GLOBAL DEMOGRAPHIC CONVERGENCE? A RECONSIDERATION OF INEQUALITY IN NATIONAL FERTILITY ESTIMATES

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Abstract:

This research challenges the notion that the last half of the twentieth century was a period of global demographic convergence. To be sure, fertility rates fell substantially during the period, but with considerable unevenness. The decline in total fertility across population-weighted countries was sufficiently disproportionate that between-nation fertility inequality, estimated using standard measures of inequality, did not begin to decline until at least 1995. Regression analysis also suggests that only very recently did lagging nations begin to catch up with early adopters of low fertility. Contrary to findings from health inequality research, counterfactual models indicate that sub-Saharan Africa has had a greater impact on fertility inequality than China. The trend in fertility inequality, where convergence appears to be a relatively new phenomenon, stands in stark contrast to inequality in other domains, such as income, education, and life expectancy.

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Using an innovative approach to the problem of global demographic change, along with an improved dataset, Wilson (2001) provided a valuable quantitative assessment of the extent to which the fertility revolution has become a truly global phenomenon and his summary finding was that the last fifty years have witnessed a steady increase in the share of the world's people living under conditions of rising life expectancy and declining fertility. It was this finding that led him to describe the period as one of 'global demographic convergence'. A growing body of research on life expectancy inequality generally confirms Wilson's (2001) finding of rising and converging expectation of life. A number of studies have applied a wide range of convergence tests and conclude that most of the period from 1920 to 2000 was one of convergence in average life expectancy (Becker, Philipson, and Soares 2005; Bourguignon and Morrison 2002; Easterlin 2000; Goesling and Firebaugh 2004; Neumayer 2003, 2004; Pradhan, Sahn, and Younger 2003; Ram 1982, 1998, 2006; see Cornia and Menchini 2006 for an exception). But beginning around 1990, due in large part to declining male life expectancy in Eastern Europe and Russia and the spread of HIV/AIDS primarily in sub-Saharan Africa, the trend toward convergence reversed itself (Goesling and Firebaugh 2004; Neumayer 2004). Using United Nations estimates, Neumayer (2004, see Table 2) suggests that the current trend toward divergence will once again turn toward convergence, possibly as soon as 2015. The between-nation trend in life expectancy at birth from 1955 to 2000, then, was one of convergence in the sense that inequality was lower in 2000 than in 1955. The decline has been uneven, however, and the current and near future looks to be a period of continued divergence because of health declines in Eastern Europe and sub-Saharan Africa.

We know much less about level and change in between-nation fertility inequality. While Wilson's (2001) research confirms that fertility rates around the world have been falling, this might not mean that fertility rates are converging. Only if the variance around the mean is declining proportionally faster than the mean can we conclude that national fertility rates are converging and, unfortunately, to my knowledge, no study has directly modeled the between-nation fertility trend in this way. By piecing together studies in this area we can, however, develop an informed hypothesis and there is, in fact, some evidence to challenge the notion that the last half of the twentieth century was a period of fertility convergence.

Consider first what we know about the rise of the modern fertility revolution. Fertility was already low and still declining among developed nations throughout the period from 1955 to 2005. During the same period nearly all LDCs also began the transition at some point during this period, but in two fairly distinct waves, where the first included most of the nations of Asia and Latin America. But as Dyson and Murray (1985) observe, in nearly all countries during this period, fertility increased for a decade or more just prior to the onset of fertility decline. We also know that much of sub-Saharan Africa and some nations in West Asia have yet to begin the fertility transition. Taken together, the evidence suggests that the period from 1955 to 2005 was one of increased separation at the tails of the fertility distribution. With countries staging for and entering the transition, there has been significant variation in the middle of the distribution (some rising and some falling fertility). In a recent study, Casterline (2001) modeled the pace of fertility decline in less developed countries from 1950 to 2050 and found a significant level of inter-country and intra-regional variation in the pace of fertility decline. So much variation, in fact, that in his view "what is most impressive is the inter-country variability in the amount of [fertility] decline" (Casterline 2001: 26). In another recent study, Crenshaw et al. (2000) used a growth rate regression model (a conditional β-convergence model, discussed in more detail later) to test human ecology and evolutionary theory in the context of change in fertility rates. In all of their conditional models, the evidence suggested convergence. But conditional models are, in a sense, counterfactuals. They tell us what the size and direction of change in Y *would have been* if not for the contaminating influence of the independent variables. While they did report a non-significant zero order correlation (.03) between the TFR in 1965 and change in the TFR from 1965 to 1990, this was for a reduced sample of LDCs and not for the world. Finally, data from Wilson (2001, Figure 1) suggests that despite significant intra-distributional movement from 1955 to 2000, the distance between the tails of the three distributions does not appear to have declined over the period.

