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# The Rise and Fall of Worldwide Education Inequality from 1870-2010: Measurement and Trends

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# **The rise and fall of worldwide education inequality from 1870-2010: Measurement and trends**

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## **Abstract**

This research documents long-run trends in between-country education inequality and proposes a method for doing so that accounts for the ways in which most education variables differ from continuous variables such as income. Historical, national-level estimates of primary schooling enrollment rates and years of completed primary, secondary, and total schooling are used to identify several problems that arise when formal measures of inequality are employed to estimate inter-country education convergence, including violation of the welfare, scale invariance, and anonymity principles. An alternate measurement strategy shows that the inter-country trend in the dispersion of education has followed an approximately normal curve over the last 140 years, but with considerable variation across measures of education. These results are in contradiction to previous education inequality studies, which have reported either monotonically rising or falling inter-country inequality.

# **THE RISE AND FALL OF WORLDWIDE EDUCATION INEQUALITY FROM 1870-2010: MEASUREMENT AND TRENDS**

## **INTRODUCTION**

The increasing availability of comparable cross-national measures of education has contributed to a growing body of transnational education scholarship. This scholarship has, in turn, established the basic world trends in education and shed considerable light on the causes and consequences of the global expansion of mass schooling. It is now widely accepted that the Western model of mass education has been diffusing around the world for quite some time. So much so, in fact, that it has been called a world education revolution (Meyer et al. 1977). The global expansion of education includes rising literacy rates (Crafts 2002), an increase in schooling enrollment rates (Benavot and Riddle 1988; Benavot et al. 1991; Meyer, Ramirez, and Soysal 1992; Ramirez and Meyer 1980) and completed years of primary, secondary, and tertiary education (Barro and Lee 2000; Cohen and Soto 2007; Morrisson and Murtin 2009), as well as improvements in math and science achievements (Baker and LeTrendre 2005; Sahn and Younger 2007). Worldwide gains in virtually all measures of education have been made possible by positive gains within every major world region (see Figures 2 and 3).

What is not clearly understood, and is the primary goal of this research, is the effect of the worldwide education revolution on inter-country education inequalities. To be sure, average education levels, whether measured by literacy, enrollment rates, education attainment, or test scores, have been rising virtually everywhere (Barro and Wang 2000; Crafts 2002; Goesling and Baker 2008; Morrisson and Murtin 2009; Sahn and Younger 2007), but what this means for the cross-national distribution of education is unclear because among the few attempts to directly

estimate between-country education inequality, there is virtually no agreement about whether inequality is rising or falling.

Previous studies of international education inequality (IEI), or the uneven distribution of education *between* countries, paint as contentious and contradictory a picture of the magnitude and direction of education inequality as we have seen in the income inequality literature. Using Barro and Lee (2000) education data, Goesling and Baker (2008) found that population-weighted inequality in average total completed years of schooling declined by almost 50 percent from 1980 to 2000. Morrisson and Murtin (2009) constructed their own cross-national education database and report falling inequality in completed years of primary, secondary, and higher education from 1870 to 2000, but rising human capital inequality over the same period. In another study, the slowest mid-century school enrollment growth rates were reported in countries with the highest *and* lowest initial levels of education (Meyer et al.1977), suggesting there was little compression in the distribution of education from the 1950s to the 1970s. One of the few studies to consider the unequal distribution of student performance found that while test scores were rising all around the world, there has been virtually no compression in the international distribution of test scores (Sahn and Younger 2007). And in perhaps the most far reaching study of inter-country education inequalities, Kenny (2005) estimated inequality in literacy, years of completed schooling, and primary and tertiary enrollment rates for most of the last half of the 20<sup>th</sup> century using three different tests of convergence: growth rate convergence, sigma convergence, and coefficient of variation convergence. Regressing education growth rates on initial education levels (growth rate convergence), he reported declining inequality in four education outcomes. Using the standard deviation (sigma convergence) to measure education dispersion, Kenny reported *rising* inequality in primary and tertiary school enrollments, no

change in the standard deviation of completed years of schooling, and *declining* inter-country literacy inequality. He also found that the coefficient of variation was smaller in the last survey year than in the first year for all four education outcomes. Based on this survey of studies, it seems all but impossible to establish the basic facts regarding world trends in education inequality. And it is not hard to see that establishing the basic facts about education inequality has significant bearing on a number of other domains of central importance to sociologists, developmental economists, demographers, policy makers, and perhaps most importantly, to ordinary people all around the world.

A large body of research on advanced industrial economies documents a robust relationship between education, wages (including current and lifetime earnings) and occupational mobility *within* countries (see, for example, Card 1999; Hout 1984, 1988). Because of the strong correlation between educational attainment, earnings and occupational mobility, it is likely that rising education inequalities within countries will contribute to rising intra-country income and occupational disparities. A similarly strong link between education and both physical and mental health, including the link between inequalities of education and health disparities (Adler and Newman 2002; Miech et al. 2011), is well documented in previous empirical studies (Long, Ichovics, Gill, and Horwitz 2001; Ross and Wu 1995, 1996).

The implications of *between*-nation differences in average levels of education (IEI), which is the focus of this paper, are equally significant. National education levels, whether measured by literacy rates, enrollment rates, or attainment, are robustly correlated with other measures of human well being such as income levels, life expectancy, and political and religious freedoms. High levels of human capital are associated with higher rates of innovation and technological adaptation (Nelson and Phelps 1966), implying that between-country education inequalities are

likely to contribute to persistent and even growing inequalities in innovative domains such as the health sector, information technologies, and the like. Mulligan and Sali-i-Martin (1992), find a positive correlation between education levels and economic growth (see also Barro and Lee 2010) since higher levels of human capital accumulation contribute to greater investments in physical capital relative to a country's gross domestic product. Nations with higher average levels of education tend to recover from economic shocks faster than those with lower human capital accumulation suggesting that the IEI contributes to inequalities in human suffering. Thus, it is important to know the direction and magnitude of change in international health inequality, since an increase in education inequality is likely to serve as a wellspring for increases in between-nation inequality in other life domains whereas declining inequality might promote declining between-nation inequality in these and other domains.

The central goal of this research is to measure long-run trends in education inequality across countries, regions, and the world for a relatively long period (1870 to 2010) and to expressly link change in IEI to the diffusion of mass education. A secondary goal is to identify some of the challenges associated with measuring inequality in non-pecuniary variables such as education and outline a strategy for doing so that adequately accounts for the ways in which measures of education differ from measures of income and other ratio-scaled variables. In section one, I review terms and concepts central to inequality analysis, highlight several problems that can arise when mean-invariant inequality indexes are used to measure IEI, and propose an alternative method for studying IEI. In section two, I describe the data and methods. In sections three and four, I provide some background and descriptive, historical context for the study of IEI before modeling world trends in schooling inequality from 1870 to 2010.

## **SECTION 1: MEASURING INTERNATIONAL EDUCATION INEQUALITY**

There are at least three reasons why the picture of international education inequality appears to be so muddled. First, most previous studies of international inequality have applied a conceptualization of inequality that often incorrectly favors relative differences over absolute ones. The second reason for the lack of consensus on trends in IEI is due to the incorrect matching of the level of measurement (e.g. ordinal, ratio) with measure of dispersion (e.g. standard deviation, Gini coefficient, etc.). And third, many types of variables can be just as meaningfully expressed in either native scale or in an inverse scale (e.g. literacy/illiteracy, enrolled/non-enrolled). All three issues merit further discussion and we will consider each in turn, but first, we need to explicitly identify some of the most common types of variables used to study inequalities of education in social science research before considering how best to assess the dispersion of these types of variables.

When it comes to measuring cross-national education inequality, researchers have a much wider selection of variables to choose from than in many other types of research. In practice, data coverage often determines which measures are used in a particular study, but some of the most commonly used variables in cross-national education studies are literacy rates, net and gross enrollment rates (primary, secondary, and higher education), schooling completed (primary, secondary, higher, and total years), educational financing, and test scores (e.g. TIMSS).<sup>1</sup> Literacy has become an increasingly popular indicator of the degree to which people have the most basic skills necessary to successfully function in the contemporary world. Enrollments represent access to schooling, and schooling attainment measures quantity of schooling. Education quality can be assessed by inputs such as educational financing or by outputs like math or science scores (Baker and LeTendre 2005; Thomas, Wang, and Fan 2000). Education variables differ from income because they are not typically measured on a ratio scale and can often be expressed in



complementary form. They thus warrant a more cautious approach to the use of relative measures of dispersion in the context of inequality analysis.

