THE TREND IN BETWEEN-NATION HEALTH INEQUALITY*

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Approximate word count: 10,500

PAA2004goesling.doc – September 8, 2003

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ABSTRACT

Global inequality is the sum of inequality between nations plus the average level of inequality within nations. Recent research on global health inequality has focused primarily on the second component, health inequality within nations. This study is about the first component, health inequality between nations. Estimates of average life expectancy for 169 nations are used to compute the trend in between-nation health inequality from 1980 to 2000. Results show that inequality in the distribution of life expectancy across nations declined in the 1980s, but then increased through the 1990s. The recent turnaround in between-nation health inequality is significant because it reverses a long-term trend of declining inequality across nations that began in the early twentieth century. The primary cause of rising inequality across nations is declining life expectancy in sub-Saharan Africa likely due to HIV/AIDS, and life expectancy in sub-Saharan Africa holds the key to the future between-nation inequality trend.

THE TREND IN BETWEEN-NATION HEALTH INEQUALITY

Global health inequality has been identified as the one of the most pressing social problems of the twenty-first century. It is a central concern of the World Health Organization, as seen in its recent efforts to estimate both the level and distribution of health within its nearly 200 member nations (Mathers et al. 2001; WHO 2000). It is also the subject of a growing social scientific literature, one that draws on research from several disciplines, including demography, sociology, economics, and social epidemiology (Gwatkin, Guillot, and Heuveline 1999; Heuveline, Guillot, and Gwatkin 2002; Leon and Walt 2001; Pradhan, Sahn, and Younger 2003). Interest in global health inequality is motivated, in part, by social scientists' growing concern for and attention to issues about global inequality more generally (Bhalla 2002; Bourguignon and Morrisson 2002; Firebaugh 1999, 2003; Goesling 2001; Milanovic 2002; Wade 2001). In the words of one recent review: "the problem of global inequality has become one of the most pressing and contentious issues on the global agenda" (Held and McGrew 2000, p. 27).

Suppose we had a measure of "health status" for every individual in the world. Then we could calculate an inequality index (such as a Gini coefficient) from those data to obtain an estimate of global health inequality. Alternatively, we could estimate global health inequality in two steps, organized around nations. In the first step we calculate an inequality index to measure the level of health inequality among individuals *within* each nation. Then we calculate an inequality index to measure the level of inequality in *average* health status *across* or *between* nations, and finally sum the two parts. The point

is that global inequality (I_G) is the sum of inequality between nations (I_B) plus the average level of inequality within nations (I_W):

$$I_G = I_B + I_W \,. \qquad (1)$$

Equation 1 is similar to analysis of variance, where total variance in some outcome variable is divided into the sum of population-weighted between-group and within-group components. Here total inequality (a type of relative variance) is divided into the sum of population-weighted between-group and within-group components, with nations as groups. Recent research on global health inequality has centered on the second component, health inequality within nations (e.g., Gakidou and King 2002; Gakidou, Murray, and Frenk 2000; Murray, Gakidou, and Frenk 1999; WHO 2000). This paper, by contrast, is about the first component, health inequality between nations.

The paper differs from other studies of cross-nation disparities or inequalities in health because it does not focus on why population health is better in some nations than in others (e.g., Anand and Ravallion 1993; Pritchett and Summers 1996; Preston 1975; Subramanian, Belli, and Kawachi 2002; Wilkinson 1996; Wimberley 1990). Rather, its main objective is to provide a thorough empirical description of the recent trend in between-nation health inequality. We want to know whether health inequality across nations has risen or declined over the past 20 years, how the recent trend compares to historical trends, and which nations or regions contributed most to the trend. We also want to know whether the direction of the trend matches predictions of demographic theory. Answers to such questions are critical to our understanding of between-nation and global health inequality at the dawn of the twenty-first century.

BASIC CONCEPTS AND TERMS

By *between-nation health inequality* we mean the uneven distribution of health across nations. This paper is about one type of between-nation health inequality – the uneven distribution of life expectancy across nations. We use life expectancy as a measure of population health, first, because it is one of few indicators available for a near-universe of the world's population and, second, because it is a more intuitively meaningful measure of population health than some other possible measures, such as anthropomorphic data on human body mass or stature (e.g., Fogel 1993; Steckel 1995, 2001; Steckel and Floud 1997). Estimates of life expectancy would ideally be adjusted for years of healthy life lost due to disability (Crimmins, Saito, and Ingegnari 1989, 1997; Mathers et al. 2001; Murray and Lopez 1996, 1997), but here we use just total life expectancy because it provides the broadest possible coverage across nations and over time.

Health researchers sometimes distinguish between two approaches to the measurement of health inequality (Kawachi, Subramanian, and Almeida-Filho 2002; Wolfson and Rowe 2001). One approach defines health inequality as differences in average health status across population subgroups. Studies that examine health disparities by age, sex, race, or social class are common examples of this approach. Other examples are studies that analyze health disparities between rich and poor nations, such as Preston's (1975) classic study of the cross-national relationship between average national income and life expectancy. The second approach defines health inequality as the uneven distribution of health across all units in a population, independent of population subgroup (e.g, Gakidou et al. 2000; Gakidou and King 2002; Murray et al. 1999; Pradhan et al. 2003; Shkolnikov, Andreev, and Begun 2003; Wilmoth and Horiuchi

1999). In this approach, inequality is viewed as a type of overall relative variance and measured with inequality indexes such as the Gini coefficient. Wolfson and Rowe (2001) dub this the "univariate" approach to measuring health inequality, and it is akin to the methods used in the large social scientific literature on inequality in aggregate income distributions (e.g., Allison 1978; Cowell 1995; Jenkins 1991; Sen 1997).

In this study we use the second approach, examining the uneven distribution of life expectancy across nations without reference to other national characteristics. This approach is appropriate here because the goal is to gain leverage on the overall distribution of health among the world's population, as described above. We describe the indexes used to measure between-nation health inequality shortly. But first we explain what demographic theory predicts about this type of inequality and its change over time.