It is clear that both the onset and rate of fertility decline have shown remarkable cross-national variation. I argue that the observed variation in between-country fertility decline for much of the period from 1955 to 2005 points to a period of divergence, rather than convergence. In this article, I begin to fill the gap between Wilson's (2001) finding of a global decline in mean fertility (TFR), the Crenshaw et al. (2000) finding of what appears to be, if anything, divergence among LDCs from 1965 to 1990, and the findings of Casterline (2001) and Dyson and Murray (1985) that the fertility transition has been highly uneven, with rising and falling fertility during the period. Using United Nations estimates, I provide a robust convergence-divergence test of the magnitude and direction of change in fertility inequality from 1955 to 2005 for a near census of the world's countries and people. The rest of the paper will proceed as follows: section one discusses competing definitions of convergence and its measurement; section two describes the data and weights used in this analysis; section three presents covers analysis and discusses the results for convergence tests; and in section four I briefly draw some conclusions.

SECTION 1. DEFINING AND MEASURING CONVERGENCE

β-convergence. In the classical definition, convergence occurs when the growth rate among poor nations is greater than the growth rate among rich nations (Sala-i-Martin 1996, 2006). The condition where former laggards, fueled by higher growth rates, catch up with former leaders is referred to as *β*-convergence and is typically modeled using ordinary least squares regression where the annualized growth rate over the study period is regressed on the observed rate at base measurement (Barro and Sala-i-Martin 1991, 1992). The equation for *β*-convergence is

$$\ln(Y_{jt+T}/Y_{jt})/T = \alpha + \beta_1(Y_{jt}) + e_j \qquad (1)$$

where ln is the natural log, Y_{jt+T} represents the value of the indicator at second measurement for the *j*th country, Y_{jt} represents the value of the indicator at base measurement, β_1 is the convergence coefficient, α is the constant, and e_j is the error term for the *j*th country. A negative sign on the convergence coefficient indicates lagging countries are catching up with leading countries (converging), while a positive coefficient indicates laggards are falling farther behind (diverging).[i]

σ-convergence. An alternate specification of cross-national convergence, referred to as *σ*-convergence, tells us whether the distribution of *Y* is growing or declining and is measured using the standard deviation (Sala-i-Martin 1996; Neumayer 2004). If the repeated cross-sectional standard deviation increases, we say that countries are diverging and if the variance declines, we conclude that countries are converging on *Y*. Figure 1 graphs the unweighted and population-weighted trends in the mean and standard deviation of the total fertility rate from 1955 to 2005. The world mean was virtually flat until about 1970, but then began a monotonic decline that has continued unabated for the last 35 years. The population-weighted standard deviation followed a quite different trajectory, demonstrating remarkable stability from 1955 until about 1985, after which it began a slow decline. The unweighted standard deviation gradually increased from 1955 to about 1985, and has been declining steadily ever since. Weighted σ-convergence suggests that while the overall trend from 1955 to 2005 was one of convergence in the sense that the standard deviation in 2005 was smaller than the standard deviation in 1955, the precise period of convergence has only been the last two decades.

FIGURE 1 ABOUT HERE

Inequality. The standard deviation is perhaps the most common measure used to test for σ-convergence and it has been used to estimate variance in incomes (Sala-i-Martin 1996), infant and child survival rates, and life expectancy (Neumayer 2004), to mention just a few. The utility of the standard deviation in longitudinal design, however, is its appraisal of inequality under the condition of a relatively constant mean. As can be seen in Figure 2, the mean TFR has been anything but constant. When the mean of *Y* is trending up (or down), the standard deviation might also be increasing, but this doesn't necessarily mean that the distribution has become less equal. Only if the standard deviation is increasing faster *relative* to the mean is the distribution becoming more unequal. This highlights an important limitation of the standard deviation for measuring the spread of *Y*, namely, scale invariance. Measures of inequality should be scale invariant, and adhere to both the welfare principle and to the principle of transfers (Allison 1978). Students of convergence have often turned to other distributional measures of inequality that capture change in the variance of *Y* while not violating the tenets of a measure of inequality.[ii] Perhaps the simplest relative measure of inequality is the coefficient of variation, calculated by dividing the standard deviation by the mean. Other measures of inequality widely used in cross-national convergence analysis include, among others, the gini coefficient, the Theil index, and the mean log deviation. While each of these measures of inequality differ slightly in formulation, their functional commonality is that the mean of *Y* is included in the denominator, making them scale invariant.

Following recent research on international and global inequality in income and life expectancy (Bourguignon & Morrison 2002; Firebaugh 1999, 2003; Firebaugh & Goesling 2004; Goesling 2001; Goesling & Firebaugh 2004; Korzeniewicz and Moran 1997), I report results for a number of inequality indexes which can be expressed in summary form using the following equation:

$$I = \Sigma_j p_j f(r_j) \qquad (2)$$

where *I* is the index of inequality; r_j = $X_j / \overline{X}$ is the fertility ratio of the *j*th unit (fertility for the *j*th unit divided by the world average fertility); $p_j = n_j/N_j$, the population share of the *j*th unit; *f* = the functional form used to measure variance; and $\Sigma_j p_j f(r_j)=0$ when $r_j = 1$ for all *j*'s (Firebaugh 1999; Firebaugh and Goesling 2004). Equation 2 establishes a standard formula into which various summary measures of inequality can be inserted.