*Absolute vs. relative disproportionality.* A key distinction to be made in studies of dispersion is whether to model absolute or relative variation. The measurement of relative disproportionality, or the uneven distribution of  $Y$ , is typically accomplished through some form of mean standardization (Firebaugh 2003; Sala-i-Martin 1996).<sup>ii</sup> The simplest relative measure of inequality is the coefficient of variation, which is the standard deviation divided by the mean ( $CV=sd/\mu$ ). Other relative measures of inequality, which are typically referred to as ‘inequality indexes’ or ‘measures of inequality’ include, among others, the Gini coefficient, Theil index, and the mean log deviation. Relative measures of inequality, which facilitate the comparison of income distributions derived from different currencies, give greater weight to change near the bottom of the income distribution over similar gains near the top of the distribution. The unequal weighting of income gains among the rich and poor is important because it is widely agreed that the value of personal income increases the closer a person is to subsistence living. Thus, relative inequality indexes are more sensitive to small income gains among the poor than among the rich. The problem that arises from using relative measures of inequality such as the Gini coefficient to assess IEI is more clearly understood after first considering two related concepts: level of measurement and complementary scales.

*Level of measurement.* Unlike income, most non-pecuniary variables are not continuous, even though we often treat them as such in our research. A common feature of many non-income variables is they have either absolute or logical upper or lower bounds, or both, which is characteristic of levels of measurement below the ratio scale. National literacy and enrollment rates are reported as a percentage of the population and range from 0-100.<sup>iii</sup> Educational

attainment is typically measured in years and has a lower bound of zero and a probable population-level upper bound of around 15 years (Crafts 2002). The bounded nature of many education variables is important because boundedness affects growth rates, which in turn stands to affect the magnitude and direction of inequality trends. When countries reach the upper limits of the measurement scale in, say, literacy, the only possible gains are among lagging nations and so inequality must decline (Sutcliffe 2004). This kind of phenomenon might be considered a 'saturation effect' because as the universe of potential adopters becomes saturated, there is a dwindling supply of future adopters. Discrete variables trending toward the upper limits are subject to ceiling effects, which favor absolute and relative gains near the top of the distribution, while variables trending toward the lower bound are subject to floor effects that similarly favor small declines near the bottom of the distribution (Cornia and Menchini 2006; Dorius 2008). Thus the limits of the measurement scale favor long-run convergence when variables are trending toward the upper bound and favor divergence for variables trending toward the lower bound.

*Complementarity.* A second unique feature of bounded variables is they can often be meaningfully expressed in complementary, or inverse, scale (Kenny 2005). Examples of complementary variables include literacy ( $Y$ ) and illiteracy ( $\sim Y$ , or not  $Y$ ), the share of enrolled and non-enrolled students, adult survival and mortality (Deaton 2007), and life expectancy at birth and years of lost life (Cornia & Menchini 2006). Complementary variables pose a unique challenge to inequality studies because when a variable can be expressed in complementary form it is possible to produce opposing inequality trends, depending on whether the mean is converging on the lower or upper bound of the measurement scale. When this occurs, complementary variables violate what is known as the anonymity principle.

To be rightly considered a measure of inequality, an index must adhere to a number of principles, including the anonymity, scale invariance and welfare principles. The anonymity principle states that the level of inequality in a given distribution should not be affected by other characteristics of the units of analysis such as race or religion (Litchfield 1999). Similarly, the degree of inequality should be unaffected by the simple switching of how the units are labeled or coded so long as recoding doesn't change the overall distribution. In terms of an income distribution, switching the incomes of any two individuals should have no effect on the observed degree of inequality, while in the context of education distribution, reversing the coding of enrollment rates from enrolled to non-enrolled should similarly leave the level of inequality unchanged.

To see how this works, consider two equally-sized nations comprised of two groups of people, haves and have-nots. In both countries, the haves are enrolled in school and the have-nots are non-enrolled. In Country A, the haves account for 10 percent of the total population (the have-nots account for the remaining 90 percent), and in Country B, the haves account for 90 percent of the total population. Which country is more equal? At first blush, we might be inclined to say Country A is the more equal society because 90 percent of its citizenry are enrolled in school, while only 10 percent of the citizenry of Country B are enrolled, but adherence to the anonymity principle means that if we simply switch enrollment slots within each country so the haves are now the have-nots and the have-nots the haves, the degree of inequality should be unaffected. This is so because the shares are the same in both societies (.90 and .10). We can visualize how this works using national level enrollment data in 1910 for the world.

Figure 1 graphs kernel density estimates for the world distribution of enrolled and non-enrolled students and the average years of primary schooling and lost years of schooling with the assumption of six years as the maximum attainable years. Comparison of the two sets of distributions confirms that the dispersion of enrollments is identical to, but the inverse of, non-enrollments and that the distribution of schooling is identical and inverse to lost years of schooling. We would be hard pressed to claim that one distribution is more equal than the other. In accordance with the anonymity principle, an appropriate measure of variance should report the same degree of inequality for both distributions since a) they contain the same people only with different labels and b) the spread of the two distributions are identical, only inverse. Importantly, standard measures of inequality *violate the anonymity principle when a variable is discrete and can be expressed in complementary form.*

#### **INSERT FIGURE 1 ABOUT HERE**

Returning now to the concept of absolute and relative inequality, let's consider what IEI would look like if we used relative measures of dispersion to gauge the degree of inter-country inequality in primary school enrollments. The population-weighted point estimates reported in Table 1 show that the world school enrollment rate rose from 15.2 percent in 1870 to 93.2 percent in 2000. Absolute change was 77.9 percentage points, but the relative growth rate was 511 percent. Even though absolute change in the world *non-enrollment* rate from 1870-2000 was an identical 77.9, the relative decline was a much smaller 93 percent. That countries trending toward higher primary school enrollment are simultaneously trending toward lower non-enrollment is hardly a surprising finding, so let's consider the inequality trends. Both the Gini coefficient and the Theil index report declining inequality in primary school enrollment and rising inequality in the non-enrollment rate. Because the mean log deviation, the Theil index, and

all other mean standardized inequality indexes were constructed to measure relative income differences, they favor small absolute gains at the bottom of the distribution over similar absolute gains near the top of the distribution.<sup>iv</sup> Switching from enrolled to non-enrolled changes the world mean which, in turn, affects the relative difference between countries. This is a desirable feature when studying something like income, but when the variable of interest is bounded or complementary, it is likely to distort between-country differences in ways that do not reflect the real value or meaning of education at either the individual or national level. To summarize: Formal measures of inequality are mean-standardized. Although mean standardization makes sense for continuous variables such as income, in the case of bounded variables subject to floors and ceiling effects, mean standardization is superfluous *and* it creates problems.

#### **INSERT TABLE 1 ABOUT HERE**

If conventional, mean-standardized measures of inequality such as the Gini are not appropriate for studying the convergence of bounded education variables, what should we use? In keeping with previous conventions, I propose that the best measure for studying cross-national convergence in discrete variables, including binary and proportional variables, is the standard deviation (Allison 1978). While the current study is not the first to use the standard deviation (SD) in the study of cross-nation convergence (Deaton 2007; Neumayer 2004; Sala-i-Martin 1996), it is among the first to spell out the advantages of SD over standard measures of inequality for an entire class of variables. SD has several properties that make it a desirable and intuitive measure of the dispersion of education. First, the upper-bound for SD will never exceed one-half the scale range and SD is zero when the mean of  $Y$  is zero, assuming  $Y$  cannot take on negative values (Ram 1990). With a fixed range of zero to one half the range of the measurement scale, it is relatively easy to gauge both perfect equality and maximum inequality. In the case of

literacy rates, maximum education inequality exists when SD=50 and perfect equality is when SD=0. Because SD will always range between zero and 50 for education *rates* (e.g. literacy, enrollment, graduation, retention, etc.), researchers can readily make cross variable inequality comparisons for many education variables. A second benefit of SD is that since it is reported in the same units as the measurement scale, the substantive meaning of the degree of inequality is often more intuitive than is the case with mean standardized measures. And third, research suggests that SD better fits education models than standard measures of inequality such as the Gini (Ram 1990).

The strength of SD is most apparent in the case of binary variables. Consider again two equally-sized nations comprised of haves and have-nots accounting for 90 percent and 10 percent of the population in each society. Earlier, we asked which of the two countries was more equal. Relying solely on conventional mean-standardized measures of inequality, the country comprised of 90 percent haves would be considered the more equal society. Using SD as our measure of inequality, and consistent with the anonymity principle, we would conclude that the two societies have the same degree of inequality. The standard deviation in both countries is 0.3 since the standard deviation for a proportion is simply

$$\sigma = \sqrt{p(1 - p)} \quad (1)$$

The spread of the distribution is the same in both countries and is confirmed by absolute measures of dispersion such as SD. The same is true of other types of discrete variables such as years of completed schooling: SD will produce the same degree of inequality for completed years as it will for lost years. The symmetrical feature of discrete variables, including binary variables and aggregate measures based on binary outcomes, means that symmetrical measures of dispersion such as SD produce the same estimate of inequality for both  $Y$  and  $\sim Y$ .<sup>v</sup> Scale

invariant measures of inequality are appropriate for continuous variables but as has been illustrated, are problematic when used to make comparisons among distributions of discrete variables.