DEMOGRAPHIC TRANSITION THEORY

There is no formal theory of between-nation health inequality in the social sciences. The closest match is demographic transition theory, which predicts how and why cross-nation differences in life expectancy change over time.[1] Average life expectancy now varies widely across nations, from less than 50 years in many poor African nations to more than 75 years in many nations in the West and in Asia (UNPD 2002). Demographic transition theory predicts that such disparities are now decreasing in size, as mortality rates converge across nations. As Wilson (2001, p. 155) puts its: "the concept of convergence lies at the heart of demographic transition theory." Briefly, demographic transition theory predicts that with modernization comes sweeping change in a nation's patterns of

[1] Demography transition theory is especially well-suited for the present study, given our operational definition of between-nation health inequality as the uneven distribution of life expectancy across nations.

fertility and mortality (for reviews, see Chesnais [1992] and Kirk [1996]). The transition is thought to occur in two stages. In the first stage, mortality rates drop, due to improving material living standards and advances in medical technology and public health. The immediate effect of this stage is to boost population growth, since mortality has declined but fertility remains high. In the second stage, fertility then declines, partly in response to the drop in mortality. The second stage returns population growth to the relatively low rate that held before the start of the transition.[2]

The demographic transition has several important social and economic consequences, chief among these a trend of rising life expectancy among a nation's population. In Western Europe, for instance, the transition began in the late-eighteenth or nineteenth century, then life expectancy nearly doubled over the next 100 years (Maddison 2001, table 1-5a). Similar trends have occurred in other nations and regions, with different tempo and timing.[3] More important for this study is that the demographic transition also prompts change in the distribution of life expectancy across nations, since the timing of modernization and hence the timing of the transition varies across nations. In the early nineteenth century, cross-nation differences in life expectancy were relatively small, as mortality was high nearly everywhere (Maddison 2001, table 1-5a). Had the demographic transition begun simultaneously in all nations, these differences would have remained small, with all nations experiencing similar gains in average life expectancy. But, in fact, the timing of the transition was staggered, starting first in the West in the

[2] Historical demographers disagree about the extent to which historical trends match these predictions. The most contentious issues are, first, whether mortality declines have always preceded fertility declines – some argue that fertility declines occurred first in some nations – and, second, the mechanisms through which mortality and fertility declines occur (Bengtsson 2001; Chesnais 1992; Coale and Watkins 1986; Kirk 1996). Because these issues do not bear directly on our present concern for cross-nation disparities in life expectancy and their change over time, we do not address them in detail here.

[3] In general, the tempo of the mortality decline has been faster in nations that started the transition later.

late-eighteenth or nineteenth century, then gradually spreading to other world regions.[4] This uneven timing produces two stages of change in the distribution of life expectancy across nations. In the first stage, life expectancies diverge across nations, as the West pulls ahead and other world regions lag behind. In the second stage, the transition then spreads to other world regions, these regions start to catch up to the West, and a period of convergence begins. In short, there is a relatively short period of divergence followed by a long-term trend of convergence. The latter trend is a main prediction of demographic transition theory (Wilson 2001).

To understand what the theory implies for the trend in between-nation health inequality, suppose we use average life expectancy as a measure of a nation's population health, so between-nation health inequality refers to the unevenness of the distribution of life expectancy across nations. Given this definition, demographic transition theory predicts that the long-term trend in between-nation health inequality follows an inverted-U shaped pattern: first there is a period of increasing inequality as life expectancies diverge across nations, then there is a period of declining inequality as life expectancies converge. Between-nation inequality is low at both ends of the process, but high in the middle stage. Conventional wisdom holds that the world is now on the downward slope of this curve, well beyond the period of rising inequality across nations.

CROSS-NATIONAL EVIDENCE

Empirical evidence generally supports these predictions about the trend in between-nation health inequality over the long run: inequality increased through the late

[4] Some argue that the mortality decline began earlier in the West, perhaps before the mid-eighteenth century (Bengtsson 2001). The exact timing of the decline is not critical for our argument here.

nineteenth and early twentieth centuries, peaked in the twentieth century between the two world wars, then declined over the next half-century. It is unclear, however, whether this trend of declining inequality persisted through the end of the twentieth century, as demographic transition theory predicts. In this section we first review evidence about the long-term trend in between-nation health inequality, then turn to evidence about the trend since 1980.

Historical Trends

The past two centuries have witnessed a stunning rise in global population health as measured by human longevity. One recent study estimates that life expectancy at birth for the world as a whole grew by more than 150 percent from the early nineteenth century to the end of the twentieth century, from 26 years in 1820 to 66 years in 1999 (Maddison 2001). Such historical estimates are based on imperfect data and must be read with caution. Yet even if the exact numbers are inaccurate, there is still little doubt about the overall direction of the long-term trend (Easterlin 1996; UNPD 2002). Chesnais (1992) calls this growth in average global life expectancy "one of the most monumental changes experienced by the human race in the course of its history" (p. 47).

There has also been significant change in the international distribution of life expectancy over the past 200 years. In the early nineteenth century, life expectancies were low (as noted above) and the range in life expectancy across nations was small. The best historical estimates suggest that in the early 1800s life expectancy ranged from the low 20s in the least-healthy nations to the low 40s in the healthiest nations, with most nations clustered between these extremes (Maddison 2001). Inequality across nations

then increased in the second half of the nineteenth century, when a "Mortality Revolution" (Easterlin 1996) swept through the West. In the early 1800s, average life expectancy in Western Europe was perhaps 36 years; by 1900 it had swelled to 46 years, and by 1950 stood at nearly 70 years (Maddison 2001). A similar trend occurred in the Western Offshoots – Australia, Canada, New Zealand, and the United States. These trends prompted inequality to rise across nations through the late nineteenth and early twentieth centuries, since other world regions did not experience comparable gains until more recently.

Inequality appears to have peaked in the twentieth century between the two world wars (Easterlin 1996, pp. 70-72). At that peak, life expectancy was perhaps twice as great in the West as in sub-Saharan Africa, South Asia, and China. East Asia (outside China), Latin America, and Eastern Europe were middle regions that lie between the two extremes. The second half of the twentieth century then saw a sharp drop in inequality across nations, as the mortality decline spread to other parts of the world. Since the middle of the twentieth century, the largest gains in life expectancy have occurred in regions where levels of life expectancy are lowest. Life expectancy has increased by 36 percent in Africa, by over 34 percent in Latin America and the Caribbean, and by almost 60 percent in Asia since the mid-twentieth century (UNPD 2002). To be sure, there are still large differences in life expectancy from nation to nation, but these differences are on average smaller today than they were 50 or 100 years ago.

Such an inverted-U shaped trend is also reported by Bourguignon and Morrisson (2002, figure 3), in their recent study of inequality in global living standards over the nineteenth and twentieth centuries. Their results are based on an analysis of long-term

trends in life expectancy for 33 nations or groups of nations[5] from 1820 to 1992. They find that inequality in the distribution of life expectancy across nations increased steadily through the nineteenth and early twentieth centuries, then declined sharply in the second half of the twentieth century. The turning point occurred around 1930. According to their estimates, between-nation inequality was no greater in the late twentieth century than it was in the early nineteenth century. Hence the bulk of cross-national evidence supports predictions of demographic transition theory about the long-term inequality trend.