In this research note I test for both *β*-convergence and fertility inequality because it is possible that the results from the several tests might simultaneously point to *β*-convergence *and* rising inequality. Recall that *β*-convergence assesses intra-distributional mobility, the average mobility of individual units on *Y*, while measures of inequality assess change in the overall size and shape of the distribution of *Y*. It is not improbable that a given distribution has significant switching between units with some moving above the mean and others moving below the mean, yet no change in the overall spread of the distribution (Sala-i-Martin 1996). While *β*-convergence is a necessary condition for declining inequality—the only way the distribution of *Y* can decline is if former laggards gain on former leaders—it is not a sufficient condition. By only testing for

β-convergence, we run the risk of drawing faulty conclusions should the two tests yield contradictory results.

SECTION 2. DATA AND METHODS

Data. Data for this analysis cover the period from 1955 to 2005 and are drawn from the United Nations Common Database (2007). United Nations fertility estimates are extensive and therefore population coverage for this analysis is unusually high. I include 195 countries covering well over 90 percent of the world's people. The data are listwise complete, so each nation is measured for each time period. I rely primarily on two variables, the TFR and national population estimates. From the population estimates I constructed population shares (the ratio of the population of country *j* to the total world population) where the sum of the population shares equals 1.0. Population and fertility estimates for many LDCs, particularly for the earliest years in the study, clearly contain measurement error. However, given that this study is looking at broad, macro-level trends, it is highly unlikely that even improved data would alter the substantive conclusions of this analysis.

Weights. A great deal of debate over level and change in global income inequality has stemmed from decisions surrounding data weights. Early studies of between-nation income inequality, conducted primarily among economists, treated each country equally because their principle units of interest were economies. More recently, sociologists weighed in on the debate (no pun intended) and noted that if the researcher's interest is in the economic welfare of individuals, rather than economies, then the more appropriate approach is to weight countries by their population shares (Firebaugh 1999, 2003; Korzeniwitz and Moran, 1997). Doing so ensures that a change in *Y* for a large country like China has a greater impact on the world mean than a change in *Y* for a much smaller country like Jamaica. The σ-convergence trends in Figure 1 illustrate the influence of weighting schemes on fertility inequality, where the unweighted trend showed rising inequality for much of the period and the weighted trend was relatively flat for the same period. Because my focus, as was Wilson's (2001), is on change in the TFR for the world, all estimates are adjusted by population shares, unless noted otherwise. I use Milanovic's (2005) term, international inequality, when referring to population-weighted, between-nation inequality.[iii]

SECTION 3. *β*-CONVERGENCE, *σ*-CONVERGENCE AND INEQUALITY ANALYSIS

To further illustrate the significance of data weights with regard to fertility convergence, Figure 2 estimates β-convergence models with alternate weights specifications. In the unweighted model, the slope is flat and is not statistically significant while in the population-weighted model the predicted regression line is negative and statistically significant. The latter model suggests that populations with high fertility in 1955 had, on average, a larger relative decline in TFR than did populations with lower fertility in 1955. So while *countries* were neither converging nor diverging over the last fifty years, *populations* appear to have converged. The unweighted model suggests that knowing the 1955 TFR for the average *country* tells us nothing about that country's subsequent fertility decline over the subsequent fifty years, due to the lack of correlation between the two variables. Alternatively, knowing the TFR in 1955 for a *population*, where countries are weighted by their population share, tells us a great deal more about the pace and direction of decline over the last fifty years.

FIGURE 2 ABOUT HERE

An often overlooked limitation to the cross-sectional growth regression approach is that it ignores all variation occurring between the two end points. The implicit assumption with the cross-sectional growth model is that change for the entire period is monotonic, when the intra-period correlation between the fertility growth rate and initial fertility might instead be non-linear. To explore the possibility of contradictory underlying trends during the 50 year period, I estimated piecewise regressions that reduced the measurement period to decade growth intervals. β-convergence results, reported in model 1 of Table 1, indicate that the 50 year growth regression model for the world masks decidedly uneven underlying trends. When the convergence coefficient is broken down into five separate 10 year periods, we see that the only period of statistically significant convergence was between 1995 and 2005. And other than the decade from 1965 to 1975, when TFR's for the world diverged, the other three decades were periods of little to no convergence or divergence.

FIGURE 3 ABOUT HERE

Two additional lines of reasoning with regard to the global trend in β-convergence warrant consideration. The first is that much like its influence over the distribution of life expectancy and income, China is the key driver behind the recent world fertility trend due to its sheer demographic weight (Goesling 2001; Firebaugh 1999, 2003; Firebaugh and Goesling 2004; Goesling and Firebaugh 2004). The second stems from Figure 3 where, contrary to most of the rest of the world, the weighted regional mean TFR for sub-Saharan Africa has proven to be remarkably stable over the last half of the twentieth century. Perhaps convergence and divergence in fertility is more a story of China's demographic pull in population-weighted trends or in the seeming stubbornness of African fertility to respond to the larger global trend toward fertility decline. Results from alternate sample specifications, one that excludes China and another that excludes the nations of sub-Saharan Africa, are reported in Table 1. Contrary to change in between-nation inequality in income and life expectancy, where China has been a major contributor to recent global convergence, the exclusion of China had a surprisingly small effect on the observed world trend. While the exclusion of China weakens the statistical significance of the 50 year growth coefficient, the sign is still negative. In the piecewise regressions, removing China would only have secured the decade of 1955-65 from one of uncertainty to one of unequivocal divergence. Possibly the more important story regarding the *rate* of fertility decline over the last 50 years is the braking effect that the nations of sub-Saharan Africa appear to be exerting on β-convergence, where the counterfactual simulation indicates that without these nations, global convergence would have begun a full twenty years earlier.