## **SECTION 2: DATA**

The substantive goal of this research is to document long-run, worldwide trends in educational inequality which necessarily limits the number of education variables for which historical cross-national comparisons can be made. I chose to measure education inequality using primary enrollment rates and years of completed schooling partly for practical reasons—they are among the few variables that have extensive geographic and temporal coverage—and partly for methodological reasons. Because enrollment rates are based on a binary variable, it has a complementary form, that is, the non-enrollment rate. Years of education is a semi-continuous variable with an absolute lower bound but a somewhat ‘softer’ upper bound. Measuring inter-country inequality trends for both variables illustrates the sensitivity of inequality trends to different types of education scales.

Estimates and projections of primary, secondary, and total years of completed schooling for the period from 1870-2010 come from Cohen and Soto (2007) and Morrisson and Murtin (2009).<sup>vi</sup> Population estimates were compiled from four sources: the United Nation’s *World Population Prospects: the 2008 Revision* (United Nations 2009), the World Bank’s *World Development Indicators Database* (2009), a dataset obtained from Benavot and Riddle (1988), and Angus Maddison’s, *The World Economy: Historical Statistics* (2004). I used observed regional growth rates to fill a limited number of missing population observations.<sup>vii</sup>

The enrollment data time series, spanning the period from 1870-2000, was assembled from UNESCO’s Institute for Statistics primary school enrollment data, the World Bank’s *World*

*Development Indicators Database* (2009), and from published estimates (Benavot and Riddle 1988; Easterlin 1981) based on Mitchell's (1998) historical schooling estimates dating back to 1830. The *World Development Indicators* data estimates are *gross* enrollments while the Benavot and Riddle education data are *unadjusted* enrollments. The difference between the two is that the denominator used to calculate the unadjusted enrollment rate is based on a constant school age population of 5-14, while gross enrollment rates use a variable denominator based on the actual age range of primary school attendees in each country. Though calculation of the two enrollment rates is slightly different, the substantive differences in long-run, global trends are negligible (Benavot and Riddle 1988). Easterlin's (1981) data are primary enrollments per 10,000 in the total population, rather than per 100 in the school-aged population. To harmonize the Easterlin data with the other enrollment data I first recalibrated the Easterlin data to enrollments per 100 in the total population and then adjusted the rate to the child population.<sup>viii</sup>

After the data were merged I used linear mean interpolation to fill inter-temporal missingness in the data (e.g. data for  $T_1$  and  $T_3$ , but not  $T_2$ ). The interpolated primary school enrollment data-series accounts for 93 percent of the world's people in 1920 and still a majority of the world's people dating back to the late 1800s. Observed primary enrollment rate data were used to calculate regional growth rates for each ten-year interval from 1870-2000. Assuming countries within each region shared roughly similar growth rates, I then used the average of each of the 14, 10-year regional growth rates over the period 1870-2000 to extrapolate a similar growth rate for countries with missing data.

### **SECTION 3: BACKGROUND AND DESCRIPTIVE ANALYSIS**

It is instructive to begin our analysis of world trends in IEI by first situating the underlying patterns of change in both world and regional means within the context of the larger historical



and theoretical framework that explains the global rise of mass education. World polity theorists have long argued that the worldwide diffusion of mass schooling is part of a larger package of global institutional change whereby a) the nation-state has become an increasingly central global actor and b) the organization of states and national institutions are becoming more uniform in both time and geographic space (Benavot et al. 1991; Ramirez and Meyer 1980). As partial evidence for these claims, they point to the expansion of primary school enrollment rates and show that it is strongly linked to diffusion processes net of economic development and world system position (Meyer et al. 1977).

The world trend in primary schooling reported in Figure 2 confirms that primary schooling enrollments have indeed followed the hallmark S-shape diffusion curve, with slow initial growth followed by a much steeper increase and then a leveling off in the growth rate as countries approach full enrollment. The trends in Figure 2 also suggest that the establishment of formal schooling systems not only made possible rapid gains in enrollment rates, but that time in school, as measured by average years of completed schooling, has also been expanding. Inspection of regional education trends help to illuminate how and why global schooling growth rates have recently begun to accelerate.

### **INSERT FIGURE 2 ABOUT HERE**

In 1870 mass education was largely a regional phenomenon (Figure 3). Europe, including the ‘offshoot’ nations of Canada, the United States, New Zealand, and Australia, was the only country-group with a mean enrollment rate in excess of 20 percent in 1870. As far back as the late 1800s, the mean primary school enrollment rate for this region was over 60 percent and had eclipsed 80 percent by the early 1900s. In all other world regions, 1870 enrollments were below 20 percent. Sixty years later, no other region had yet to achieve a mean enrollment rate of 50

percent. All of that change beginning around the middle of the 20<sup>th</sup> century, when enrollment rates surged in all world regions. By 1970 East Europe, Latin America, and much of Asia had mean enrollments in excess of 80 percent. Even in the lagging nations of West Asia and North Africa, the mean enrollment rate rose by more than 50 percentage points from under 20 percent in 1940 to over 70 percent in 1990. Regional trends in completed years of education paint a similar picture: Europe holds a sizable education advantage over the other five world regions, but recent decades have witnessed sizable increases in both school enrollments and attainment.

### **INSERT FIGURE 3 ABOUT HERE**

Historically large regional disparities in education reflect the origins and early diffusion of mass education where the early pioneers in formal schooling were the Protestant nations of North and West Europe nations (Cippola 1969; Easterlin 1981; Melton 1988). The story of mass education has changed dramatically over the last century from essentially a regional, religious peculiarity rooted in the rise of Protestantism (Cippola 1969) to a worldwide phenomenon. Importantly, we are now fast approaching the time when primary schooling will be a universal fact of life virtually everywhere, an historical first in human history. What should be clear from the trend analysis of world and regional mean education levels is that the overall pattern of education expansion in each of six major world regions was slow initial growth followed by more rapid recent gains. From 1870 to 1940, total years of completed schooling increased by an average of about .3 years per decade but since 1950, the rate doubled to an average of almost .6 years per decade. The post-World War II gains in primary and secondary schooling increased over the pre-war period by 44 percent and 234 percent, respectively. The timing of the ‘globalization’ of mass education is important because it squares with several other significant world developments during this period.

The decades immediately following the end of World War II witnessed the birth of the United Nations, which expedited two other processes—one institutional and the other ideational—that were already well underway. The first was decolonization, which gave rise to a large number of newly independent nations, many of whom were eager to emulate the material successes of their former colonizers. The second was a commonly held set of beliefs about the causes of economic development that provided the ideational roadmap which virtually every nation in the world would soon follow. Societal elites and ordinary people alike throughout the world shared (and continue to share) a common belief that educating individuals and societies would lead to economic and social development of the kind exemplified by rich Western nations (Thornton 2005). The congruence in developmental objectives between UN development agencies, political leaders in Western and non-Western nations alike, and the vast majority of the citizen's of most countries around the world played an essential role in the expansion of mass education. Another significant event contributing to the expansion of mass education across every major world region has been the world polity. The proliferation of world cultural models began long before the more recent global take-off in mass education, but its influence on education inequality was aided by growth in the world polity, including governmental institutions such as the United Nations and non-governmental organizations that shared a common objective of 'developing' all of these newly created nations and peoples. The convergence of developmental goals created tremendous institutional isomorphic pressure which, in turn, guided nation-states into mimicking the institutional structures of western nations, including education systems (Meyer et al. 1997).<sup>ix</sup>

While each of these and other forces provide a model of mass schooling and an essential justification for the universality of education, cross-national variation in the presence and

influence of the world polity (Beckfield 2003) as well as substantial variation in state resources critical to the expansion of mass education suggest that the diffusion of education, though universal, has been far from even. In the next section, we focus more explicitly on the world distribution of education and how it has varied over time.

#### **SECTION 4: DISPERSION ANALYSIS**

*Density distributions.* Density distributions are a useful tool in the analysis of inequality because they provide insights into the data that often go undetected by sole reliance on univariate statistics such as the mean or variance. Kernel density distributions, for example, help to identify multi-modal and other non-normal distributional features in the data. Visual inspection of world education distributions at  $T_1$  and  $T_n$  is also a simple method for assessing between-country education convergence: Compression in the spread of the distribution points to convergence and a widening and flattening distribution suggests divergence, or rising inequality.

