WPS3580

On the Contribution of Demographic Change to Aggregate Poverty Measures for the Developing World

Martin Ravallion*

Development Research Group, World Bank
mravallion@worldbank.org

Recent literature and new data help determine plausible bounds to some key demographic differences between the poor and non-poor in the developing world. The paper estimates that selective mortality — whereby poorer people tend to have higher death rates — accounts for 10-30% of the developing world's trend rate of "$1 a day" poverty reduction in the 1990s. However, in a neighborhood of plausible estimates, differential fertility — whereby poorer people tend also to have higher birth rates — has had a more than offsetting poverty-increasing effect. The net impact of differential natural population growth represents 10-50% of the trend rate of poverty reduction.

World Bank Policy Research Working Paper 3580, April 2005

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the World Bank, its Executive Directors, or the countries they represent. Policy Research Working Papers are available online at http://econ.worldbank.org.

* Helpful comments on an earlier version of this paper were received from Kathleen Beegle, Monica Das Gupta, Michael Lipton, Lant Pritchett, T. Paul Schultz, Damien de Walque, Dominique van de Walle and Adam Wagstaff. For useful discussions on this topic and helpful comments on earlier versions of this paper the author is particularly grateful to Etienne van de Walle.

1. Introduction

The question as to whether population growth contributes to poverty is longstanding in population and development studies. Yet one cannot find in the huge literature on that topic the most obvious calculations needed to measure the direct contribution of demographic change to the extent of poverty in the developing world. Poverty is routinely measured as the headcount index, given by the proportion of the population living in households with consumption or income below the poverty line. The headcount index falls when a poor person dies but it rises when a non-poor person dies (*ceteris paribus*). Similarly, the poverty rate rises when a child is borne into a poor family, while it falls when a child is born into a non-poor family. Furthermore, recent research (reviewed later) points to significant socioeconomic differentials in mortality and fertility; in particular, both birth rates and death rates tend to be higher for the poor.

These observations beg the main question addressed by this paper: How much bearing do socioeconomic differentials in mortality and fertility have on the most widely used international measure of poverty for the developing world, namely the headcount index for $1 a day at Purchasing Power Parity, as given in Figure 1 (from Chen and Ravallion, 2004)? The paper measures the contribution of socioeconomic differentials in demographics against an explicit counterfactual, namely the situation when births and deaths are random, i.e., independent of poverty status. The simplest approach to measuring that counterfactual is to net out the differential demographic changes over a given time period and then recalculate the poverty measure at the end point. Comparing this counterfactual poverty measure to the actual value gives us an estimate of the contribution of the demographic changes during that period. By comparing those impacts to the actual changes one can assess the contribution to the evolution of measured poverty.

That is the approach taken here. As we will see, even this conceptually straightforward approach faces some severe data limitations, which generate considerable uncertainty about the poverty impacts of demographic change. And even without these data problems, one would rightly question the assumptions underlying this approach. Most importantly, it does not allow for possible indirect effects on living standards of the high rates of mortality and fertility found among the world's poor. A higher fertility rate for the poor may also entail lower future real wages for unskilled labor and hence higher poverty independently of the direct demographic effect; indeed, there is evidence for precisely this effect for India (van de Walle, 1985; Datt and Ravallion, 1998, both using state-level panel data). Or higher death rates for the poor may undermine future productivity of the survivors; for example, it has been argued that the orphans resulting from the sharp rise in adult deaths due to the HIV/AIDS epidemic have had lower schooling than they would have had otherwise.[1]

An alternative empirical approach is to regress rates of economic growth and/or poverty reduction at country level on rates of population growth and/or their demographic covariates, with controls for other factors affecting growth. Following this approach, Kelley and Schmidt (2001) and Williamson (2001) present evidence of adverse effects of high population growth rates on rates of economic growth; Williamson argues that the key demographic variable is the growth rate of the dependent population. By this view, changes in the age composition of the population affect aggregate savings and (hence) growth. Eastwood and Lipton (1999, 2001) use instead changes over time in poverty measures as their dependent variable, for a cross-section of countries, and find evidence of adverse effects of higher fertility on measures of poverty; they find that these effects are transmitted thought both growth and distribution. However, while

[1] See Ainsworth and Filmer (2002) who also warn against such generalizations, given the diversity in apparent impacts across countries.

aggregate time series or cross-sectional regressions have the potential to reveal the more subtle indirect effects of demographic change, this approach brings its own problems. The implementation inevitably raises concerns about the possible endogeneity of demographic variables and what control variables to use. Schultz (2004) raises a number of concerns about the robustness of the existing cross-country evidence on the demographic determinants of aggregate savings. The robustness of the recent findings from cross-country growth regressions that a higher population growth rate lowers the rate of GDP growth can also be questioned in the light of the results of Sala-I-Martin et al. (2004).[2]

As this paper will show, the contribution of demographic changes to aggregate poverty measures is non-parametrically identified. The calculations presented in this paper quantify the first-order poverty impacts of selective mortality and fertility without a regression model. The calculations suggest that the annual impacts of the demographic differentials on poverty account for a sizeable share of the trend rate of "$1 a day" poverty reduction in the developing world. At the same time, the results point to the need for better data on socio-economic differentials in mortality and fertility, and for further research on the social and economic processes linking demographic changes to the evolution of poverty measures.