TABLE 1 ABOUT HERE

To extend the analysis of σ-convergence beyond the trend for the standard deviation reported in Figure 1, I calculated three population-weighted measures of inequality: the gini coefficient, the mean log deviation (MLD), and the Theil Index.[iv] I use these three measures because each tell us something slightly different about change in inequality and thus help us to identify the source of change in the fertility distribution. The MLD is more sensitive to change at the bottom of the distribution,[v] and the gini is relatively more sensitive to change in the middle of the distribution, where a large increase or decrease in the gini would suggest that the greater source of change in inequality is due to movement among populations with TFR's close to the world mean. Like the MLD, the Theil index also uses the log of Y, but does a secondary log adjustment that offsets the over importance of low tail units, leaving the Theil more sensitive to change at the top of the distribution (Allison 1978). Greater relative growth or decline in the MLD or the Theil would locate the source of change in fertility inequality in low and high fertility countries, respectively.

Prior to presenting results of the distributional analysis, a final word on relative and absolute change in fertility might be helpful. The distinction between absolute and relative change in fertility is important for understanding change in inequality because the two stand to affect the between-nation inequality trend quite differently. When considering change in the level of inequality, it is possible that the absolute gap between countries with the highest and lowest TFR might be decreasing, while inequality is simultaneously increasing. Consider countries A and B in Table 2, where the absolute change in fertility was larger for lagging Country A and the fertility gap between the two countries decreased. Now consider the relative change where the growth rates for Countries A and B were 17 and 25 percent, respectively. Because the relative gain was greater for the leader, in this case Country B, inequality increased even though the absolute difference between the two countries decreased. It is clear that absolute convergence in fertility rates is neither a necessary nor a sufficient condition for declining inequality.

TABLE 2 ABOUT HERE

In contrast to β-convergence, inequality increased monotonically from 1955 to 1995 when estimated using three summary measures of inequality (see Table 3). The inequality index coefficients agree with the regression convergence coefficient for the most recent decade, where both show convergence from 1995 to 2005. The Theil registered the largest percentage increase (99 percent) during the 40 year period of rising inequality (1955 to 1995), suggesting that the single biggest source of divergence in the TFR was the stability in fertility among countries with high fertility in 1955. The MLD registered the greatest percentage decline (7 percent) for the most recent 10 year period, suggesting that what is most responsible for the recent decline in fertility inequality was the slowing of fertility decline in developed countries with already low fertility. So while Africa appears to have been a major factor in the trend toward β-divergence and rising inequality, a slowing in the relative decline in fertility among the nations of Europe and its offshoots appears to have played a larger role in the recent convergence of the fertility distribution from 1995 to 2005. Somewhat surprisingly, but in full support of the *β*-convergence and inequality findings, change in the middle of the distribution, largely comprising the countries involved in the second wave of the fertility transition, had a relatively modest influence on fertility inequality (as measured by the gini coefficient). That the inequality trend is due to change at both ends of the distribution is in line with previous research on two accounts. First, fertility continues to decline among countries with already very low fertility (McDonald 2006), though at an ever slower pace. Second, the movement toward higher fertility among nations with already high fertility is in line with Dyson and Murphy's (1985) finding that most countries experience a noticeable increase in fertility just prior to sustained, long-term declines.

A notable limitation with the univariate cross-sectional estimation of inequality employed here is the absence of statistical inference. Once we have estimated inequality (*I*) for each cross-sectional fertility distribution, we would like to be able ascertain the likelihood that the observed change in *I* is due to chance. Confidence interval estimates allow us to make just this sort of statistical inference about the inequality trends generated from the repeated cross-sectional distribution comparisons. If *I* at time T_n falls outside the confidence interval of $T_{0,}$ then we can cautiously conclude that the change in *I* from T_0 to T_n is not due to chance (Moran 2006). In Table 3, I report bias corrected, bootstrap confidence interval estimates for the Theil index. The 1955 Theil index estimate of .057 falls outside the confidence intervals beginning in 1985, allowing us to conclude, with caution, that with a 30 year interval the observed change in the Theil was significant.

Finally, using United Nations medium variant projections, I extended the analysis in Table 3 from 2005 to 2050 and the results, not reported here, suggest that the year 2000 appears to have been the high water mark for fertility inequality. The projection data indicate that the population-weighted fertility distribution will continue to decline in the coming decades.[vi]

TABLE 3 ABOUT HERE

Results from the analysis of the overall and intra-period *β*-convergence and *σ*-convergence fertility trends, coupled with the inequality trends, for the period from 1955 to 2005 give rise to one last question within the scope of this article. How does fertility inequality compare to inequality in 'quality of life' indicators over recent decades? Because the inequality coefficients derived from scale invariant measures of inequality are readily comparable across indicators, regardless of the scale from which the inequality coefficient is derived, I am able to briefly address this question. In Figure 4 I compare the international inequality trend in fertility to the inequality trends for income, education, and life expectancy at birth. All three indicators are commonly used in 'standard of living' and 'quality of life' indexes. When we compare the trend in fertility inequality to those of the other three indicators, the standout finding is that while fertility rates diverged over most of the last half century, population-weighted nations were converging on per capita income, educational attainment, and life expectancy at birth. From 1960 to 2000 the gini coefficient declined by 6 points for income, by 18 points for education, and by 7 points for life expectancy. Over the same period the gini coefficient for fertility increased by 9 points. So while the populations of the world, in aggregate, were becoming increasingly homogeneous in three diverse quality of life indicators, the opposite was true of fertility.