Figure 4 graphs three population weighted Gaussian kernel density distributions (1870, 1950, and 2010) for each of the four education measures. The distributions of all four measures were concentrated near zero in 1870 but widened and flattened over time as education expanded. The distribution of primary enrollments gives the clearest example of how mass schooling is, in many ways, a story of worldwide diffusion. Primary schooling was scarce in 1870 and enrollment rates were concentrated near zero. By 1950 the spread of the distribution had widened to nearly the full width of the measurement scale, with some countries still near full non-enrollment and others having achieved universal enrollment. Over the next 50 years, rates increased rapidly among lagging nations and now national average enrollments are tightly concentrated near 100 percent. The distributions in the other three domains appear to be following a similar trajectory,

though with significant variation in both the rate and form of diffusion. For example, the take-off in completed years of primary schooling started earlier than secondary schooling and was bimodal: The majority of nations fall into one of two dominant primary schooling clusters (in 1950, most countries were clustered around one or five years of primary schooling and in 2010, the modal clusters were concentrated near 3.5 and 5.5 years). As recently as 1950, the world distribution of secondary education was still positively skewed with most nations clustered around very low secondary attainment levels. By 2010, a large number of nations were clustered around 1.5 years of secondary schooling, and a much smaller cluster of leading nations had begun to cluster near full secondary schooling attainment, suggesting that secondary schooling may yet follow the sharply bimodal diffusion pattern observed in primary schooling attainment.

**INSERT FIGURE 4 ABOUT HERE**

*Inequality analysis.* I have argued that measures of absolute dispersion are preferred over mean-standardized measures of inequality when the purpose of the research is to compare the distributions of discrete measures of education. In Figure 5, I report trends in the standard deviation of primary school enrollments and completed years of primary, secondary, and total schooling from 1870-2010. I graph unweighted trends (each country treated equally) and trends that are population weighted by the size of each country's total population.<sup>x</sup> In unreported analysis, I also used a child population weighting scheme and the results were nearly identical to the total population results reported here. My discussion will largely focus on the population weighted estimates since the results are broadly similar regardless of whether or not the data are weighted by population.

Inequality trends in each of the four domains were sufficiently similar that we can draw several broad conclusions regarding between-country education inequality. First, the worldwide

expansion of education was decidedly uneven. By each measure, inequality rose sharply as mean levels of education rose. Second, the long-run inequality trend appears to be following an inverted U-shape of first rising and then falling inequality. The pattern of rising and then falling inequality, referred to as the inequality transition (Dorius 2010; Firebaugh 2003), is unequivocal in primary schooling and though it is too early to state with certainty, it appears that the same general pattern is unfolding in secondary and total years of completed schooling. And third, there is considerable variation in the inequality slopes and in the timing of peak inequality across the four education variables.

Primary enrollment inequality peaked in 1910 (SD=30) before declining to just over 10 percent in 2000, meaning that over 60 percent of the world's people now live in a society where the primary enrollment rate is at least 83 percent (mean enrollment in 2000=93 percent).<sup>xi</sup> Inequality in primary years of education reached a peak SD of 2.1 in 1940 and has been declining at an even faster pace than enrollment inequality ever since. In fact, between-country inequality in both primary school indicators is lower now than at any point in the last 130 years. The high water mark for inter-country inequality in secondary and total completed years of education was 1990 and 1980, respectively.

If we ignore the modest degree of cross-national variation in the required number of years to graduate from school and assume that every country requires six years to complete primary schooling and an additional six years to complete secondary education (and this assumption is very close to reality) then we can identify a critical distinction between trends in the mean and SD of primary and secondary years of education. The inequality transition in primary schooling was more compressed than the secondary schooling transition, but also more unequal. Secondary education inequality took almost 50 years longer to peak than primary education inequality, but

it peaked about .4 years lower than did primary schooling, which means that while secondary education is expanding more slowly than primary education, the expansion has also been more equitable. With the world fast approaching full primary enrollment and universal primary school completion, education inequalities in the 21<sup>st</sup> century will largely play out in secondary and higher educational attainment (and, of course, schooling inputs, returns to education, and academic performance).

One final observation regarding world IEI trends is worth noting. The unweighted inequality trends closely paralleled the population weighted trends in all three completed years of schooling measures, and to a somewhat lesser degree in primary enrollments. In simplest form, when weighted and unweighted inequality trends sharply differ in either level or trend, it means that what is happening in very large countries is not representative of what is occurring in the average country. We have the opposite case with education inequality: What is happening in the average nation is also occurring in very large countries, which is to say that education is expanding everywhere and not just in a few large countries such as India, China, or Brazil.

#### **INSERT FIGURE 5 ABOUT HERE**

We have seen that the early expansion of education was highly uneven, but that the recent past witnessed a general trend toward cross-national convergence in measures of education. In concluding, it is useful to disaggregate the world education inequality trends separately by region because it points to future directions in IEI research. The same pattern of first rising and then falling between country inequality that we observed at the world level is occurring at the regional level, but with some notable inter-regional differences (Figure 6). By three of the four measures, regional inequality was greatest in Asia and if current trends hold, education inequality in the Middle East and North Africa (MENA) will be similarly unequal. The expansion of mass

education was the most equitable in Latin America and Europe. By three of the four measures, inequality peaked at the lowest levels in Latin America, with total years of completed schooling peaking at the lowest level among European countries.

A comparison of education trends in Asia and Latin America is instructive. The mean level of education in Latin America and Asia followed a parallel trajectory in all four domains, with mean education in Asia slightly lower than in Latin America at every time period (Figure 3). *Inequality* trends in the two regions were not nearly as uniform since peak levels of inequality in Latin America were less than half the levels recorded in Asia. A comparison of the inequality trends across regions suggest that local factors, such as regional heterogeneity of linguistic, cultural, economic, and political context are likely causes of inter-regional variation in education inequality. Latin America, for example, has a much more homogenous religious, linguistic, and colonial heritage than either Africa or Asia and it is likely that the higher relative degree of intra-regional homogeneity in Latin America is partly responsible for the more equitable diffusion of mass education in that region than in others.

**INSERT FIGURE 6 ABOUT HERE**

## **SECTION 5: DISCUSSION**

This research set out to measure long-run world trends in education inequality and to establish a method for doing so that adequately accounts for the ways in which measures of education differ from measures of income. Because many of the variables mostly frequently used in cross-national research are bounded and can often be expressed in complementary form, researchers must carefully consider the risks associated with using mean-standardized measures of inequality for traditional inequality analysis of education. I have argued that using the standard deviation or other, similarly non-normalized statistics is an appropriate method for



measuring world education inequality of symmetrical education variables, at least in the context of convergence analysis.

Inequality trends from 1870 to 2010 indicate that we are rapidly approaching the end of inter-country inequality in primary school enrollments and in years of completed primary schooling. Should the same patterns hold for secondary and total years of completed schooling, we can expect to see a steady decline in inter-country education inequality in both secondary and total years of completed education over the coming years. Since the contours of world education inequality were broadly similar regardless of which weighting scheme was used, we can conclude that the trends reflect both a world phenomenon (population-weighted) and a national phenomenon (country weighted).

It is possible to draw at least two broad conclusions from this research. First the global expansion of mass schooling can be accurately characterized as a worldwide education revolution (Meyer et al. 1977). Educational enrollment rates and completed years of schooling have been rising virtually everywhere for over 100 years and have more recently begun to accelerate. Even places that lagged behind the rest of the world, such as North Africa and West Asia, have experienced such large absolute gains in schooling over recent years that they are converging on, and even eclipsing observed rates in other regions.

Second, the transition from low to high education led first to rising inequality and only much later, declining IEI. Much like with other forms of innovation diffusion, the onset of mass education was concentrated among a small number of innovator nations. In this case, the innovators were the Protestant countries of Europe, including offshoot nations (Cippola 1969; Easterlin 1981; Melton 1988). The spread of mass education outside of Europe led to an increase in world education inequality that only began to decline fairly recently. Ultimately, between-

country inequality in access to, and quantity of, education can be expected to continue to decline so long as the worldwide education revolution continues.

World polity theorists have described the history of nations and its people as being comprised of “eras of innovation and contestation and eras of consolidation and institutionalization” (Ramirez et al. 1997; see also Tolbert and Zucker 1983, Bradley and Ramirez 1996). Within the context of education, the origins and early expansion of mass schooling represent a period of innovation and contestation that led to rising between-country inequality. In the more recent past, the world appears to have entered a period of consolidation because of the institutionalization of the western model of mass education. The worldwide institutionalization of formal schooling, in turn, is a central reason for more recent declines in inter-country education inequalities.

