	1235	15272
Libya	1950	3760	8838	0.9957	4.9047	3.8030	8.5774	1.1	10.6	4084	39294
Morocco	1820	1539	11100	0.9926	1.1735	2.1995	8.9775	0.0	6.3	3119	19435
Tunisia	1820	1565	19014	0.9939	0.9302	3.3566	10.350	0.0	9.7	2664	37772

region	N	g_y	g_k	g_h	g_x	g_{tfp}	share$_{tfp}$	share$_x$
world	168	1.33	2.04	1.11	1.42	-0.09	-0.06	1.04
Western Countries	18	1.69	1.85	1.52	1.63	0.06	0.04	0.95
Southern Europe	7	2.55	2.72	1.88	2.16	0.39	0.15	0.85
Central & Eastern Europe	24	0.78	0.93	0.49	0.63	0.15	0.19	0.81
New Industrialized Countries	5	1.87	2.20	1.41	1.67	0.20	0.11	0.89
Asia	20	1.49	1.82	1.30	1.47	0.02	0.01	0.99
Sub-Saharan Africa	48	1.32	2.89	1.05	1.66	-0.34	-0.26	1.26
Latin America	28	1.26	1.58	1.03	1.21	0.05	0.04	0.96
Middle East	13	0.99	2.20	1.38	1.66	-0.67	-0.68	1.68
North Africa	5	1.24	1.90	0.70	1.10	0.15	0.12	0.88
population weighted								
world	168	1.18	1.47	1.02	1.17	0.01	0.01	0.99
Western Countries	18	1.46	1.67	1.34	1.45	0.01	0.004	0.996
Southern Europe	7	1.47	1.65	1.25	1.38	0.10	0.06	0.94
Central & Eastern Europe	24	0.88	1.08	0.50	0.69	0.19	0.21	0.79
New Industrialized Countries	5	1.81	2.10	1.46	1.67	0.14	0.08	0.92
Asia	20	1.12	1.13	1.07	1.09	0.03	0.03	0.97
Sub-Saharan Africa	48	1.03	2.68	0.91	1.50	-0.47	-0.46	1.46
Latin America	28	1.22	1.35	0.80	0.98	0.24	0.19	0.81
Middle East	13	1.39	2.42	0.87	1.39	0.00	0.003	0.997
North Africa	5	1.18	1.46	0.59	0.88	0.30	0.26	0.74

Table A2: *Economic Inquiry* weights

region	N	gy	gk	gh	gx	gtfp	share$_{tfp}$	share$_{x}$
world	168	1.17	1.33	1.03	1.13	0.04	0.04	0.96
Western Countries	18	1.45	1.67	1.34	1.45	0.01	0.005	0.995
Southern Europe	7	1.45	1.63	1.23	1.37	0.08	0.06	0.94
Central & Eastern Europe	24	1.25	1.41	0.74	0.96	0.29	0.23	0.77
New Industrialized Countries	5	1.81	2.10	1.46	1.67	0.14	0.08	0.92
Asia	20	1.05	1.06	1.04	1.05	0.00	0.001	0.999
Sub-Saharan Africa	48	1.06	2.45	0.92	1.43	-0.37	-0.35	1.35
Latin America	28	1.22	1.32	0.74	0.93	0.29	0.24	0.76
Middle East	13	1.17	1.81	0.67	1.05	0.12	0.10	0.90
North Africa	5	1.17	1.40	0.57	0.85	0.33	0.28	0.72

Table A3: Plausible Upper Bounds on Variance Decomposition (only initial conditions changed)

region	N	share$_x$	share$_{tfp}$
world	168	0.5059	0.5076
Western Countries	18	0.9236	0.7528
Southern Europe	7	0.9841	0.9262
Central & Eastern Europe	24	0.5271	0.5934
New Industrialized Countries	5	0.9453	0.2830
Asia	20	0.3731	0.7476
Sub-Saharan Africa	48	0.6337	0.4497
Latin America	28	0.5386	0.5964
Middle East	13	0.2639	0.7919
North Africa	5	0.7125	0.5066
larger regions			
W.C. & S.E.	25	0.9735	0.8941
W.C., S.E. & N.I.C.	30	0.9706	0.8824
W.C., S.E., N.I.C., & N.A.	35	0.9097	0.6389
W.C., S.E., N.I.C., N.A, Asia	55	0.6419	0.6327
W.C., S.E., N.I.C., N.A, Asia, Sub-Saharan Africa	103	0.6040	0.5429
W.C., S.E., N.I.C., N.A, Asia, Sub-Saharan Africa, Central & Eastern Europe	127	0.5659	0.4462
W.C., S.E., N.I.C., N.A, Asia, Sub-Saharan Africa, Central & Eastern Europe, L.A.	155	0.5580	0.4491