However, the approach taken here shares a limitation of the cross-country regressions cited above, namely that it does not tell us that any specific demographic policy (such as family planning or promoting female education) will be effective against poverty. Nor do the findings of this paper even establish that policies that operate via demographic variables are any more important than other policies. Promoting economic growth and/or improved distribution from the point of view of the poor may simultaneously reduce fertility and poverty.

[2] In a meta-study of all the cross-country growth regressions with an average of seven regressors (chosen from 67 candidates drawn from the literature on cross-country growth regressions) Sala-I-Martin et al (2004) report that the rate of population growth is only significant in one fifth of cases.

The paper first defines the counterfactual poverty rate, when births and deaths are random (Section 2). Then Section 3 reviews existing evidence on differential mortality and fertility, and presents some new evidence. Section 4 then provides estimates of the contribution of these two demographic forces to existing global measures of poverty. Section 5 concludes.

2. Counterfactual poverty measures

The following analysis is built on the most widely used measure of poverty, namely the headcount index given by the proportion of the population living in households with real consumption or income per person below a predetermined poverty line. There are well-known deficiencies of this measure, such as the fact that it does not reflect distribution below the line. In the present context, it has been argued that the measure suffers from another deficiency. With selective mortality one should be wary of interpreting a decline in poverty (or a gain in some other measure of social welfare) as indicating that the specific individuals in either the original or the final population are "better off." Recent theoretical work by Kanbur and Mukerjee (2003) has explored alternative approaches to measurement that do not have the property that selective mortality, whereby death rates tend to be higher for the poor, reduces poverty.

It remains an open question whether we should measure poverty any differently knowing that poor people have higher mortality rates. If all the poor migrate out of some region, or die, and there are no adverse impacts on the non-poor, then (as a purely descriptive statement) poverty will have fallen to zero. Nonetheless, whether or not one wants to measure poverty any differently, it is of interest to know what impact differential mortality has on these measures. How much does it attenuate poverty measures in practice? And how much is that effect offset by differential fertility, whereby poor households tend also to have higher fertility rates?

To outline the proposed method of assessing the poverty impact of demographic changes in more formal terms, let $H = N^p / N$ denote the headcount index of poverty at a specific date where N^p is the number of poor people in a population of size N at that date. (One can imagine these variables having a continuous time subscript *t*, but I do not write them that way for notational simplicity.) Consider mortality first. Let DR_τ^p denote the death rate for the poor during a period of time τ years prior to the date in question, where $DR_\tau^p = D_\tau^p / N^p$ and D_τ^p is the number of deaths among the poor in the period τ. (Note that, unlike N^p and N, which are stock variables, D_τ^p is a flow variable, which depends on the length of τ.) Similarly, let DR_τ denote the death rate in the population as a whole while $DRD_\tau = DR_\tau^p / DR_\tau$ is the "death rate differential" — the odds ratio of mortality for the poor relative to the whole population.

The contribution of differential mortality to the observed headcount index is measured against a counterfactual headcount index under random (non-selective) mortality, whereby the probability of death is independent of poverty status. Then *DRD* converges to unity in sufficiently large populations. Let H_τ^D be the counterfactual headcount index. This is obtained by dividing the number of poor (at the date in question) if mortality had been random during the preceding period τ by the total population under the same counterfactual. Under random mortality, H_τ^D is also the headcount index that would have been observed if there had been no mortality during the period. (Of course, there are still deaths with random mortality, but they occur with the same probability for the poor as for the population as a whole.) In the absence of deaths during τ there would be $N_\tau^p + D_\tau^p$ poor in a total population of $N_\tau + D_\tau$ at the date in question. Then the counterfactual headcount index under random mortality during period τ is:

$$H_\tau^D = \frac{N_\tau^p + D_\tau^p}{N_t + D_\tau} = H\left(\frac{1 + DRD_\tau DR_\tau}{1 + DR_\tau}\right) \tag{1}$$

Evidently, $H_\tau^D \geq (<) H$ as $DRD_\tau \geq (<) 1$; higher death rates for the poor tend to reduce the poverty rate. Note that DRD_τ reaches a maximum when all deaths are among the poor, $DRD_\tau^{\max} = 1/H$ at which point (1) reaches its upper bound of $H_\tau^{D\max} = (H + DR_\tau)/(1 + DR_\tau)$.

The same basic idea can be used to define a counterfactual poverty measure with random births, giving:

$$H_\tau^B = H\left(\frac{1 - BRD_\tau BR_\tau}{1 - BR_\tau}\right) \tag{2}$$

where BR_τ is the overall birth rate and BRD_τ is the birth-rate differential (birth rate of the poor divided by overall birth rate). Evidently, $H_\tau^B \geq (<) H$ as $BRD_\tau \leq (>) 1$; higher birth rates among the poor tend to increase the poverty rate. H_τ^B is bounded below by $(H - BR_\tau)/(1 - BR_\tau)$.

The impacts of differential (non-random) deaths and births in the period of length τ prior to the date in question are then:

$$I_\tau^D = H - H_\tau^D = H\left(\frac{(1 - DRD_\tau)DR_\tau}{1 + DR_\tau}\right) \tag{3.1}$$

$$I_\tau^B = H - H_\tau^B = H\left(\frac{(BRD_\tau - 1)BR_\tau}{1 - BR_\tau}\right) \tag{3.2}$$

respectively. Finally, the net impact on poverty of the natural rate of population growth is:

$$I_\tau^N = H\left(\frac{(NRD_\tau - 1)NR_\tau}{1 - NR_\tau}\right) \tag{4}$$

where $NR_\tau = BR_\tau - DR_\tau$ is the natural rate of population increase in the period of length τ while the natural rate differential is $NRD_\tau = (BRD_\tau BR_\tau - DRD_\tau DR_\tau) / NR_\tau$.