A key finding of this research is that low-education nations are catching up with high education nations in enrollment rates and completed years of schooling. This finding is a worthy cause for celebration. The very fact that secondary schooling attainment is diffusing more equitably than primary schooling is reason for cautious optimism about the future of inequalities in domains such as health and income. As the world continues to converge toward universal literacy and enrollment, however, it is likely that new forms of education inequality will replace older inequalities in both access to education and quantity of education. Already, we see sizable inter-country gaps in test scores (Sahn and Younger 2007) and spending on education. Without nimble intergovernmental policy prescriptions and continued efforts by governmental and non-governmental agencies alike, it is probable that education outcomes, such as test scores, occupational mobility, post-schooling earnings, and health disparities, will exhibit a high degree of between-country inequality in the coming years.

## REFERENCES

- Adler, N.E. and Newman, K. 2002. "Socioeconomic Disparities in Health: Pathways and Policies. Inequality in Education, Income, and occupation Exacerbates the Gaps Between Health Haves and Have-nots." *Health Affairs* 21:60-76.
- Allison, Paul. 1978. "Measures of Inequality." *American Sociological Review* 43:865-880.
- Baker, David and Gerald LeTendre. 2005. National Differences, Global Similarities: World Culture and the Future of Schooling. Palo Alto, CA: Stanford University Press
- Barro, Robert J. and Jong-Wha Lee. 2000. "International Data on Educational Attainment: Updates and Implications." (Center for International Development Working Paper No. 42, April)
- Barro, Robert J. and Jong-Wha Lee. 2010. "A new data set of educational attainment in the world, 1950-2010." NBER working paper number 15902.
- Beckfield, Jason. 2003. "Inequality in the World Polity: The Structure of International Organization." *American Sociological Review* 68:401-424.
- Benavot, Aaron and Phyllis Riddle. 1988. "The Expansion of Primary Education, 1870-1940: Trends and Issues." *Sociology of Education* 61:191-210.
- Benavot, Aaron, Yun-Kyung Cha, David Kamens, John W Meyer, and Suk-Ying Wong. 1991. "Knowledge for the Masses: World Models and National Curricula, 1920-1986." *American Sociological Review* 56:85-100.
- Bradley, Karen, and Francisco O. Ramirez. 1996. "World Polity and Gender Parity: Women's Share of Higher Education, 1965-1985." *Research in Sociology of Education and Socialization* 11:63-91.
- Card, David. 1999. "The Causal Effects of Education on Earnings". In *Handbook of Labor*

- Economics*, vol 3. Eds O. Ashenfelter and D Card. Elsevier Science.
- Cippola, C.M. 1969. Literacy and Development in the West. Harmondsworth, England: Penguin Books.
- Cohen, Daniel, and Marcello Soto. 2007. "Growth and Human Capital: Good Data, Good Results." *Journal of Economic Growth* 12:51-76.
- Cornia, Giovanni Andrea and Leonardo Menchini. 2006. "Health Improvements and Health Inequality during the Last 40 Years." *WIDER Research Paper: UNI-WIDER*: 1-26
- Crafts, Nicholas. 2002. "The Human Development Index, 1870-1999: Some Revised Estimates." *European Review of Economic History* 6:395-405.
- Deaton, Angus. 2007. "Global Patterns of Income and Health: Facts, Interpretations, and Policies." UNU-WIDER Annual Lecture 10.
- Dorius, Shawn. 2008. "Global Demographic Convergence? A Reconsideration of Changing Intercountry Inequality in Fertility." *Population and Development Review* 34:519-537.
- Dorius, Shawn F. and Glenn Firebaugh. 2010. "Trends in Global Gender Inequality." *Social Forces* 88:1941-1968
- Easterlin, Richard A. 1981. "Why Isn't the Whole World Developed?" *The Journal of Economic History* 4:1-19.
- Firebaugh, Glenn. 2003. *The New Geography of Global Income Inequality*. Cambridge and London: Harvard University Press.
- Goesling, Brian and David P. Baker. 2008. "Three Faces of International Inequality." *Research in Social Stratification and Mobility* 26:183-198.
- Hout, Michael. 1984. "Status, Autonomy, and Training in Occupational Mobility." *American Journal of Sociology* 89:1379-1409.

- Hout, Michael. 1988. "More Universalism, Less Structural Mobility: The American Occupation Structure in the 1980s." *American Journal of Sociology* 93:1358-1400.
- Kenny, Charles. 2005. "Why are We Worried About Income? Nearly Everything That Matters is Converging." *World Development* 33:1-19.
- Litchfield, Julie A. 1999. Inequality: Methods and Tools. World Bank Working Paper.  
Downloaded March 2010 from  
"<http://siteresources.worldbank.org/INTPGI/Resources/Inequality/litchfie.pdf>"
- Long, J.A., Ichovics, J.R., Gill, T.M., and Horwitz, R.J. 2001. "The Cumulative Effects of Social Class on Mental Status Decline." *Journal of the American Geriatrics Society*. 49: 1005-1007.
- Maddison, Angus. 2004. *The World Economy: Historical Statistics*. Organization for Economic Co-operation and Development: Paris.
- Miech, Richard, Fred Pampel, Jinyoung Kim, and Richard G. Rogers. 2011. "The Enduring Association between Education and Mortality: The Role of Widening and Narrowing Disparities." *American Sociological Review* 76:913-34.
- Morrisson and Murtin.2009. "The Century of Education". *Journal of Human Capital* 3:1-42
- Meyer, John W, Francisco O Ramirez, Richard Rubinson, and John Boli-Bennett. 1977. "The World Education Revolution, 1950-1970." *Sociology of Education* 4:242-258.
- Meyer, John W, Francisco O Ramirez, and Yasemin Soysal. 1992. "World Expansion of Mass Education, 1870-1980." *Sociology of Education* 65: 128-49.
- Mulligan, Casey B and Xavier Sala-i-Martin.1993. Transitional Dynamics in Two-Sector Models of Endogenous Growth. *The Quarterly Journal of Economics*. 108(3): 739-73.
- Nelson, R. R. and E. S. Phelps. "Investment in Humans, Technological Diffusion, and Economic Growth," *American Economic Review*. 56(2): 67-75.

- Ram, Rati. 1990. "Educational Expansion and Schooling Inequality: International Evidence and Some Implications." *The Review of Economics and Statistics* 72: 266-274.
- Ramirez, Francisco O, John W Meyer. 1980. "The Social Construction of the Modern World System." *Annual Review of Sociology* 6:369-399.
- Ramirez, Francisco O., Yasemin Soysal, and Suzanne Shanahan. 1997. "The Changing Logic of Political Citizenship: Cross-National Acquisition of Women's Suffrage Rights, 1890 to 1990." *American Sociological Review* 62:735-745
- Ross, C.E. and Wu, C. 1995. "The Links Between Education and Health." *American Sociological Review* 60:719-745.
- Ross, C.E. and Wu, C. 1996. "Education, Age, and the Cumulative Advantage in Health." *Journal of Health and Social Behavior* 37:104-120.
- Sahn, David E. and Stephen D Younger. 2007. "Decomposing World Education Inequality." Cornell Food and Nutrition Policy Program No. 187.
- Sala-i-Martin, Xavier X. 1996. "The Classical Approach to Convergence Analysis." *The Economic Journal* 106:1019-1036.
- Sutcliffe, Bob. 2004. "World Inequality and Globalization." *Oxford Review of Economic Policy* 20:15-37.
- Thomas, Vinod, Yan Wang and Xibo Fan. 2000. "Measuring Education Inequality: Gini Coefficients of Education." *World Bank Policy Research Working Paper*, no. WPS2525. Washington, D.C.: World Bank.
- Thornton, Arland. 2005. Reading History Sideways. The Fallacy and Enduring Impact of Developmental Paradigm on Family Life. University of Chicago Press: Chicago, IL.
- Tolbert, Pamela S. and Lynne G. Zucker. 1983 "Institutional Sources of Change in the Formal

Structure of Organizations: The Diffusion of Civil Service Reform, 1880-1935."

*Administrative Science Quarterly* 28:22-39.

United Nations. 2009. *World Population Prospects: the 2008 Revision*.

—. 2009. Demographic Yearbook. United Nations, Department of Economic and Social Affairs.

World Bank. 2009. World Development Indicators 2009. Washington, DC: World Bank.

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<sup>i</sup> TIMSS has a limited temporal scope (1995-2007) and less extensive regional coverage than other international education variables and so it has not been as widely used in international convergence studies (Sahn and Younger 2007).

<sup>ii</sup> There is some confusion over the meaning and use of the term ‘absolute’ in the context of dispersion analysis, with some suggesting that mean standardization is what constitutes an absolute measure of dispersion (Yule and Kendall 1968). Here I take the more conventional view that *relative* disproportionality is the essential feature of mean standardized measures of inequality.