Beyond just change in inequality, another clear difference between the four indicators in Figure 4 is the sizable variation in the level of inequality. Next to life expectancy, fertility inequality, though rising, is still noticeably lower than inequality in either educational attainment or income. The results demonstrate the benefits of using multiple measures to assess the changing nature of between-nation variation in fertility. Having only relied on a 50 year growth regression model, we would have concluded that between-nation differences declined over the last 50 years. The σ-convergence and inequality results, however, indicate that there was a general widening of the fertility distribution for much of the period and this occurred to varying degrees at all points in the distribution.

FIGURE 4 ABOUT HERE

SECTION 4: DISCUSSION AND CONCLUSION

The object of this research note was to provide a detailed quantitative assessment of the extent to which fertility rates have converged or diverged over the last fifty years. This research builds on Wilson's (2001) finding of a global decline in fertility by testing for two types of convergence. Recognizing that a study of convergence is essentially an analysis of inequality between nations (Peacock et al.. 1988), I also included measures of inequality. Together, the analysis estimates both the rate of convergence and also change in the distribution of fertility over the last half of the twentieth century.

β-convergence analysis suggests that the overall trend for the last 50 years was one of convergence, but the piecewise regression results demonstrate that only very recently did the relative decline in fertility among late adopters exceed the rate of decline among early adopters. σ-convergence shows a much longer stall, where an appreciable decline only began in about 1990, fully 20 years after the beginning of the decline in the world mean. The inequality analysis confirms the finding that convergence only began relatively recently, in about 1995, but contrary to β-convergence and σ-convergence, inequality analysis found that the fertility distribution increased steadily for the whole period from 1955 to 1995. It appears then, that fertility convergence across nations is a relatively new phenomenon, but one that is being driven by the twin effects of the recent, though delayed, onset of fertility decline among high-fertility nations and the relative slowing of fertility decline among developed countries. The data indicate that we reached the high water mark for fertility inequality around the turn of the twenty first century and barring major unforeseen shocks, this trend will continue unabated in coming decades.

This research note makes three important contributions. First, this analysis quantifies global variation in fertility such that we can now state with greater accuracy the extent to which the world as a whole has participated in fertility decline over the last fifty years. Wilson and Airey (1999: 127) claim that "our theories should combine the global nature of the forces leading to [fertility] transition and the unique path-dependent course followed within each society." I argue that the quantification of between-nation fertility inequality presented here fills a clear gap in our knowledge of the global trend in fertility inequality. While students of demographic transition have long been aware of significant between-nation variation in the onset and rate of fertility decline (c.f. Bongaarts and Watkins 1996; Casterline 2001; Coale and Watkins 1986; Dyson and Murphy 1985), the estimates here quantify the magnitude and direction of fertility inequality over the last half of the twentieth century in a way that helps to pinpoint global turning points in macro-level variation in fertility.

The second is a two-fold methodological contribution. This research demonstrates the benefit of using multiple measures for assessing the changing nature of between-nation fertility inequality. Having only relied on the 50 year cross-sectional regression analysis, we would have concluded that the last half of the twentieth century was one of convergence. Results from the piecewise regression, as well as σ-convergence and inequality analysis, make clear that only much more recently did national fertility estimates begin to converge. These findings stand as a reminder to researchers of the importance of population weights, where unweighted analysis is appropriate when the unit of interest is countries and weighted analysis is appropriate when the unit of interest is populations. Estimates presented here found that population-weighted results generally tended to favor convergence, indicating that larger populations have been converging more so than the average, unweighted nation.

Lastly, this analysis represents the long overdue entrance of fertility into the larger debate regarding global inequality. Moving beyond income, global inequality research is now asking questions about processes underlying the broader diffusion of quality and quantity of life (Becker, Philipson, and Soares 2005), and material and ideational diffusion in truly world models (Meyer, Boli, Thomas, and Ramirez 1997; Meyer, Ramirez, and Soysal 1992). Rising fertility inequality over much of the last half century stands in stark contrast to inequality in most other areas, where inequality has generally been declining for some time. The counterfactual models estimated in Table 1 point to another way in which fertility inequality differs from trends in other quality of life indicators. China appears to have had only a modest effect on fertility inequality, but its influence on income inequality and health inequality has been significant (Goesling 2001; Firebaugh 1999, 2003; Firebaugh and Goesling 2004; Goesling and Firebaugh 2004). Sub-Saharan Africa, on the other hand, has had a noticeable braking effect on fertility convergence. Some researchers have recently begun to argue that the nations of sub-Saharan Africa will play an increasingly important role in global inequality in life expectancy (Neumayer 2004) and income (Dollar 2005), such that Dollar (2005) speculates about the "Africanization" of poverty and underdevelopment. So clearly there are some areas of cleavage between fertility inequality and inequality in other domains, yet there are also important areas of overlap. Demographic change, occurring in successive waves that lead to rising and then falling inequality, is true of both life expectancy (Vallin and Meslin 2004) and fertility inequality.