Note that, unlike the actual headcount index, the counterfactual and (hence) the impact measures above depend on the length of time τ over which deaths and births are counted; at any given date, the impacts will naturally differ if one looks back $\tau = 1$ year prior to the date in questions versus $\tau = 10$ years (say).

3. Evidence on differential mortality and fertility

This section reviews existing evidence on relevant socioeconomic differentials in mortality and fertility. No attempt is made to explain why such differentials exist; for the present purposes, the sole task is to establish plausible bounds to the extent of such differentials, so as to estimate their likely impacts on measures of poverty.[3] The "poor" will be identified as the poorest quintile in the developing world (low and middle income countries), in accordance with the estimates of the $1 a day poverty rate around 2000 (Figure 1). So both *DRD* and *BRD* are somewhere between 1 and 5, though (thankfully) we can narrow the range considerably.

3.1 Evidence on differential mortality

The Crude Death Rate (CDR) is the number of deaths per year in a given population. This is known to be a potentially deceptive measure of mortality, as it is influenced by the age distribution, which depends (heavily) on the fertility rate, as well as mortality. (Thus, the CDR for aging European countries is similar to that found in many developing countries, though for very different reasons.) However, the CDR is the appropriate measure of DR_τ in equations (1) and (3.1), so this is what the following discussion will initially focus on.

[3] For a broader discussion of the sources of socioeconomic differentials in mortality see Hummer et al. (1998).

The CDR for low and middle income countries as a whole is estimated to be 9 deaths per year per 1,000 people in 2001 (World Bank, 2004).[4] This has been quite stable over recent years; the CDR was also 9 per 1,000 in 1990. (These data should not be considered very reliable. Vital registration systems are weak in many developing countries though censuses and surveys have provided some useful validation data.)

While estimates are readily available for overall death rates, that is not the case for death rates conditional on income or other socio-economic variables. An instructive exception is for the United States, where the National Longitudinal Mortality Study (NLMS) surveyed over one million adults from multiple waves of the Current Populations Surveys, thus allowing mortality data to be linked directly to socio-economic data including incomes. The data reveal death rates for the poor that are two-three times higher than for upper-income households for most age-gender groups (Sorlie et al. 1995).[5]

However, surveys such as the NLMS are not available in any developing country to my knowledge. The surveys used to measure poverty typically have adequate sample sizes for that purpose, but cannot provide reliable estimates of relatively low-frequency events such as adult deaths. Censuses can help as a source of mortality data (if the appropriate questions are asked), but they typically do not include the data needed for measuring poverty. Thus we generally do not get data on deaths and living standards for the same sampled households.

An important new source of information on socioeconomic differences in health indicators has been developed by Gwatkin et al., (2000), based on the Demographic and Health

[4] In standard statistical sources, the CDR is measured as the number of deaths in the last year relative to mid-year population. The calculations in this paper ignore the difference between mid-year population and end-of-year population.

[5] Earlier estimates by Pappas et al., (1993) for 1986 suggested even larger differentials (though it is not clear why). Naturally the mortality differentials narrow considerably among the elderly (Sorlie et al., 1995). Evidence for Western Europe can be found in Mackenbach et al. (1997).

Surveys (DHS). Health and nutrition indicators have been measured for different strata of households defined in terms of a proxy indicator of "wealth" constructed by principal components analysis from the DHS (following a methodology introduced by Filmer and Pritchett, 1999).[6] Again the indicators do not include the crude death rate since this cannot be measured reliably with the sample sizes of a typical DHS. The differences in death rates for children indicate that on average the poorest quintile in developing countries (in terms of the proxy wealth indicator) has an infant mortality rate that is 17% higher than average (implying *DRD*=1.2), though this rises to 35% (*DDR*=1.4) if one focuses on low and middle income countries only.

It is not clear how well the DHS "wealth index" reflects actual wealth or the most widely used indicator of living standards, namely aggregate expenditure on consumption (including imputed values for consumption in kind). So it is of interest to also see what can be learnt from surveys for which more familiar consumption or income measures are available. Using nine such surveys for developing countries, Wagstaff (2000) provides estimates of the infant and under-5 mortality rates grouped into quintiles according to household income or expenditure per person. Using the poorest quintile, the implied values of *DRD* are in the range 1.1 to 1.8.[7]

What about adult deaths? While there is currently nothing like the NLMS available for developing countries, there are some useful clues to likely differentials in overall (child + adult) death rates.[8] The demographic surveillance system implemented in Matlab thana in Bangladesh by the International Center for Diarrhoeal Disease Research has been an important source of data

---

[6] Details on the methodology can be found at http://devdata.worldbank.org/hnpstats/pvd.asp. The estimates for various demographic and health variables are also available at that site, and (for a broader set of variables) at http://www1.worldbank.org/prem/poverty/health/ .

[7] Wagstaff (2003) also estimates child mortality and nutrition indicators at the $1 a day line for 32 developing countries. However, his methodology does not allow one to calculate the *DRD*.