Trends Since 1980

Has health inequality continued to decline? Most assume that once life expectancies start to converge across nations, the trend does not reverse. Empirical evidence about the recent inequality trend, however, is mixed. Wilson (2001) finds that life expectancies have converged rapidly across nations since 1950, the year his analysis begins. The result, he argues, is a world where national boundaries are of "diminishing demographic relevance" (p. 168). Mayer (2001) also reports a trend of convergence, but only within – not between – groups of rich and poor nations. That is, rather then a trend toward universal global convergence, Mayer sees a more limited trend toward three "convergence clubs." In one "club," the world's poorest nations are converging around a very low level of life expectancy (perhaps 45 or 50 years), while in the other two clubs, richer nations are converging around much higher levels of life expectancy (perhaps 75 or 80 years). The result, according to Mayer, is an international distribution of life

[5] Large nations such as China, India, and the United States are included in their analysis individually, while smaller nations are grouped to maximize coverage.

expectancy with "twin peaks," one peak in the bottom half of the distribution and one peak in the top half. If Wilson's analysis is right, then between-nation inequality likely declined in the late twentieth century, continuing the long-term trend. But if Mayer's analysis is right, then between-nation inequality may not have declined, if the inequality-depressing effects of convergence within each "club" were overshadowed by the inequality-boosting effects of a persistent divide between each club.

To show further evidence of recent inequality trends, Table 1 lists estimates of average global life expectancy (both sexes combined) in 1980, 1990, and 2000. It also disaggregates these world averages into 10 regional averages.[6] Nations are weighted by population size in all global and regional estimates. The two columns in the far right-hand side of the table show the percent change in life expectancy from 1980 to 1990 and from 1990 to 2000.

TABLE 1 ABOUT HERE – World and Regional Trends, 1980 to 2000

Three trends in Table 1 bear on the recent between-nation inequality trend. First, the long-term trend of rising global life expectancy continued through the late twentieth century. Global life expectancy increased by about 4.3 percent from 1980 to 1990 and by 1.9 percent from 1990 to 2000. By 2000, global life expectancy stood at 66.4 years. The largest recent gains occurred in the Middle East/North Africa, South Asia, and East Asia, three regions where life expectancy was below the world average in 1980. Gains were

[6] Throughout the paper we present results for life expectancy for both sexes combined, but results are similar when divided by sex (identifying reference). We separated China and Japan from the rest of East Asia because China is home to such a large share of world population and because life expectancy has historically been higher in Japan than in most other East Asian nations.

smaller in regions such as Western Europe, the Western Offshoots, and Japan, where life expectancy is already very high.

Second, most distressing in Table 1 are the trends of declining life expectancy in sub-Saharan Africa and the Transition Economies. From 1990 to 2000, life expectancy declined by 7 percent in sub-Saharan Africa and by nearly 2 percent in the Transition Economies. The trend of declining life expectancy in sub-Saharan Africa is likely due to the recent HIV/AIDS epidemic (Buvé, Bishikwabo-Nsarhaza, and Mutangadura 2002; UNAIDS 1998, 2002). The cause of declining life expectancy in the Transition Economies is harder to pin down (Marmot and Bobak 2000), but the timing of the decline coincides with the collapse of the former Soviet Union and other ex-Communist states.

Third, because life expectancy changed at different rates across regions, the shape of the international distribution of life expectancy changed too. In 1980, life expectancy was above average in six of the ten regions listed in Table 1, and below average in four regions. The gap in life expectancy between nations at the top of the distribution and nations at the bottom of the distribution was about 29 years. By 2000, however, sub-Saharan Africa and South Asia were left as the only two regions with life expectancies below the world average, and the gap in life expectancy between nations at the top of the distribution and nations at the bottom of the distribution had grown to nearly 35 years. In short, the distribution of life expectancy across regions became wider and more skewed.

Overall, the trends of faster-than-world-average growth in life expectancy in the Middle East/North Africa, South Asia, and East Asia no doubt reduced the level of inequality across nations by compressing the distance between life expectancies in these regions and the global average. Yet the trend of declining life expectancy in sub-Saharan

Africa boosted inequality by stretching the bottom tail of the distribution. Did this inequality-boosting trend offset the trends that were inequality reducing? Or did the inequality-reducing trends dominate? To answer these questions, we need to analyze the recent between-nation inequality trend more formally.

MEASURING INEQUALITY ACROSS NATIONS

The rest of the paper reports a more formal analysis of the between-nation inequality trend since 1980. We begin in this section by describing the four indexes we use to measure inequality in the distribution of life expectancy across nations. We use four indexes because they each have different properties, as explained shortly. The indexes are the Gini coefficient, Theil index, mean logarithmic deviation (MLD), and squared coefficient of variation (CV^2), four standard and well-known measures of inequality.[7] In the following equations, j indexes nation, p_j is the jth nation's share of the world's total population (i.e., p_j = population j / world total, so $\Sigma_j p_j = 1.0$), and r_j is life expectancy in nation j divided by average global life expectancy (i.e., $r_j = X_j / \Sigma_j p_j X_j$, where X_j is life expectancy in nation j). The term r_j is called the *life-expectancy ratio*, since it is the ratio of life expectancy in nation j to average global life expectancy.

Based on this notation, the four inequality indexes are expressed as follows (Firebaugh 2003, pp. 82-83):

Gini coefficient = $\Sigma_j p_j r_j (q_j - Q_j)$,

[7] Although these indexes generally are used to measure inequality in income distributions, they can also be used in the context of other ratio-level variables, including average life expectancy (identifying reference). Good introductions to the large, technical literature on measuring inequality include Allison (1978), Cowell (1995), Jenkins (1991), Schwartz and Winship (1980), and Sen (1997). For the application of inequality indexes to health-related data, see Gakidou et al. (2000), Gakidou and King (2002), Murray et al. (1999), Shkolnikov et al. (2003), and Wilmoth and Horiuchi (1999).

$$\text{Theil index} = \Sigma_j p_j r_j ln (r_j) ,$$

$$\text{MLD} = \Sigma_j p_j ln (1/r_j) ,$$

$$\text{CV}^2 = \Sigma_j p_j (r_j - 1)^2 , \quad (2)$$

where q_j is the proportion of the world's population in nations where life expectancy is lower than in nation j, Q_j is the proportion of the world's population in nations where life expectancy is greater than in nation j, and *ln* refers to the natural logarithm.

All four indexes are calibrated to zero when life expectancy is distributed evenly across nations – that is, when life expectancy in each nation is equal to the world average. The index values then increase as the level of inequality across nations increases. The indexes differ in their sensitivity to changes in different parts of the distribution. Compared with the other indexes, the Gini coefficient is relatively sensitive to change in the middle of the distribution, both the Theil index and CV^2 are relatively sensitive to change in the top of the distribution, and the MLD is relatively sensitive to change in the bottom of the distribution.[8] Because of this, each index yields a somewhat different estimate of change in between-nation inequality, depending on how the distribution of life expectancy has changed.