<sup>iii</sup> It is not uncommon for *gross* enrollment rates to exceed 100 percent for a short time. This typically occurs in the early stages of mass schooling expansion when youth and adults above the primary school age range are enrolled in school and is seen as reflecting pent-up demand for schooling.

<sup>iv</sup> Not all relative measures of inequality give greater weight to change at the bottom of the distribution. The Gini coefficient, for example, gives greater weight to change near the middle of the distribution. The common feature of relative measures of inequality that is relevant to education inequality is that identical improvements in education have a differential effect on the degree of education inequality, depending on their location in the overall distribution.

<sup>v</sup> Standard deviations are symmetrical in the sense that one unit below the mean is equivalent to one unit above the mean.

<sup>vi</sup> See Morrisson and Murtin (2009) for a detailed explanation of how the completed schooling estimates were obtained.

<sup>vii</sup> I tested a number of alternative time spans in order to obtain an appropriate average growth rate for each region and the 1820-2000 average most closely approximated the world population totals provide by Maddison (2004).

<sup>viii</sup> The United Nations (2005) estimates the average share of the under-16 population in less-developed countries to be approximately 37 percent of the total population. After testing a number of estimates, I found that for pre-demographic transition societies, using a 45 percent child population share most closely approximated the Benavot and Riddle historical estimates. Using this figure, the Easterlin enrollment estimates were nearly identical to the Benavot estimates, with a mean deviation of less than 10 percentage points.

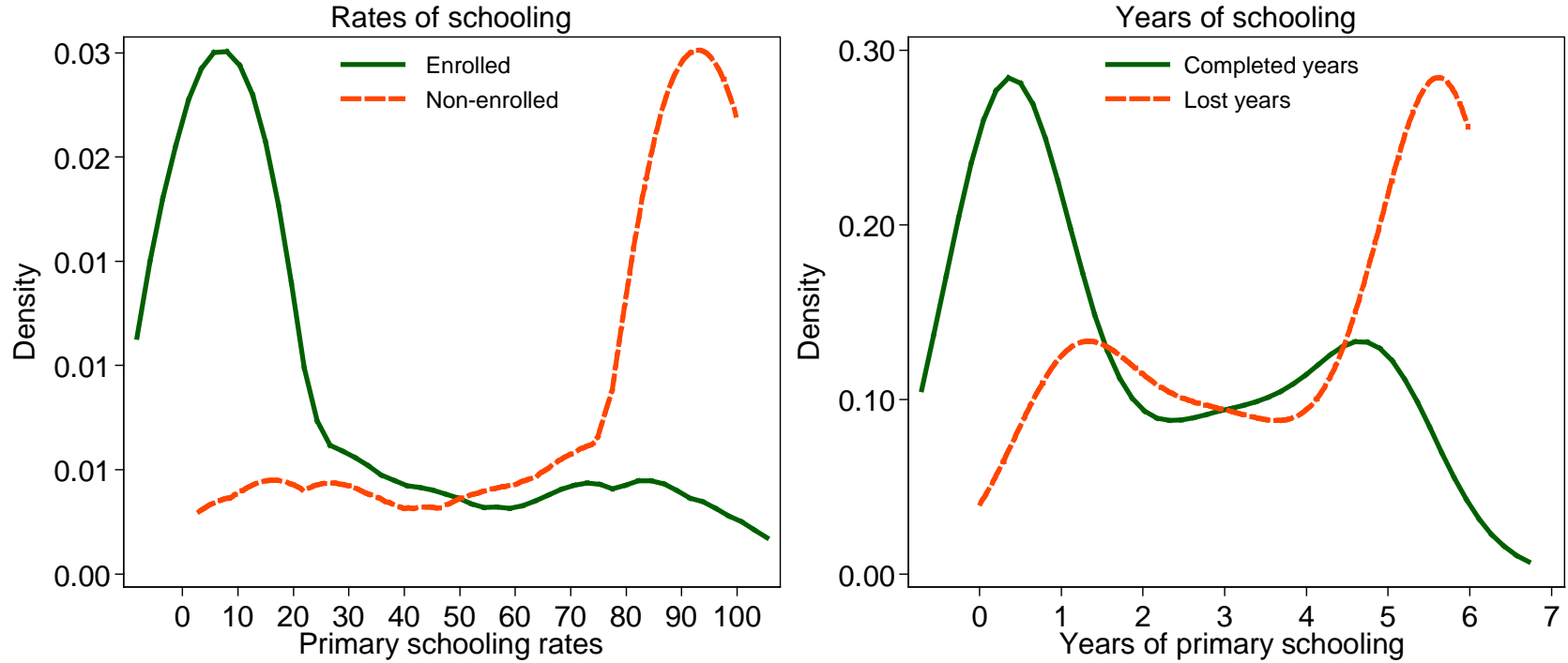
<sup>ix</sup> A host of other factors, including the gender equality movement which opened the doors of schooling to girls, have also contributed to growth in mean enrollment rates, but since the focus of this paper is not to *explain* schooling growth rates per se, I only summarize a few key causal factors here.

<sup>x</sup> As previously noted, since education inequality is here measured using the standard deviation, the trends graphed in Figure 6 would be the same whether we used enrollments or non-enrollments, completed years or lost years.

<sup>xi</sup> Unreported analysis that compared inequality trends for interpolated and extrapolated data show that the overall results are substantively equivalent regardless of which data series is used.



Figure 1. Primary schooling rates and years in 1910



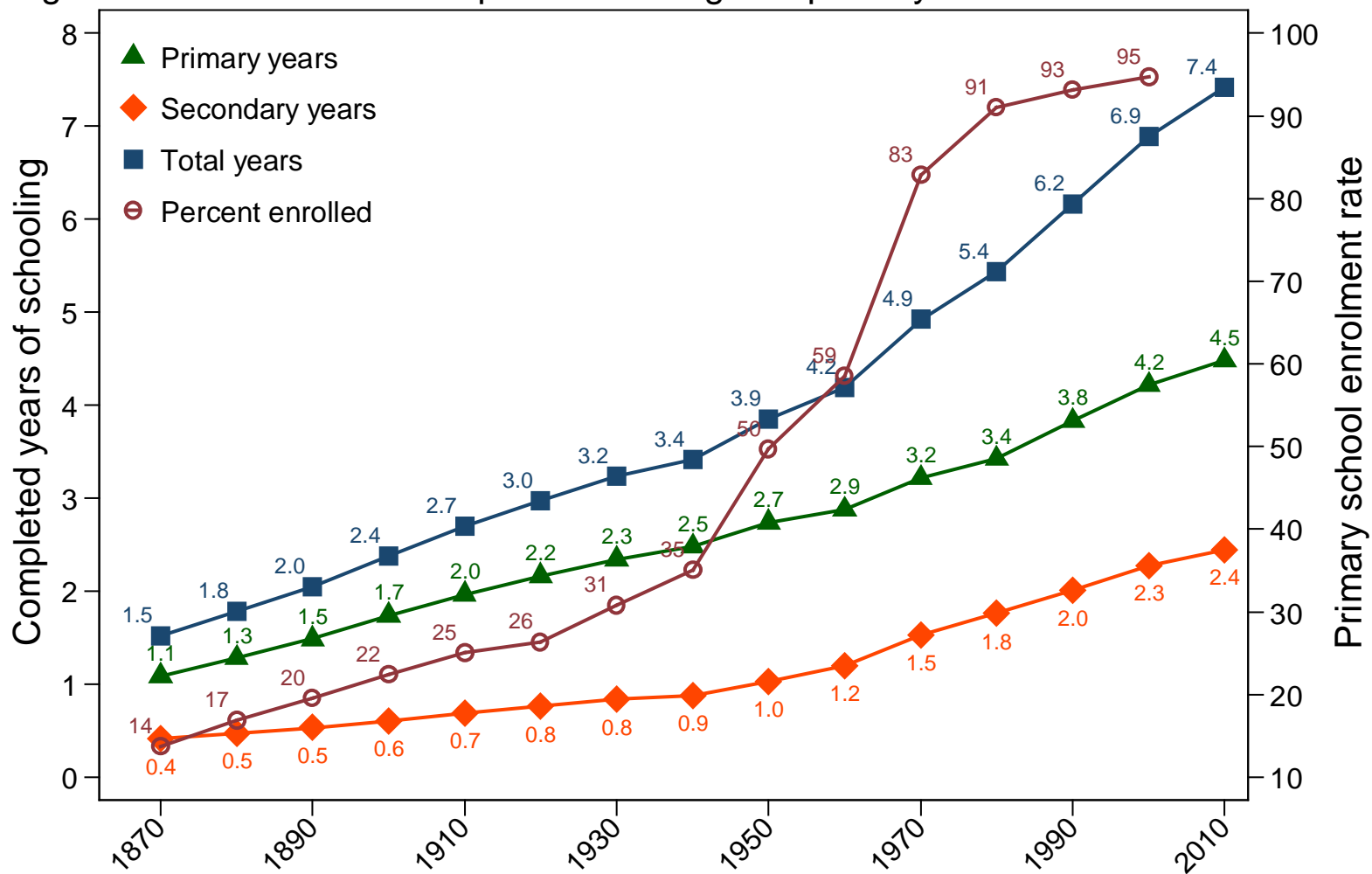
NOTE: Density distributions (gaussian kernel function). Estimates are population weighted.