[8] I know of one large sample survey (in the field at the time of writing) that did collect recall data on mortality for both children and adults, namely the Malawi Integrated Household Survey.

on socioeconomic inequalities in health within a developing country. Though incomes are not available, Hurt et al., (2004) report death rates among those with no education that are about double those found for people with five or more years of formal education.[9]

Estimates with more comprehensive coverage are provided by Gwatkin (2000), who reports death rates by age group for the poorest 20% of the population of the developing world. This follows a method outlined in Gwatkin et al. (1999) in which the country is the unit of observation for income and death rates. However, this method has the drawback that differences within countries are ignored; the differentials are driven entirely by between-country differences in average incomes (though states were used for China and India). By this method, deaths in the poorest 20% account for 35% of all deaths at age group 0-4 years, falling to 32% for ages 5-29, 27% for 30-44, 23% for 45-59 and 20% for 60+. The implied values of *DRD* for each age group are 1.8, 1.6, 1.2 and 1.0 respectively.

Recognizing the aforementioned data problems in studying the socioeconomic differences in social indicators, Bidani and Ravallion (1997) use an indirect method of inferring the conditional means from cross-country (or cross-regional) aggregates. An econometric-decomposition method on cross-country data is used to estimate the differences in various social indicators between the poor and non-poor; hereafter this is termed the BR method. In essence, the regression coefficient of the social indicator on the poverty rate across countries estimates the difference between the mean social indicator for the poor and that for the non-poor.

Bidani and Ravallion did not implement their decomposition for overall death rates. However, it is not difficult to do so for the purpose of this paper. Figure 2 gives a scatter plot of the CDR for 2002 against the latest Chen-Ravallion "$1 a day" poverty rates across the 83

[9] Significant income effects on mortality arising from higher prices for foodstaples in Matlab thana are also reported by Ravallion (1987).

developing and transition countries; the data are reported in World Bank (2004) (though I supplemented this source with data from *PovcalNet*).[10] The poverty rate is the most recent estimate provided it is no earlier than 1995 (the median survey year is 1999), though the poverty data predate the death rate data. Using the BR method the implied mean CDR for the poor is 22.6 per 1,000 people with a (heteroscedasicity-corrected) standard error of 2.5; the CDR for the non-poor is 8.1 (standard error of 0.5).[11] The implied value of *DRD* is 2.2.

One region that looks notably different in the relationship between death rates and poverty incidence is Sub-Saharan Africa (SSA). Indeed, if one just focuses on the 18 observations in this data set for SSA then one finds no correlation between death rates and the incidence of poverty. In other words, one cannot reject the null hypothesis that the CDR is the same for the poor as the non-poor. (The estimates implied by the BR method are 19.3 for the poor, with a standard error of 7.1, and 17.1 for the non-poor, with a standard error of 1.56; the difference is not significant; t-statistic=0.6.) South Africa is an outlier, however, with a high CDR relative to its poverty rate (*DR*=20; *H*=7.1%). The correlation between the CDR and the poverty rate is stronger if one drops South Africa, but it is still not statistically significant. Dropping South Africa the estimates CDR for the poor in Africa is 20.3 (standard error of 2.7) while that for the non-poor is 16.2 (standard error of 1.7); the implied *DRD* is slightly over 1.1.

Since Africa will be prominent in later results in this paper, it is worth exploring further why one finds a low *DRD* for this region using the BR method. A plausible explanation lies in the fact that SSA has a higher $1 a day poverty rate than average for the developing world — slightly under 50% in SSA versus about 20% on average (Chen and Ravallion, 2004). So a

[10] *PovcalNet* is a data tool accompanying Chen and Ravallion (2004) that allows users to access the underlying distributional data from all 500 surveys used for the Bank's global poverty measures; see http://iresearch.worldbank.org/povcalnet .

[11] All standard errors reported in this paper are corrected for heteroscedasticity using White's method.

lower DRD is to be expected, assuming that the death rate declines monotonically with income, though this would have a hard time explaining a *DRD* so close to unity. However, one cannot rule out the possibility of bias. One reason to suspect underestimation of the *DRD* using the BR method is greater attenuation bias due to greater noise in the poverty data for Africa.

There are other possible factors. It might also be conjectured that the HIV/AIDS epidemic in Africa may has weakened the correlation between the death rate and poverty. At the early stages of the epidemic, it appears that HIV/AIDS incidence was higher among non-poor groups (at least as indicated by education and living in urban areas). However, there is evidence that this has changed over time, as better educated (and hence less poor) groups were better able to protect themselves from the disease (de Walque, 2004).[12]

The very low death rate differential for Africa suggested by the *BR* method is also hard to reconcile with the aforementioned DHS analyses, which indicate a differential in infant and child mortality rates for SSA between the poorest quintile and overall mean of 1.1, though this is still lower than that for low and middle income countries as a whole (at around 1.4).[13]

3.2 Evidence on differential fertility

Turning next to fertility differentials, one faces similar data problems. The overall Crude Birth Rate (CBR) for low and middle income countries in 2001 is 23 births per year per 1,000 people (World Bank, 2004). Similarly to the death rate, we know less about the conditional mean birth rates, though recent analyses of DHS data have provided some valuable new information.