The study of fertility inequality has much to offer the larger debate surrounding stability and change in global inequality, where fertility research brings a particular wealth of knowledge concerning the ideational and cultural determinants of diffusion (Lestheaghe 1983, 1995; Lestheaghe and Vanderhoeft 2001; Rosero-Bixby and Casterline 1993) that is somewhat less developed in some of the other literatures. Clearly, the diffusion of ideational and material innovations related to health, wealth, and education is occurring with greater ease than is diffusion associated with fertility decline. While “nearly everything that matters” has been converging over the last 50 or more years (Kenny 2005), fertility stands out for being so heterogeneous. A possible answer to the question of convergence in health, wealth, and life expectancy is the consistent linkage between these three domains and the development project. The development project and has been strongly associated with diffusion in other domains (Berkovitch and Bradley 1999), and thus far, fertility appears to have been less consistently linked to the development project than other variables. These findings point to the need for additional research to expand our understanding of the determinants of the uneven diffusion of the fertility revolution and help us better understand the mechanisms underlying global convergence and divergence.

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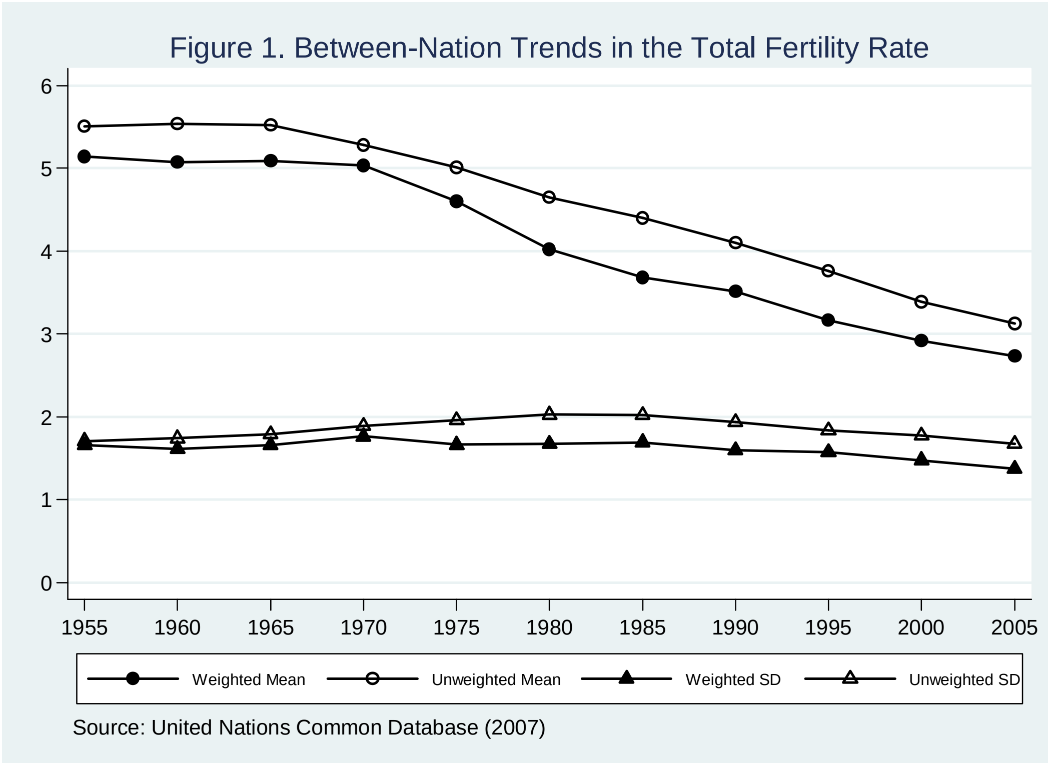
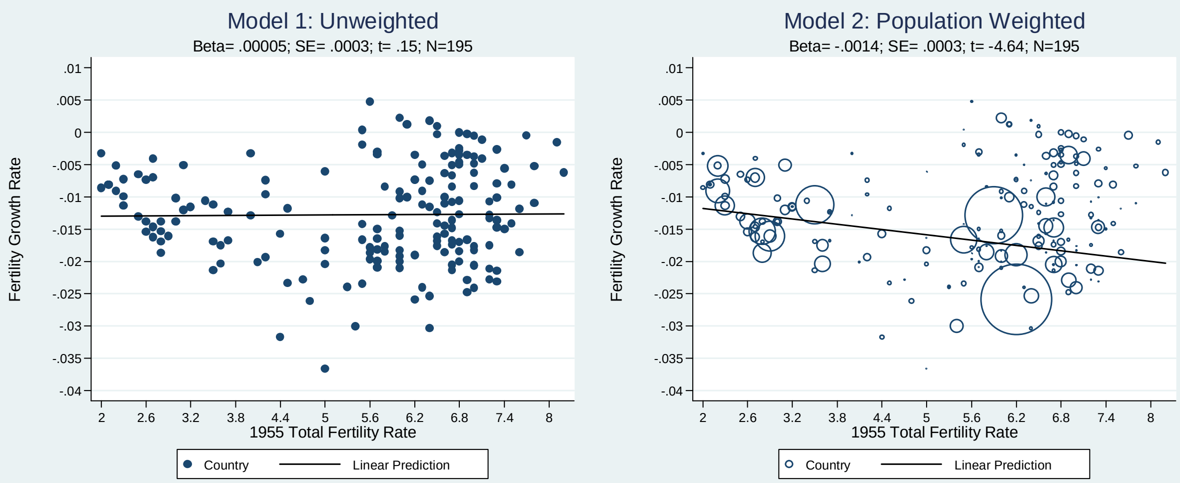