Note that the four equations above reduce to a single expression (Firebaugh 1999):

$$Inequality = \Sigma_j p_j f (r_j) , \quad (3)$$

where the terms j, p_j, and r_j are the same as above, and f is the functional form used to transform the life-expectancy ratios (see below). The indexes listed in equation 1 can be

[8] Technically, the Gini coefficient is most sensitive to the mode of the distribution (Allison 1978, p. 868), but for the distribution of life expectancy across nations, the mode is closer to the middle of the distribution than to either extreme tail, making it appropriate to associate the Gini with the middle of the distribution.

derived from this expression by substituting different functions for $f(r_j)$. For instance, the MLD uses $f(r_j) = ln(1/r_j)$ and the Theil index uses $f(r_j) = r_j ln(r_j)$.

Equation 3 is useful because it shows that between-nation inequality as measured by any common inequality index is determined by just two terms, population shares (p_j's) and life-expectancy ratios (r_j's). The population shares simply weight nations by the relative size of their national populations,[9] so the life-expectancy ratios are ultimately the key term for measuring inequality. The ratios indicate whether life expectancy in nation j is proportionate to the world average. Equality – the absence of inequality – occurs when $r_j = 1.0$ for all units; otherwise, there is inequality, as life expectancy is disproportionately high ($r_j > 1.0$) in some nations and disproportionately low ($r_j > 1.0$) in other nations (Firebaugh 1999, 2003). Equation 3 shows that inequality indexes work by averaging life-expectancy ratios across nations. None of the indexes computes just a simple weighted average because the weighted average ratio is 1.0 across nations (i.e., $\Sigma_j p_j r_j = 1.0$). Instead, each index first transforms the ratio with a unique mathematical function ($f[r_j]$), then averages across the transformed values. The functions used to transform the ratios vary across the indexes, but all converge to zero as the life-expectancy ratio approaches 1.0. Put another way, the $f(r_j)$ increase in absolute value as the r_j move away from 1.0.[10] The greater the distance of the average ratio from 1.0, the greater the level of inequality across nations.

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[9] It is important to weight nations by population in this study because the goal is to gain leverage on the trend in global health inequality, and global inequality is the sum of *population-weighted* between-nation and within-nation inequality, as described above (Equation 1). Sensitivity analyses (not shown, but available from authors) find that the main results of the study do not change when we weight nations equally.

[10] The one exception is the function for the Theil index, where $f(r_j) \rightarrow 0$ as $r_j \rightarrow 0$. Nonetheless, for the Theil index itself, the index value still increases as distance of the average r_j from 1.0 increases.

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Figure 1 depicts the trend in between-nation health inequality from 1980 to 2000 as measured by the MLD, one of the four inequality indexes featured in this study. Inequality for each year is calculated from estimates of life expectancy (both sexes combined) and population size for a constant panel of 169 nations (see Table 1 for a list), which together account for a near-universe of the world's population. Data are from the World Bank (2002). Results of the analysis are surprising: Between-nation inequality declined from 1980 to about 1992, but then *increased* from 1992 to 2000. The initial decline in inequality across nations continued the long-term trend of convergence that began about 50 years earlier, between the two world wars. The subsequent rise in between-nation inequality then marked a significant reversal of this long-term trend. According to these estimates, the level of between-nation health inequality was about the same in 2000 as it was in 1980. This recent U-turn in the between-nation inequality trend runs counter to the long-term trend of convergence predicted by demographic transition theory.

FIGURE 1 ABOUT HERE – line graph for MLD

Table 2 shows that the trend is robust across four different inequality indexes. From 1980 to 1990, between-nation health inequality declined by 13.3 percent as measured by the Gini coefficient, by 22.3 percent as measured by the Theil index, by 21.5 percent as measured by the MLD, and by 22.5 percent as measured by the CV^2. From 1990 to 2000, inequality then increased by 5.6 percent as measured by the Gini coefficient, by 23.8 percent as measured by the Theil index, by 26.2 as measured by the

MLD, and by 19.4 percent as measured by the CV^2. All four indexes report that the turnaround in the inequality trend began in the early 1990s.

TABLE 2 ABOUT HERE – Trend in Between-Nation Health Inequality, 1980 to 2000

By reporting results for multiple indexes, Table 2 provides an important clue about why inequality began climbing again in the 1990s. All four indexes report that between-nation health inequality increased in the 1990s, but the largest gain is registered by the MLD. That the MLD reports the largest increase means that the greatest inequality-boosting effects occurred in nations near the bottom of the international life expectancy distribution, since, compared to the other indexes, the MLD is more sensitive to change in the bottom of the distribution. Hence, to determine why the inequality trend reversed in the 1990s, we should focus on nations in the bottom of the distribution. This focus leads us to the trend of declining life expectancy in sub-Saharan Africa, as we now see.

DECOMPOSITION ANALYSIS

The previous section shows that between-nation health inequality tracked downward in the 1980s, then increased in the 1990s. The trend of declining inequality in the 1980s is easy enough to explain: gains in life expectancy were greatest among nations below the global average (Table 1), causing levels of life expectancy to converge across nations. The trend of rising inequality in the 1990s is more difficult to explain, so that trend is our focus here. Specifically, we use decomposition techniques, and other types of simulation, to answer two key questions. First, did between-nation health inequality rise in the 1990s

primarily because life expectancy changed at different rates across nations – increasing in some nations but declining in others – or primarily because populations grew faster in countries with unusually low (or unusually high) life expectancies? Second, was the trend dominated by a few influential regions or nations?

Growth Effects versus Allocation Effects

Recall that the level of between-nation health inequality for any given year is determined by population shares (p_js) and life-expectancy ratios (r_js) (equation 3, above), so change in inequality is a function of change in population shares and in life-expectancy ratios. More formally, it can be shown that change in an inequality index between any two points, t and $t + 1$, can be divided into two additive components, one reflecting the effect of changing life-expectancy ratios and one reflecting the effect of changing population shares. Change in between-nation inequality due to changing life-expectancy ratios is called a *growth effect*, since it captures the effect of cross-nation differences in life expectancy growth on the inequality trend. Change in between-nation income inequality due to changing population shares is called an *allocation effect*, since it captures the effect of cross-nation differences in rates of population growth.

Here we give the decomposition formula only for the MLD, since it decomposes more readily than the other indexes (Mookherjee and Shorrocks 1982):

$$\Delta MLD = \sum_j \left(\overline{r_j} - \overline{\ln r_j} \right) \Delta p_j + \sum_j \left(\overline{p_j r_j} - \overline{p_j} \right) \Delta \ln \left(X_j \right), \qquad (4)$$

where the terms j, X_j, p_j, and r_j are the same as above, Δ is the difference operator (i.e., $\Delta MLD = MLD\,(t + 1) - MLD\,(t)$), and the over-bar indicates an average of the variable

across the two time-points (e.g., $\overline{r_j} = \left[r_j(t+1) + r_j(t) \right] / 2$). Equation 4 is derived from the formulas given in Mookherjee and Shorrocks (1982) and Jenkins (1995).[11]

The first term on the right-hand side of the equation is the allocation effect and the second term on the right-hand side of the equation is the growth effect. The allocation effect refers to the effect of the changing relative size of nations, *independent of* changes in the life-expectancy ratios. To understand how between-nation inequality can change due to population growth independent of change in the life-expectancy ratios, suppose life expectancy grows at the same rate for all nations – so life-expectancy ratios are constant – but population grows fastest in nations where life expectancy is close to the world average. Then the middle of the distribution "fattens" relative to the tails of the distribution and inequality declines. By the same logic, inequality increases if populations grow fastest for countries in the tails of the distribution (countries that stand out with either high or low life expectancies relative to the world average). The allocation effect refers to change in between-nation inequality due specifically to the changing shape of the population-weighted life-expectancy distribution across nations as populations grow faster in some nations than in other nations.