---

[12] There is evidence of lower usage rates for condoms among the poor; the aforementioned analyses of the DHS data indicate a condom usage rate of 18% for the poorest quintile, versus 27% on average (http://devdata.worldbank.org/hnpstats/pvd.asp.). Against this effect, access to multiple sex partners probably rises with income (at least among males).

[13] See at http://www1.worldbank.org/prem/poverty/health/data/index.htm.

It has long been known that birth rates tend to be higher for the poor in the developing world, which is the main reason why household size tends to be negatively correlated with household consumption or income per person.[14] The same analyses of the DHS data summarized above provide estimates of the differentials in fertility rates.[15] Averaged over 45 developing economies, the total fertility rate is estimated to be 6.2 for the poorest quintile as compared to 3.3 for the richest quintile, with a population average of 4.7. However, to estimate *BRD* it is simpler to use instead the overall age-specific fertility rate calculated as the number of births per 1,000 women aged 15-49.[16] The overall birth rate per capita of women 15-49 is 154.0 for the poorest quintile versus 113.4 for the population as a whole. The implied *BRD* is 1.4, under the assumption that the population share of women 15-49 is the same for the poor as the population as a whole. (That assumption may not hold in reality, but it is probably not far wrong.) There are regional differences, with implied *BRD* values of 1.8 for East Asia, 1.3 for EECA, 1.9 for Latin America, 1.3 for the Middle East and North Africa, and 1.2 for both South Asia and Sub-Saharan Africa.

Returning to the Bidani-Ravallion method, analogously to Figure 2, Figure 3 plots the crude birth rate (CBR) against the poverty rate. (Notice that the correlation with poverty is stronger for the birth rate; the simple correlation coefficient is 0.77, versus 0.51 for the death rates in Figure 2.) For the sample as a whole, the implied birth rate for the poor is 61.3 (standard

---

[14] Economies of size in household consumption will attenuate, though probably not eliminate, these differences; for further discussion see Lanjouw and Ravallion (1995). The present analysis is confined solely to the (standard) method in which the ranking variable is per capita.

[15] See http://www1.worldbank.org/prem/poverty/health/data/index.htm .

[16] To derive the *BRD* from the differential in the total fertility rate (TFR) between the poor and population as a whole one would need to assume that the age distribution of poor women is the same as that for the population as a whole, which seems unlikely to hold. If instead one bases the calculations of *BRD* on the general fertility rate then one can get a way with a weaker assumption that the overall population share of women 15-49 is the same for the poor versus non-poor. (Note that the TFR is obtained by aggregating the age specific fertility rates by year for women 15-49 years.)

error of 3.4) per 1,000 people versus 15.9 (standard error of 0.9) for the non-poor. The birth rate differential is 2.6. However, there is a marked clustering of low birth rates and low poverty rates evident in Figure 3, which on closer inspection turns out to be mainly due to the countries of Eastern Europe and Central Asia (EECA). Excluding EECA the birth rate for the poor is 55.5 (3.1) versus 20.4 (1.0) for the non-poor and the *BRD*=2.0, which can be considered more representative of low and middle-income developing countries. However, the BR method is clearly giving a higher differential than suggested by the DHS.

Here too the demographic differential implied by the BR method is lower for Africa. Focusing only on the 18 observations for SSA, the birth rate for the poor is 46.9 (standard error of 4.1) versus 31.4 (2.7) for the non-poor, implying *BRD*=1.2 (the same as from the DHS). As for the death rate differential, the higher poverty rate in SSA is a plausible explanation for the lower birth rate differential, though attenuation bias cannot be ruled out.

4. Impacts on poverty measures

Given the data problems noted in the last section, it would be unwise to insist on a single point estimate of either the *DRD* or *BRD*. Values of both the demographic differentials in the range 1.2 to 2 are suggested by the evidence presented above. Since the CDR and CBR are calculated for one year, it is convenient to set $\tau = 1$.[17] The following calculations will focus on 2001, the latest year for the Chen-Ravallion estimates of global poverty, for which the poverty rate in developing countries as a whole is 21.1%.

Starting again with mortality, Table 1 gives the implied impacts ($H - H_1^D$) on the Chen-Ravallion estimates of the headcount index of poverty for \$1 a day over this range of values for

[17] In principle one can use $\tau > 1$ though this requires a more complicated calculation involving the past time series of death rates and population growth rates at country level; it is easier to use $\tau = 1$ but take proper account of this when interpreting the results.

DRD. At a death rate for the poor that is 20% above the mean, the impact of differential mortality on the headcount index is about 0.04 percentage points. It rises to about 0.2 percentage points when the death rate for the poor is twice the mean. (The upper bound, when all deaths are among the poor, is 0.7 points.)

These impacts may look small, but recall that they are the impacts in one year. So they should be compared with annual rates of poverty reduction. The Table 1 also gives the impacts expressed as a percentage of the annual rates of poverty reduction from 1990 to 2001. The impact at *DRD*=1.2 represents 7% of the annual average rate of reduction in the headcount index over this period. Naturally the impacts are even higher for higher values of *DRD*, rising to 15% for DRD=1.5 and 30% for *DRD*=2.