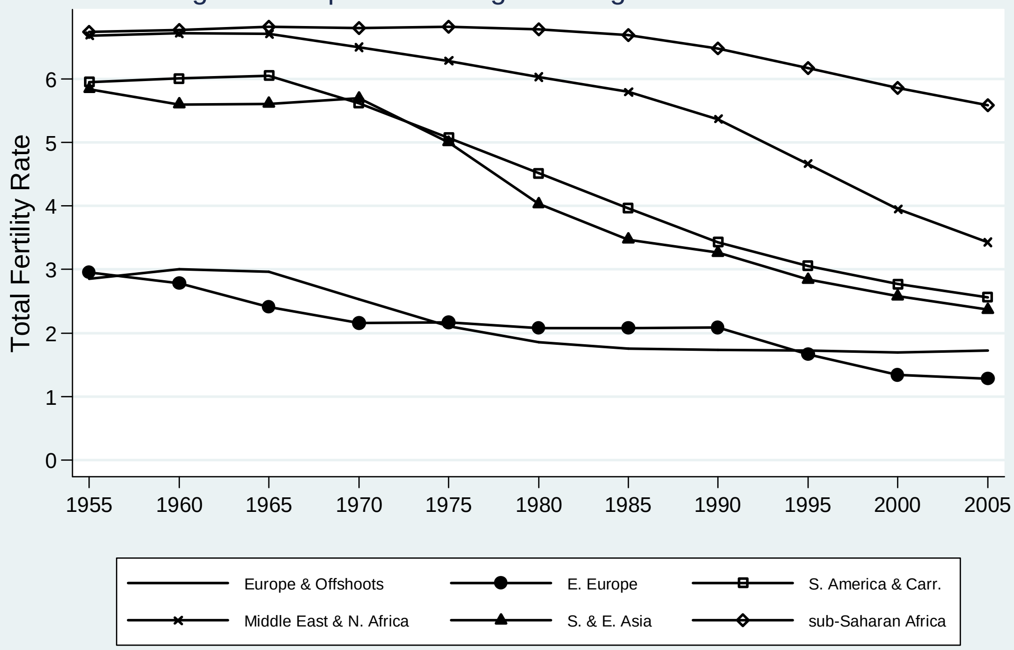
Figure 1. Between-Nation Trends in the Total Fertility Rate
0
1
2
3
4
5
6
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Weighted Mean
Unweighted Mean
Weighted SD
Unweighted SD
Source: United Nations Common Database (2007)

Figure 2. Beta-Convergence Models With Alternate Weights



Source: United Nations Common Database (2007)
Note: Growth Rate = log(2005 TFR/1955 TFR)

Figure 3. Population Weighted Regional TFR: 1955-2005



Source: United Nations Common Database (2007)

Table 1. Population-weighted Piecewise β-convergence with Alternate Samples

	World		Excluding China		Excluding sub-Saharan Africa	
Year	β^a	*Direction*	β	*Direction*	β	*Direction*
1955-65	0.0009	↔	0.0022	↑	0.0006	↔
1965-75	0.0052	↑	0.0055	↑	0.0042	↑
1975-85	-0.0025	↔	0.0001	↔	-0.0073	↓
1985-95	0.0000	↔	-0.0021	↔	-0.0034	↓
1995-05	-0.0047	↓	-0.0036	↓	-0.0117	↓
1955-2005	-0.0014	↓	-0.0003	↔	-0.0020	↓

Data Source: United Nations Common Database (accessed October 18, 2007)

[a] "↑" = statistically significant divergence, "↔" = non-significant, cannot say either way, and "↓" = statistically significant convergence. Convergence occurs when high fertility is correlated with low (negative) growth. The coefficient is the annualized growth rate of fertility in five year increments.