Here we use equation 4 to determine if the trend of rising between-nation health inequality in the 1990s is explained primarily by cross-nation differences in rates of life expectancy growth – what we are calling a growth effect – or by cross-nation differences in rates of population growth – an allocation effect. This is a useful first step in

[11] Readers will find that the decomposition of the MLD given in both Mookherjee and Shorrocks (1982) and Jenkins (1995) has four additive terms – two for between-group inequality and two for within-group inequality. For the present analysis, the two within-group inequality terms drop out, since our focus is health inequality between – not within – nations. The two terms given in equation 4 here correspond to Mookherjee and Shorrocks's equations 14c and 14d and to "term C" and "term D" in Jenkins's equation 5.

accounting for the recent inequality trend. From 1990 to 2000, between-nation health inequality grew by 26.2 percent as measured by the MLD (from Table 2). Results of the decomposition (equation 4) find that a growth effect accounts for about 75 percent of this increase and that an allocation effect accounts for only about 25 percent. Hence, most of the increase in between-nation health inequality occurred because life expectancy grew at different rates across nations. Cross-nation differences in rates of population growth had a much smaller effect on the population-weighted inequality trend.

Given the nature of the recent relationship between population growth and life expectancy, the small size of the allocation effect is not surprising. In the 1990s, there was a strong negative relationship between life expectancy and national population growth – for the 169 nations in this analysis, $r = -.61$ for the bivariate relationship between 1990 life expectancy and 1990-2000 population growth. That is, population has tended to grow fastest in nations where life expectancy is low and slowest in nations where life expectancy is high. As a result, population growth in the middle of the international distribution of life expectancy has not differed greatly from the *average* growth in the two tails, leaving little net effect of differential population growth on the overall inequality trend.

Was the Trend Dominated By a Few Influential Regions?

The decomposition method above divides the observed gain in between-nation inequality into an overall growth effect and an overall allocation effect. However, the method cannot further divide the overall growth and allocation effects into effects for specific

nations or regions (see Appendix A), so another method is needed to determine if the trend of rising inequality in the 1990s was produced by a few influential regions.

One way to quantify the growth effect or allocation effect for a specific region is to run a simulation exercise where the rate of population growth or of life expectancy growth for the given region is set at the world average (Berry, Bourguignon, and Morrisson 1983; Bourguignon and Morrisson 2002; Sala-i-Martin 2002). A predicted between-nation inequality trend is computed under the counterfactual condition, and the difference between the actual change in between-nation inequality and the predicted change under the counterfactual condition is taken as an estimate of the growth or allocation effect for the specific region. By doing this simulation for each region in turn, we can determine which regions contributed most to the trend in between-nation health inequality. Moreover, we can also determine the direction of each region's contribution (whether change in that region boosted or reduced health inequality across nations).

Tables 3 and 4 report results from this sort of simulation exercise. Table 3 is for growth effects and table 4 is for allocation effects. The bottom row of each table lists the observed change in between-nation health inequality from 1990 to 2000, as measured by each of the four inequality indexes (from table 2). The other rows then report the predicted change in between-nation inequality under telling counterfactual conditions. The top row of table 3, for instance, shows the predicted change in between-nation health inequality if life expectancy in Western Europe had grown by 1.9 percent from 1990 to 2000 – the world-average rate – instead of 2.4 percent – its actual rate (table 1). Similarly, each row in table 4 reports the predicted change in between-nation health

inequality after setting population growth for the corresponding region at the world-average rate.

TABLES 3 AND 4 ABOUT HERE – Growth and Allocation Effects, by Region

The results are best read by comparing the predicted change to the observed change (in the bottom row of each table). The larger the difference between observed and predicted values, the larger the effect of the region. To illustrate, consider the effect of life expectancy growth in China from 1990 to 2000. The effect is quite small, since the predicted change (+5.5 percent as measured by the Gini coefficient) differs very little from the actual change (+5.6 percent as measured by the Gini coefficient). Clearly, then, changing life expectancy in China did not cause the reversal of the trend in between-nation and between-region health inequality in the 1990s. Had life expectancy in China changed at the same rate as the world average, we would have seen the same change in health inequality. Nor did trends in life expectancy in the West, or in Latin America, or in the Middle East, or in Japan and East Asia (outside China) have a major effect either. We must look elsewhere for the cause of the reversal. What occurred in the 1990s to arrest the decline in between-nation health inequality?

The answer is that life expectancy declined in the 1990s in sub-Saharan Africa. On the basis of the simulations (Table 3), had life expectancy not declined in sub-Saharan Africa during this period but had, instead, increased by 1.9 percent (the average for the rest of the world), then between-nation health inequality would have continued to decline – by 4.8 percent as measured by the Gini coefficient, by 5.3 percent as measured by the Theil, by 4.4 percent as measured by the MLD, and by 6.1 percent as measured by CV^2.

In other words, the upturn in between-nation health inequality experienced in the 1990s was due entirely to deteriorating life expectancy in sub-Saharan Africa.

A second major finding is that population growth in sub-Saharan Africa exacerbated the rise in between-nation inequality. Despite declining life expectancy, the population in sub-Saharan Africa continued to grow faster than the world average because fertility rates remained higher there than in other regions of the world. Had population growth in sub-Saharan Africa not exceeded the world average, between-nation inequality would have grown less than it did (Table 4). Faster-than-world-average population growth in sub-Saharan Africa boosted inequality by fattening the lower tail of the cross-national life expectancy distribution. Because life expectancy is so much lower in sub-Saharan Africa than it is in the rest of the world – the estimate of 46.5 years is more than 15 years below the next-lowest region, South Asia – health inequality increases across nations when populations grow faster in African nations than in other nations.

In short, sub-Saharan Africa is central to the story of between-nation health inequality in the late twentieth century. Even though only about one-tenth of the world's people live in sub-Saharan Africa, trends in this region of the world in the 1990s were solely responsible for reversing a half-century trend toward increasing *equality* in life expectancy across nations. Because life expectancy in sub-Saharan Africa is by far the lowest in the world, inequality in life expectancy across nations is boosted by slower-than-world-average growth in life expectancy, and by faster-than-world-average growth in population, in that region. Both occurred during the 1990s. In fact, life expectancy declined in sub-Saharan Africa during an era when life expectancy was increasing in

most other regions. That trend alone accounts for the reversal of the between-nation inequality trend since, as seen in Table 3, the trend would have continued its downward trajectory had life expectancy in sub-Saharan Africa kept up with the world average.