Annual rates of poverty reduction naturally depend on the start date. Beginning instead with the Chen-Ravallion estimates for 1981, the annualized rate of poverty reduction for $1 a day is about one percentage point per year — about ten times the estimated impact of differential mortality in 2001 for *DRD*=1.5. However (as Chen and Ravallion argue), the early 1980s were an unusual period, given the rapid poverty reduction achieved by China in that period (associated with its successful agrarian transition); see Figure 1. Starting the clock at 1984 instead, the annualized rate of poverty reduction in the developing world is similar to the trend since 1990. However, there has been a slowdown in the overall rate of poverty reduction (in percentage points per year, though not proportionately) since the late 1990s. If instead one focuses on the five year period from 1996 to 2001 then the trend drops to one third of a percentage point per year. Differential mortality at *DRD*=1.2 accounts for about one eight of the trend, rising to over one half at *DRD*=2.

Table 1 also gives a regional breakdown of the estimated impacts of differential mortality on the 2001 headcount index. Since the headcount index is not (of course) around 20% in all regions, the estimates of *DRD* from the DHS data do not strictly apply to each region separately. One would be drawn toward lower values of DRD for the poorer regions. But even focusing on *DRD*=1.2, it is clear that the impacts are highest for Sub-Saharan Africa. The trend rate of poverty reduction in SSA has been close to zero over 1984-2001 (indeed Chen and Ravallion report a regression coefficient of the region's $1 a day headcount index on time of 0.0!). So it is not meaningful to express these impacts as a proportion of the annual rate of poverty reduction. However, the impacts are clearly sizeable. Indeed, these calculations suggest that without differential mortality, the headcount index in SSA would be rising at a non-negligible rate over time, at about 0.2 percentage points per year at *DRD*=1.2, rising to 0.8 at *DRD*=2.

The region with the second highest impacts is South Asia. At *DDR*=1.2, differential mortality adds 0.06 percentage points to the "$1 a day" headcount index in South Asia, representing 15% of the long-run trend since the mid-1980s implied by the Chen-Ravallion estimates. This rises to 0.3 points per year at *DRD*=2 though this appears to be an implausibly large value for South Asia.

Turning next to the impact of differential fertility, the calculations in the previous section also suggest a range for *BRD* of 1.2 to 2. Table 2 gives the corresponding results for the impacts of differential fertility (analogously to Table 1). At *BRD*=1.2, the poverty rate in 2001 under random fertility would have been reduced by 0.1 percentage point, representing 16% of the trend rate of poverty reduction. Again, the impacts are large in South Asia and (especially) Africa, though evidence presented in Section 3 suggests that we should probably be using a lower value

of *BRD* for both these regions, at around 1.2. Then differential fertility is adding 0.2 percentage points per year to poverty rate in South Asia, and 0.4 points to that in Africa.

Finally, Table 3 gives the analogous results for the natural rate of population increase (CBR-CDR). The calculations assume that *BRD*=*DRD*. There is no reason in theory why that would hold, but there is no clear pattern in the findings of the previous section to suggest otherwise.

The net effect of non-random births and deaths is to increase the poverty measures in the aggregate and in all regions. The (poverty-increasing) effects of differential fertility is clearly greater than the (poverty-decreasing) effects of differential mortality. At *NRD*=1.2 the annual impact on the $1 a day headcount index is equivalent to about one tenth of the trend rate of poverty reduction, rising to about one half at *NRD*=2. Again (as one would expect from the preceding findings) the impacts are largest in South Asia and Africa. At *NRD*=1.2, natural population growth is adding 0.2 percentage points per year to Africa's poverty rate.

5. Conclusions

There are important welfare effects associated with both deaths and births that one would never imagine a standard poverty measure capable of revealing. That is a good reason for monitoring welfare-relevant demographic indicators (such as infant mortality) side-by-side with standard poverty measures, as has become common practice. Nonetheless, it is of interest to know just how much socioeconomic differentials in mortality and fertility contribute to widely used measures of world poverty.

While the evidence assembled here can hardly be considered conclusive, it does point to the possibility of sizeable impacts of non-random births and deaths on the developing world's rate of progress against poverty. Differential mortality accounts for 7-30% of the trend rate of

poverty reduction in the 1990s. The impacts are highest in Sub-Saharan Africa. While aggregate poverty incidence has shown no trend increase or decrease in Africa over the bulk of the 1980s and 1990s, the results presented here suggest that without selective mortality, poverty would have been rising in this region by around 0.2-0.4 percentage points per year in a range of plausible estimates of the death rate differential for this region.

The effect of differential fertility is more than enough to eliminate these impacts of mortality. The net effect of the higher natural rate of population growth among the poor is a non-negligible increase the poverty rate, representing somewhere between 10-50% of the trend rate of poverty reduction in the developing world by the $1 a day measures. And again it is Africa where this impact is largest (followed by South Asia). In spite of the high death rate in Africa (due in part to the HIV/AIDS epidemic) the balance of the demographic forces is markedly poverty increasing.

These calculations are at best suggestive about likely magnitudes. Although there have been significant advances in our knowledge about socioeconomic differentials in mortality and fertility over the last 5-10 years (notably in the broader country coverage and deeper analyses of Demographic and Health Surveys), there is still considerable uncertainty about the extent of demographic differentials in the developing world, as well as about the (unconditional) death and birth rates. That is evident in the relatively wide ranges for the impact estimates presented here.

References

Ainsworth, Martha and Deon Filmer. 2002. "Poverty, AIDS and Childrens' Schooling: A Targeting Dilemma," Policy Research Working Paper WPS 2885, Washington DC, World Bank.