**Table 1. The problem of complements in primary schooling: enrolled versus non-enrolled**

	Enrolled			Non-enrolled		
	Mean	Theil	Gini	Mean	Theil	Gini
1870	15.2	0.92	0.69	84.8	0.04	0.11
1910	26.8	0.62	0.59	73.2	0.11	0.20
1950	51.7	0.13	0.28	48.3	0.15	0.28
2000	93.2	0.01	0.05	6.8	0.47	0.80
Absolute change (1870-2000)	77.9	0.91	0.65	77.9	0.43	0.69
Percentage change (1870-2000)	511%	-99%	-93%	-92%	1162%	632%

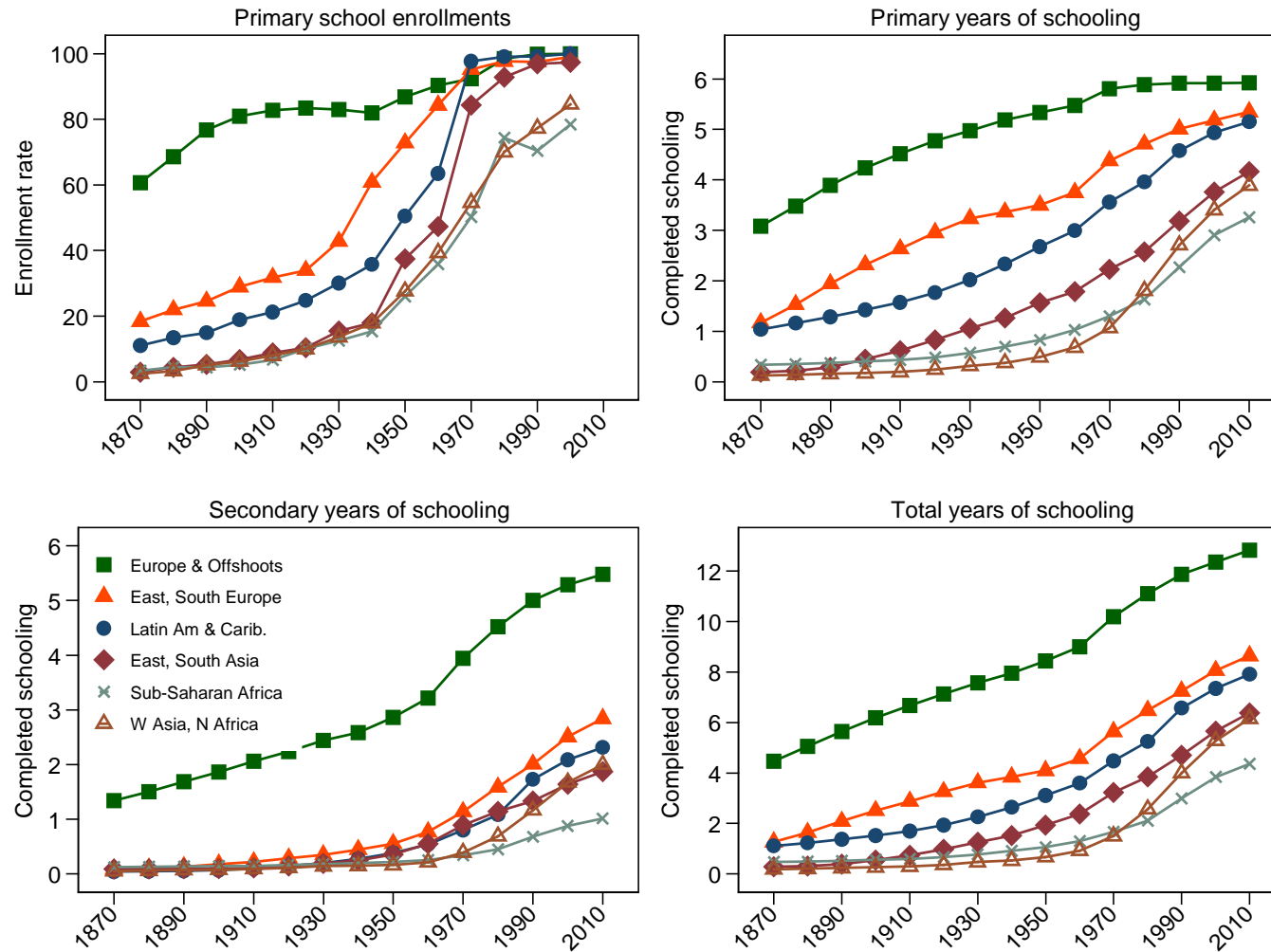
**NOTES:** Estimates are author's population-weighted calculations.

Figure 2. World trend in complete schooling and primary school enrollments



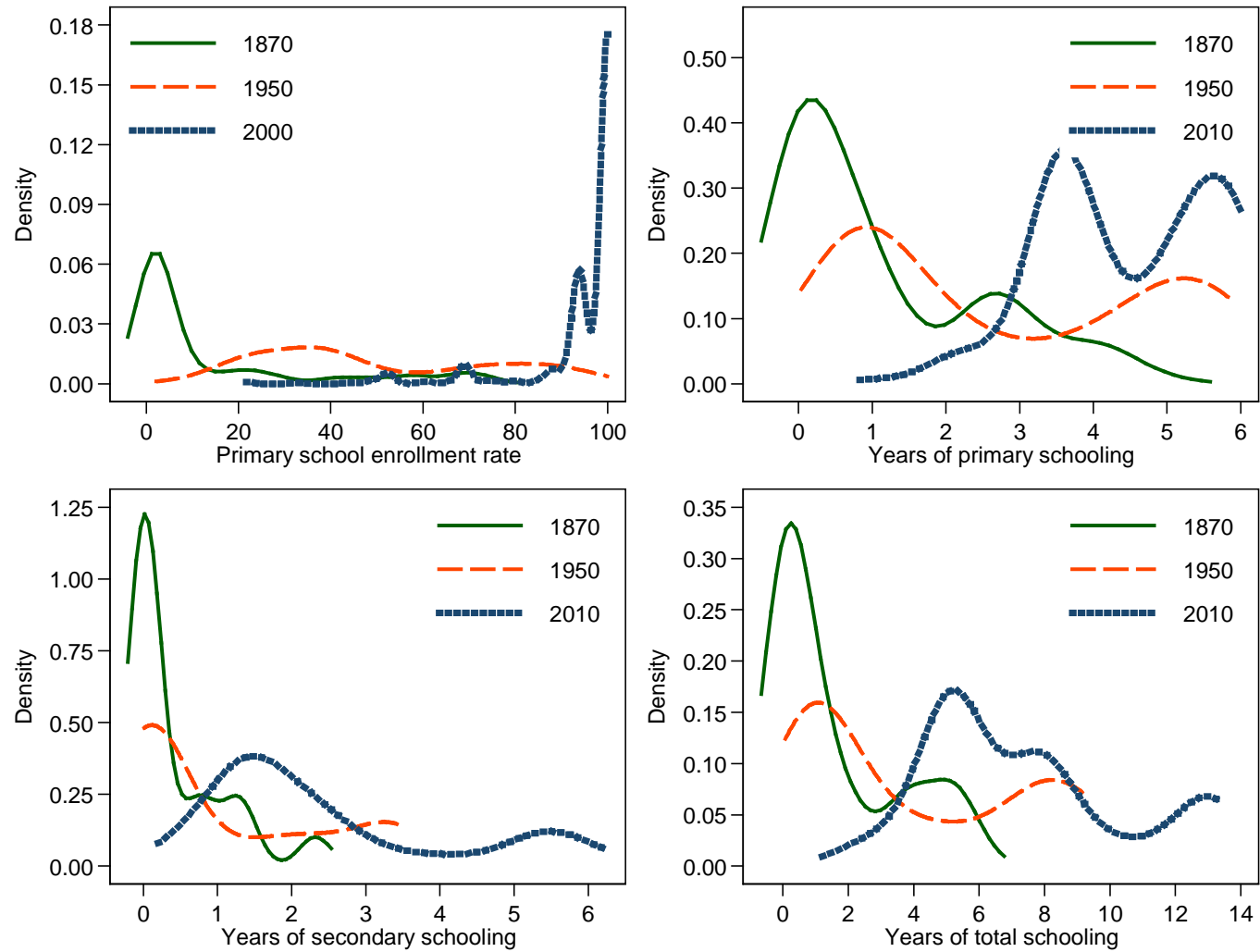
NOTE: Years of schooling are for the total population aged 15+. Estimates are population weighted.