A third major finding is that trends in South Asia contributed a counterweight to the inequality-enhancing effect of trends in sub-Saharan Africa. As of 1980, life expectancy in sub-Saharan Africa and in South Asia were not too far apart: 47.6 years in Africa, 53.4 years in South Asia (Table 1). Since 1980 their paths have diverged sharply, with life expectancy in South Asia increasing to 62.1 years and life expectancy in sub-Saharan Africa falling to 46.5 years. Because South Asia is a populous region, and because life expectancy in South Asia is moving up toward the world average, the life expectancy trend in South Asia has palpable effects on the between-nation inequality trend. In this case, however, the effects are equalizing. Had life expectancy in South Asia *not* grown faster than the world average, inequality would have risen faster than it did in the 1990s: We expect the Gini coefficient, for example, would have increased by 13.8 percent as opposed to 5.6 percent (Table 3).

Finally, note that the growth effects for specific regions are generally larger than the allocation effects, consistent with our earlier finding that a growth effect – not an allocation effect – accounts for most of the rise in between-nation inequality. Inequality increased in the 1990s primarily because life expectancies grew at different rates across nations, and only secondarily because populations grew at different rates. And, as we have seen, it is life expectancies in sub-Saharan Africa and in South Asia that mattered, with life expectancy trends in sub-Saharan Africa constituting the world's major

unequalizing force in health inequality in the 1990s and life expectancy trends in South Asia constituting the major equalizing force.

Table 5 helps summarize the results by listing the three factors that were by far the most consequential for the recent inequality trend. As we have seen, the inequality-depressing effects of rising life expectancy in South Asia (the second factor in Table 5) were more than offset by the inequality-boosting effects of faster-than-world-average population growth and declining life expectancy in sub-Saharan Africa. As a result, inequality increased overall. Hence we have an answer to the question of why between-nation health inequality increased in the 1990s. Declining life expectancy in sub-Saharan Africa, coupled with growing population there, caused the divergence. Accounting for the decline in life expectancy in sub-Saharan Africa, then, is key to understanding the recent upswing in between-nation health inequality, and we examine that issue in greater detail below.

DISCUSSION: THE IMPORTANCE OF AFRICA

This study has examined the uneven distribution of health across nations, using life expectancy as the measure of average level of health in a nation. Obviously there is more to good health than longevity. Life expectancy nevertheless is the best single indicator that we have of the average level of health for a nearly-universal sample of nations over an extended period. Any general measure of a nation's level of human development or life chances should incorporate longevity of life, and in fact life expectancy is one of the three components of the U.N.'s Human Development Index (UNDP 2003).

On the basis of limited historical data bearing on trends in life expectancy across regions and nations, we conclude that the long-term trend in between-nation health inequality has most likely followed an inverted-U shaped pattern, with inequality rising through the nineteenth and early twentieth centuries, then declining over the next half-century. This long-term trend is consistent with predictions of demographic theory, specifically demographic transition theory. Importantly, however, our analysis of life expectancy data for 1980 to 2000 indicates that the last decade of the twentieth century witnessed another reversal in the between-nation inequality trend, as inequality across nations began climbing again in the 1990s. The recent turnaround is significant, first, because it reverses the long-term trend of declining inequality across nations that began in the period between the two world wars and, second, because it is not anticipated by demographic theory. Demographic transition theory implies that once a trend of cross-nation convergence begins, it does not reverse. The findings here question this implication, by showing that periods of divergence and increasing inequality are still possible.

Our simulation results identify declining life expectancy in sub-Saharan Africa as the primary cause of the recent upswing in between-nation inequality. Although the cause of declining life expectancy in sub-Saharan Africa is beyond of the scope of this analysis, the most likely explanation is the spread of HIV/AIDS. According to recent estimates, the number of sub-Saharan Africans now living with HIV/AIDS is nearly 30 million, or roughly 4.5 percent of the region's total population, and in some nations, adult HIV prevalence rates are higher than 30 percent (UNAIDS 2002). The demographic impact of the epidemic has been severe. One recent study, for instance, estimates that in

nations such as Botswana, Lesotho, and Zimbabwe, where HIV prevalence rates are now highest, average life expectancy at birth would be as much as *25 to 30 years* higher today if not for HIV/AIDS (UNPD 2002, table 19). Life expectancies in other sub-Saharan nations have been similarly affected, although to a lesser degree. It is likely, then, that HIV/AIDS alone accounts for the decline in African life expectancy that occurred in the 1990s.

That the recent upturn in between-nation health inequality parallels the spread of HIV/AIDS in Africa underscores the importance to global demography of the HIV/AIDS pandemic in Africa. Researchers estimate that HIV/AIDS is responsible for more than 20 million deaths in sub-Saharan Africa since the late 1970s or early 1980s, when the disease first appeared (UNAIDS 1998, 2002). The annual number of deaths due to HIV/AIDS, however, has greatly increased over time, so that more than 12 million deaths – or roughly 60 percent of the total – have occurred since 1997 alone. Between-nation health inequality surged upward (note in Figure 1 the sharp upturn in health inequality from 1997 to 2000) at the same time that the annual number of deaths due to HIV/AIDS ballooned. The two trends are no doubt closely related.

The key findings here – that trends in sub-Saharan Africa have been decisive in determining recent trends in between-nation health inequality, and that sub-Saharan Africa is one of only two major world regions with life expectancy below the world average – also bear on predictions about future trends in health inequality across nations. Average life expectancy is now above the world average in all major world regions except South Asia and sub-Saharan Africa. But (as noted earlier) life expectancy is growing rapidly in South Asia, so sub-Saharan Africa will likely soon be left as the only

region in the bottom half of the international distribution of life expectancy. Given such a highly-skewed distribution, the sources for future declines in between-nation health inequality will be limited to (i) faster-than-world-average gains in life expectancy in sub-Saharan Africa or (ii) sharp drops in life expectancy in other world regions. Barring any major social or economic catastrophe, the latter is unlikely, so sub-Saharan Africa is the key to the future between-nation inequality trend. If life expectancy in sub-Saharan Africa continues to decline, then the recent trend of rising between-nation health inequality will persist. If, on the other hand, the trend of declining life expectancy in sub-Saharan Africa is reversed, then between-nation inequality is likely to track downward again as sub-Saharan Africa becomes a less pronounced outlier.