Bidani, Benu and Martin Ravallion. 1997. "Decomposing Social Indicators Using Distributional Data," *Journal of Econometrics*, 77(1): 125-140.

Chen, Shaohua and Martin Ravallion. 2004a. "How Have the World's Poorest Fared Since the Early 1980s?" *World Bank Research Observer*, 19(2): 141-170.

Datt, Gaurav and Martin Ravallion. 1998. "Farm Productivity and Rural Poverty in India," *Journal of Development Studies*, 34(4): 62-85.

De Walque, Damien. 2004. "How Does the Impact of an HIV/AIDS Information Campaign Vary with Educational Attainment? Evidence from Rural Uganda" Policy Research Working Paper 3289, Washington DC: World Bank.

Eastwood, Robert and Michael Lipton. 1999. "The Impact of Changes in Human Fertility on Poverty," *Journal of Development Studies* 36(1): 1-30.

_____ and _____. 2001. "Demographic Transition and Poverty: Effects via Economic Growth, Distribution and Conversion," in Nancy Birdsall, Allen Kelley and Steven Sinding (eds) *Population Matters*. Oxford: Oxford University Press.

Filmer, Deon and Lant Pritchett. 1999, The Effect of Household Wealth on Education Attainment: Evidence from 35 Countries," *Population and Development Review*, 25(1): 85-120.

Gwatkin, Davidson. 2000. "Poverty and Inequalities in Health Within Developing Countries: Filling the Information Gap," in David Leon and Gill Walt (eds) *Poverty, Inequality and Health: An International Perspective.* Oxford: Oxford University Press.

Gwatkin, D.R., S. Rutstein. K. Johnson, R. Pande and A. Wagstaff. 2000. Socioeconomic Differences in Health, Nutrition and Population (Country Reports). Washington DC: World Bank.

Gwatkin, Davidson, Michel Guilot and Patrick Heuveline. 1999. "The Burden of Disease Among the Global Poor," *The Lancet* 354: 586-89.

Hummer, Robert, Richard Rogers and Isaac Eberstein. 1998. "Socioeconomic Differentials in Adult Mortality: A Review of Analytic Approaches," *Population and Development*

Review 24(3): 553-578.

Hurt, L.S., C. Ronsmans and S. Saha. 2004. "Effects of Education and Socioeconomic Factors on Middle Age Mortality in Rural Bangladesh," *Journal of Epidemiology and Community Health* 58: 315-320.

Kanbur, Ravi and Diganta Mukerjee. 2003. "Premature Mortality and Poverty Measurement," Working Paper 3003-11, Department of Applied Economics, Cornell University.

Kelley, Allen and Robert Schmidt. 2001. "Economic and Demographic Change: A Synthesis of Models, Findings and Perspectives," in Nancy Birdsall, Allen Kelley and Steven Sinding (eds) *Population Matters*, Oxford: Oxford University Press.

Lanjouw, Peter and Martin Ravallion. 1995. "Poverty and Household Size", *Economic Journal*, 105: 1415-1435.

Mackenbach, Johan, Anton Kunst, Adrienne Cavelaars, Feikje Groenhof and Jose Guerts. 1997. "Socioeconomic Inequalities in Morbidity and Mortality in Western Europe," *The Lancet*, 349: 1655-59.

Pappas, Gregory, Susan Queen, Wilbur Hadden and Gail Fisher. 1993. "The Increasing Disparity in Mortality Between Socioeconomic Groups in the United States, 1960 and 1986," *New England Journal of Medicine* 329(2): 103-109.

Ravallion, Martin. 1987. *Markets and Famines.* Oxford: Oxford University Press.

Sala-I-Martin, Xavier, Gernot Doppelhofer and Ronald Miller. 2004. "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach," *American Economic Review* 94(4): 813-836.

Schultz, T. Paul. 2004. "Demographic Determinants of Savings : Estimating and Interpreting Aggregate Associations in Asia," Economic Growth Center Discussion Paper 901. Yale University.

Sorlie, Paul D., Eric Backlund and Jacob Keller. 1995. "US Mortality by Economic, Demographic and Social Characteristics: The National Longitudinal Mortality Study," *American Journal of Public Health* 85(7): 949-956.

van de Walle, Dominique. 1985. "Population Growth and Poverty: Another Look at the Indian Time Series Evidence", *Journal of Development Studies* 34(4): 62-85.

Wagstaff, Adam. 2000. "Socioeconomic Inequalities in Child Mortality: Comparisons Across Nine Developing Countries," *Bulletin of the World Health Organization* 78(1): 19-29.

_____. 2003. "Child health on a Dollar a Day: Some Tentative Cross-country Comparisons." *Social Science and Medicine*, 57(9): 1529-38.

Williamson, Jeffrey. 2001. "Demographic Change, Economic Growth and Inequality," in Nancy Birdsall, Allen Kelley and Steven Sinding (eds) *Population Matters*, Oxford: Oxford University Press.

World Bank. 2004. *World Development Indicators.* Washington DC: World Bank.