Figure 3. Regional trends in education: 1870-2010



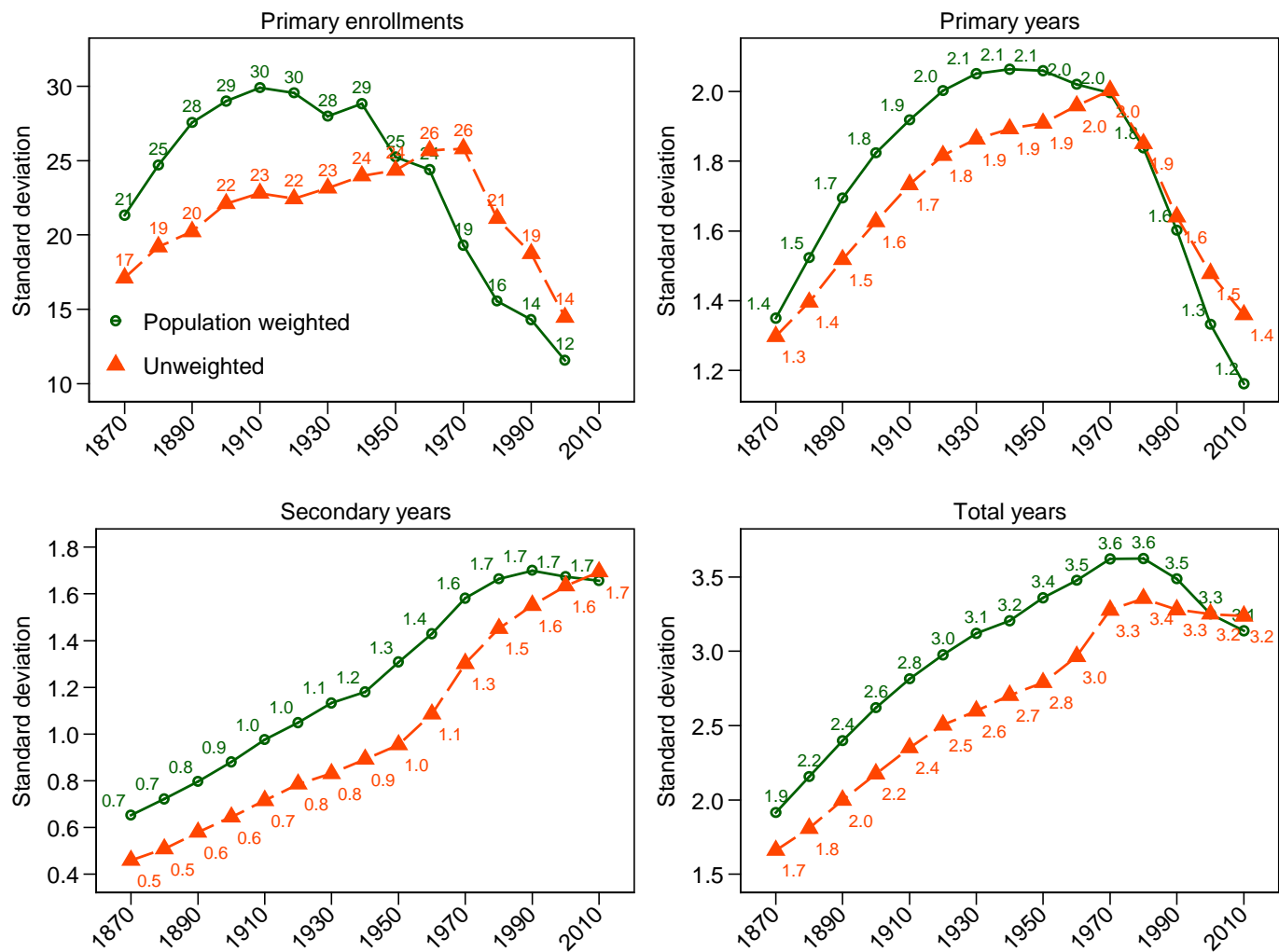
NOTE: See Appendix for country n's and population shares. Estimates are population weighted.

Figure 4. Worldwide change in the distribution of education



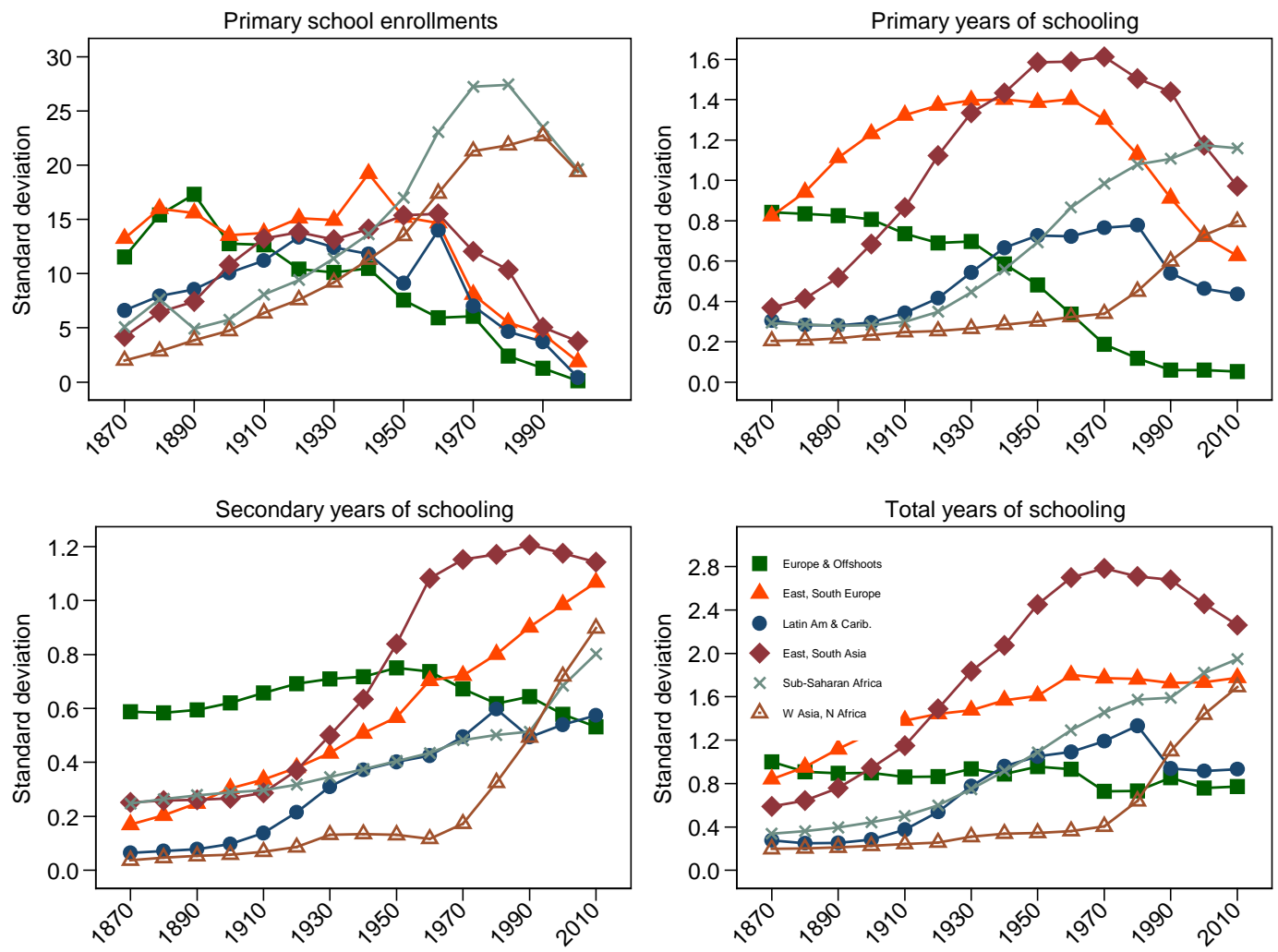
NOTE: Density distributions were estimated using population-weighted Gaussian kernel function.

Figure 5. Inter-country education inequality using the standard deviation: 1870-2010



NOTE: Total population weights are based on the entire population. Sample sizes vary by indicator. See Appendix for details.

Figure 6. Regional trends in the dispersion of education: 1870-2010



NOTE: Regional estimates of the standard deviation are population weighted.