Although HIV infection rates are now declining in some parts of Africa, the annual number of deaths due to HIV/AIDS is likely to continue to grow for at least ten more years, because so many people are already infected (UNAIDS 2002). In this context, it is useful to consider some projections from a recent report by the United Nations Population Division (UNPD) (2003). The report assesses the demographic impact of HIV/AIDS in Africa by projecting life expectancy at birth for that region over the next half-century. The estimates project that life expectancy in Africa will continue to decline over the next five or ten years, then start climbing again after about 2010. By the middle of the twenty-first century, life expectancy in Africa is projected to reach 65 years – or about 15 years greater than its present level. If these projections hold, then we can expect the trend of rising between-nation health inequality to persist for at least five or ten more years. After that point, inequality will track downward again, just as it did through much of the past half-century. It is important to note, however, that these

projections assume that HIV/AIDS prevalence rates in Africa will peak some time before 2010, then decline over the next four decades (UNPD 2003, table 17). The current trend of rising between-nation inequality is likely to persist for a longer period if the assumed declines in HIV/AIDS prevalence rates do not come about so soon.

Finally, what do these results mean for the trend in *global* health inequality? Recall (equation 1) that global health inequality is the sum of population-weighted between-nation and within-nation inequality. Our findings indicate that between-nation health inequality has been rising since the early 1990s, so the trend in global health inequality depends, first, on the direction of the trend in within-nation inequality and, second, on the relative size of between-nation and within-nation inequality. If between-nation health inequality is much larger than within-nation inequality or if within-nation inequality has changed only trivially since 1990, then global health inequality is rising. But if within-nation inequality is the larger component of global health inequality, and if within-nation inequality has declined, then the trend in global health inequality could be downward despite our discovery here of recent growth in between-nation health inequality. In one recent study of global health inequality, Pradhan, Sahn, and Younger (2003) argue that within-nation inequality now accounts for the bulk of total global health inequality. It is possible, then, that global health inequality is declining even though between-nation inequality is rising, if within-nation inequality in fact is declining. Pradhan et al.'s results, however, are based on analyses of the global distribution of children's height – a different type of global health inequality than what we analyze here – so it is difficult to combine their results with ours to infer the direction of the global trend. To determine more confidently the recent trend in global health inequality, studies

must link analyses of health inequality across nations with consonant analyses of health inequality within nations. That is the next challenge for research on global health inequality.

APPENDIX A: QUANTIFYING GROWTH AND ALLOCATION EFFECTS FOR SPECIFIC NATIONS

This appendix explains why the decomposition formula (equation 4 in text) cannot be used to quantify the growth or allocation effect for a specific nation or region. Consider the allocation effect, the first term in the equation, and recall that faster-than-world-average population growth in the tails of the distribution boosts inequality and that faster-than-world-average population growth in the middle of the distribution reduces inequality. Thus the direction of the allocation effect for a specific nation should vary based on that nation's position in the international distribution of life expectancy. For nations in the tails of the distribution, the allocation effect should be positive (inequality-producing) when $\Delta p_j > 0$ and negative (inequality-reducing) when $\Delta p_j < 0$; for nations in the middle of the distribution, the allocation effect should be positive when $\Delta p_j < 0$ and negative when $\Delta p_j > 0$. Equation 4 does not produce those results. Because the allocation term is a weighted average of the Δp_j's, where the weight, $\left(\overline{r_j} - \overline{\ln r_j}\right)$, is always positive, then the sign of the allocation effect for a specific nation depends on the sign of Δp_j. As a result, the direction of the effect is correct for nations in the tails of the distribution, but incorrect for nations in the middle of the distribution.

Now consider the growth effect. Inequality declines when life-expectancy ratios (r_j's) converge toward 1.0 and rises when life-expectancy ratios diverge from 1.0. Thus for nations where $r_j > 1.0$ the growth effect is negative (inequality-reducing) when $\Delta r_j < 0$ and positive (inequality-producing) when $\Delta r_j > 0$; the converse is true for nations where $r_j < 1.0$ (negative when $\Delta r_j > 0$ and positive when $\Delta r_j < 0$). But the growth effect term in equation 4 does not always produce these results for individual nations. The term is a weighted average of national rates of growth in life expectancy, where growth is

measured as $\Delta ln(X_j)$ and the weight is $\left(\overline{p_j r_j} - \overline{p_j}\right)$. Obviously the growth rate, $\Delta ln(X_j)$, is positive when life expectancy is increasing, and the weight is positive when $r_j > 1.0$. Based on this term, then, we would infer that the direction of the growth effect for nations with above-average life expectancies ($r_j > 1.0$) depends on whether or not life expectancies are growing in those nations. But this result contradicts the principle that change in inequality depends on the convergence or divergence of life-expectancy ratios. If life expectancies in nations in the upper half of the distribution are growing more slowly than the world average, inequality is reduced, not increased, by the presence of those nations. Similarly, the term can give the wrong sign for nations with below-average life expectancies. Again this problem occurs when life expectancies grow more slowly than the world average. In short, equation 4 is designed to estimate the *overall* allocation and growth effects, and it should not be used for determining the allocation and growth effects *for specific units* such as nations.

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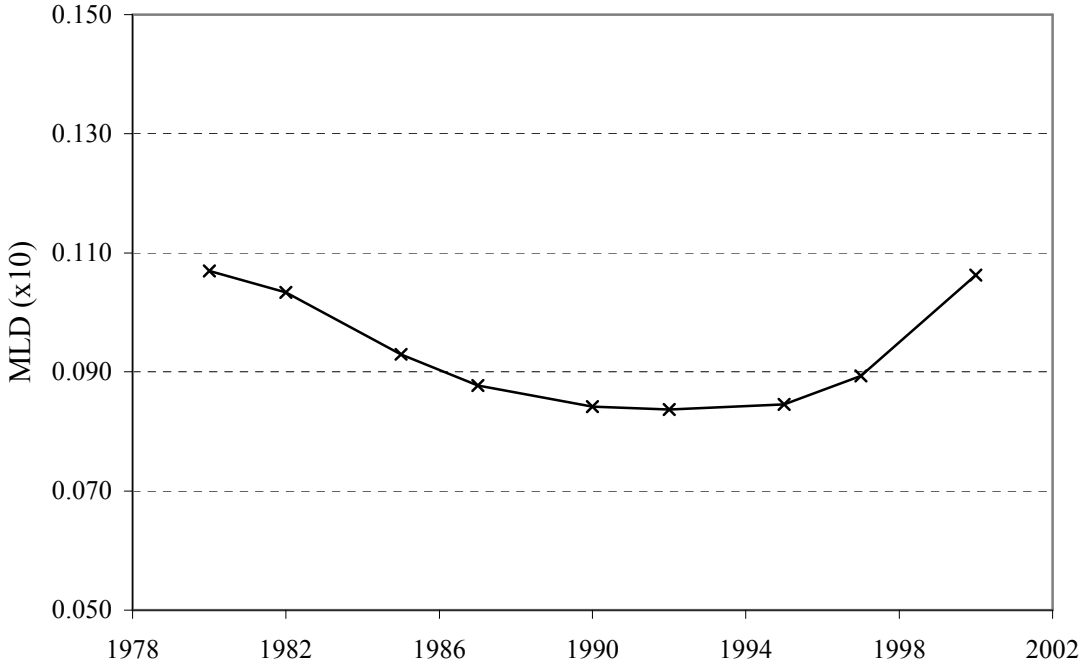
Table 1. World and Regional Trends in Life Expectancy (both sexes combined), 1980 to 2000.