Table 2. Absolute vs Relative Change in Fertility (TFR)

	1950	2000	Absolute Δ	Relative Δ
Country A	6.0	5.0	1.0	17%
Country B	2.0	1.5	0.5	25%
Fertility Gap	4.0	3.5		

Table 3. Population-weighted Fertility Inequality Trends

	MLD	Gini	Theil		
Year			*Upper CI*[a]	*Index of Inequality*	*Upper CI*
1955	0.066	0.172	0.037	0.057	0.088
1965	0.069	0.175	0.030	0.059	0.100
1975	0.084	0.197	0.037	0.072	0.132
1985	0.105	0.254	0.074	0.102	0.144
1995	0.114	0.267	0.068	0.114	0.153
2005	0.105	0.258	0.073	0.110	0.162
Percent Change, 1955-2005	0.599	0.499		0.847	
Percent Change, 1955-1995	0.725	0.547		0.993	
Percent Change, 1995-2005	-0.073	-0.031		-0.031	

Data Source: United Nations Common Database

[a] Reported Confidence intervals are for the BC bootstrap method.

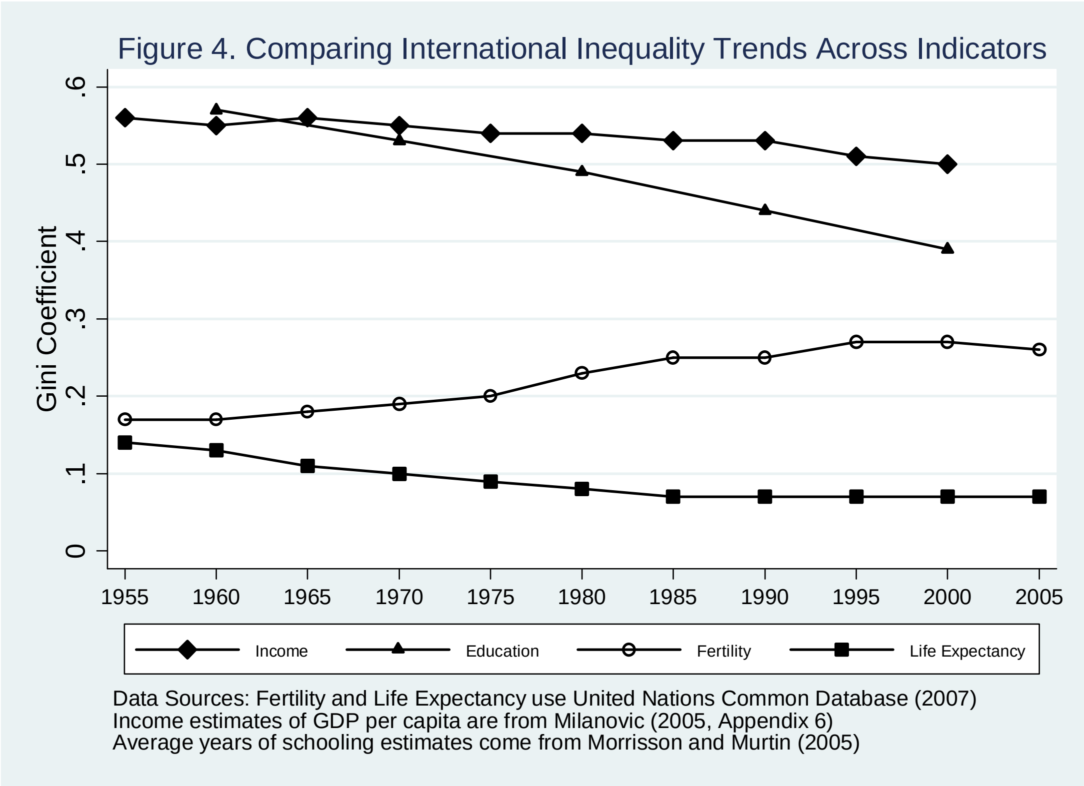


Figure 4. Comparing International Inequality Trends Across Indicators
Gini Coefficient
0
.1
.2
.3
.4
.5
.6
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Income
Education
Fertility
Life Expectancy
Data Sources: Fertility and Life Expectancy use United Nations Common Database (2007)
Income estimates of GDP per capita are from Milanovic (2005, Appendix 6)
Average years of schooling estimates come from Morrisson and Murtin (2005)

[i] Note that equation 1 is an *unconditional* model because no additional right hand side covariates are included in the model. Crenshaw et al. (2000) used a conditional model, in that they included control variables in their models.

[ii] Inequality is a measure of *relative* disproportionality concerned with the uneven distribution of goods or services across units in a population (Firebaugh 2003).

[iii] I use countries because that is the aggregation in which the data are available, but under ideal conditions, we would have representative sample data for all of the world's people over time. If we had a measure of within-nation variance in TFR's, we could use a method similar to analysis of variance and estimate the sum of the within and between-country inequalities to arrive at an estimate of *global* inequality. Because of data limitations, at this point, I am only able to measure international inequality. Implicit in this analysis, as with all studies of international inequality, is the assumption that within-nation variance is equal to zero.

[iv] To save space, I do not present the full formulas for each of the indexes. For a more complete treatment, see Allison 1978 or Firebaugh 2003.

[v] The MLD is more sensitive to change in the bottom of the distribution because Y is logged, thus reducing the importance of higher values on Y.

[vi] Following Casterline (2001), I used medium variant estimates, which assume that fertility rates for all countries will settle around replacement level and will proceed at a pace equivalent to the pace measured over the observed period. Because previous analysis has shown that once fertility decline sets in, the rate of decline often increases (Bongaarts and Watkins, 1996), the medium variant estimates might be considered conservative. Results are available upon request.