Region:	Life Expectancy			Percent Change	
	1980	1990	2000	1980-1990	1990-2000
Western Europe……	73.9	76.1	78.0	+3.1%	+2.4%
Transition Economies…….	68.1	69.3	68.0	+1.8%	-1.9%
Western Offshoots……	73.8	75.5	77.4	+2.3%	+2.4%
Latin America and the Caribbean……..	64.7	68.0	70.4	+5.1%	+3.6%
Middle East and North Africa ….	59.2	65.0	68.5	+9.7%	+5.4%
Sub-Saharan Africa……	47.6	50.0	46.5	+5.0%	-7.0%
South Asia…….	53.4	58.3	62.1	+9.1%	+6.5%
East Asia (excluding China and Japan)……	59.7	65.1	68.5	+8.9%	+5.2%
Japan…….	76.1	78.8	80.7	+3.6%	+2.4%
China…….	66.8	68.9	70.3	+3.0%	+2.0%
World……..……	62.5	65.2	66.4	+4.3%	+1.9%

Source: World Bank (2002).
Western Europe (19 nations): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.
Transition Economies (28 nations): Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, North Korea, Kyrgyz Republic, Laos, Latvia, Lithuania, Moldova, Mongolia, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Yugoslavia.
Western Offshoots (4 nations): Australia, Canada, New Zealand, United States.
Latin American and the Caribbean (29 nations): Argentina, The Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Lucia, Suriname, Trinidad and Tobago, Uruguay, Venezuela.
Middle East and North Africa (20 nations): Algeria, Bahrain, Brunei, Cyprus, Egypt, Iran, Iraq, Israel, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates, Yemen.
Sub-Saharan Africa (46 nations): Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Congo Republic, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.
South Asia (8 nations): Afghanistan, Bangladesh, Cambodia, India, Myanmar, Nepal, Pakistan, Sri Lanka.
East Asia (13 nations): Fiji, Hong Kong, Indonesia, Korea, Malaysia, New Caledonia, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Thailand, Vietnam.

Figure 1. Trend in Between-Nation Health Inequality, 1980 to 2000.



Notes: MLD is a measure of inequality (see text). Trend is based on life expectancy and population data for 169 nations (data from World Bank 2002; see Table 1 for a list of nations).

Table 2. Trend in Between-Nation Health Inequality (both sexes), 1980 to 2000.

	Index (x10)			
Year	Gini coefficient	Theil index	MLD	CV^2
1980…….	.797	.103	.107	.200
1982…….	.783	.099	.103	.193
1985…….	.740	.089	.093	.174
1987…….	.716	.084	.088	.163
1990…….	.691	.080	.084	.155
1992…….	.680	.079	.084	.153
1995…….	.680	.080	.085	.153
1997…….	.688	.084	.089	.160
2000…….	.730	.099	.106	.185
Percent change, 1980-1990:	-13.3%	-22.3%	-21.5%	-22.5%
Percent change, 1990-2000:	+5.6%	+23.8%	+26.2%	+19.4%

Notes: See text for description of inequality measures. Estimates are based on life expectancy and population data for 169 nations (data from World Bank 2002; see Table 1 for list of nations).

Table 3. Growth Effects, by Region: Predicted Change in Between-Nation Health Inequality Setting Regional Rates of Growth in Life Expectancy at the World Average, 1990 to 2000.[a]

	Index			
Region	Gini coefficient	Theil index	MLD	CV^2
Western Europe……	+5.2%	+21.7%	+25.5%	+18.4%
Transition Economies……..	+4.7%	+22.8%	+26.9%	+19.3%
Western Offshoots……	+5.3%	+21.8%	+25.6%	+18.6%
Latin America and the Caribbean……..	+5.7%	+21.9%	+25.5%	+18.8%
Middle East and North Africa ……...	+6.3%	+22.5%	+26.1%	+19.5%
Sub-Saharan Africa……..	-4.8%	-5.3%	-4.4%	-6.1%
South Asia……	+13.8%	+34.1%	+36.8%	+32.0%
East Asia (excluding China and Japan)…….	+6.7%	+23.0%	+26.4%	+20.1%
Japan……	+5.5%	+22.2%	+26.0%	+18.9%
China……	+5.5%	+22.3%	+26.1%	+19.1%
Observed change, 1990 to 2000……	+5.6%	+23.8%	+26.2%	+19.4%

Notes: See text for description of inequality measures. Estimates are based on life expectancy and population data for 169 nations (data from World Bank 2002; see Table 1 for list of nations).

[a] For each region, the change in inequality is recalculated under the assumption that life expectancy in that region had grown at the world-average rate. See text for details.

Table 4. Allocation Effects, by Region: Predicted Change in Between-Nation Health Inequality Setting Regional Rates of Population Growth at the World Average, 1990 to 2000.[a]

	Index			
Region	Gini coefficient	Theil index	MLD	CV^2
Western Europe……	+5.7%	+22.7%	+26.5%	+19.5%
Transition Economies……..	+5.0%	+21.3%	+25.1%	+18.1%
Western Offshoots……	+5.7%	+22.5%	+26.3%	+19.3%
Latin America and the Caribbean……..	+5.8%	+22.6%	+26.4%	+19.4%
Middle East and North Africa ……...	+5.8%	+22.7%	+26.5%	+19.5%
Sub-Saharan Africa……..	+2.0%	+15.5%	+19.0%	+12.5%
South Asia……	+5.6%	+22.4%	+26.3%	+19.2%
East Asia (excluding China and Japan)…….	+5.8%	+22.6%	+26.4%	+19.4%
Japan……	+5.8%	+22.8%	+26.5%	+19.6%
China……	+5.3%	+21.6%	+25.4%	+18.4%
Observed change, 1990 to 2000……	+5.6%	+23.8%	+26.2%	+19.4%

Notes: See text for description of inequality measures. Estimates are based on life expectancy and population data for 169 nations (data from World Bank 2002; see Table 1 for list of nations).

[a] For each region, change in inequality is recalculated under the assumption that populations in that region had grown at the world-average rate. See text for details.

Table 5. Leading Contributors to Change in Between-Nation Health Inequality, 1990 to 2000.

	Effect on between-nation inequality:
1. Sub-Saharan Africa, declining life expectancy	Increased inequality
2. South Asia, rising life expectancy	Reduced inequality
3. Sub-Saharan Africa, faster-than-world-average population growth	Increased Inequality

Source: Tables 3 and 4.