Table 1: Impacts of differential morality on the $1 a day headcount index of poverty

	Crude Death Rate (CDR) (Deaths/ 1000)	Headcount index		Trend rate of change (% points/ year)	Impact on headcount index in 2001 ($H - H_1^D$; % points/year) Death rate differential (*DRD*)=			
		1990	2001		1.2	1.5	1.8	2
Developing world as a whole	9	27.9	21.1	-0.6	-0.04 (-6.5)	-0.09 (-14.6)	-0.15 (-24.3)	-0.19 (-30.7)
Regional breakdown								
East Asia	7	29.6	14.9	-1.3	-0.02	-0.05	-0.08	-0.10
Eastern Europe and Central Asia	12	0.5	3.7	0.3	-0.01	-0.02	-0.04	-0.04
Latin America and Caribbean	6	11.3	9.5	-0.2	-0.01	-0.03	-0.04	-0.06
Middle East and North Africa	6	2.3	2.4	-0.0	-0.00	-0.01	-0.01	-0.01
South Asia	9	41.3	31.3	-0.9	-0.06	-0.14	-0.22	-0.28
Sub-Saharan Africa	17	44.6	46.9	0.2	-0.16	-0.39	-0.63	-0.78

Note : Poverty line of $32.74/month ("$1 a day") at 1993 Purchasing Power parity. The figures in parentheses are the impacts as % of annualized rate of poverty reduction 1990-2001. Poverty measures from Chen and Ravallion (2004). Author's calculations for the rest.

Table 2: Impacts of differential fertility

	Crude Birth Rate (CBR) (Births/100 0)	Impact on headcount index in 2001 ($H - H_1^B$; % points/year) Birth rate differential (*BRD*) =			
		1.2	1.5	1.8	2
Developing world as a whole	23	0.10 (16.2)	0.25 (40.4)	0.39 (63.1)	0.50 (80.9)
Regional breakdown					
East Asia	17	0.05	0.13	0.21	0.26
Eastern Europe and Central Asia	12	0.01	0.02	0.04	0.05
Latin America and Caribbean	22	0.04	0.11	0.17	0.21
Middle East and North Africa	26	0.01	0.03	0.05	0.06
South Asia	26	0.17	0.42	0.67	0.84
Sub-Saharan Africa	39	0.38	0.95	1.52	1.90

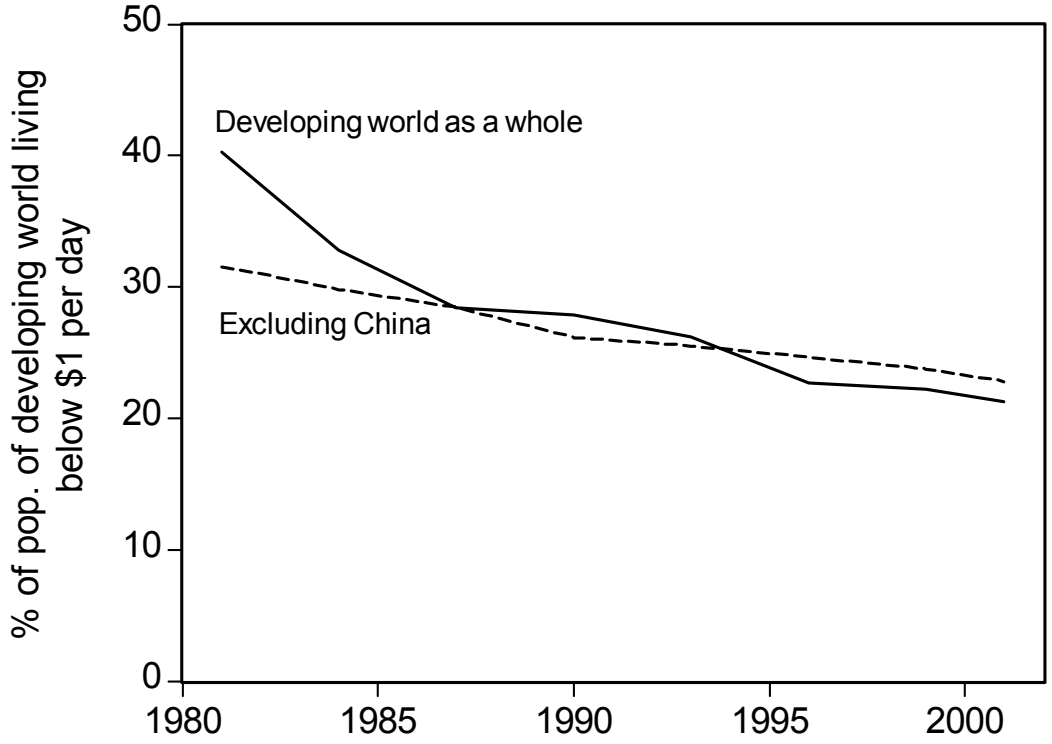
Notes: See Table 1.

Table 3: Net impacts of natural population growth

	Natural rate (CBR-CDR)	Impact on headcount index in 2001 ($H - H_1^N$; % points/year) Natural rate differential (*NRD*) =			
		1.2	1.5	1.8	2
Developing world as a whole	14	0.06	0.15	0.24	0.30
		(9.7)	(24.3)	(38.9)	(48.5)
Regional breakdown					
East Asia	10	0.03	0.08	0.12	0.15
Eastern Europe and Central Asia	0	0	0	0	0
Latin America and Caribbean	16	0.03	0.08	0.12	0.15
Middle East and North Africa	20	0.01	0.02	0.04	0.05
South Asia	17	0.11	0.27	0.43	0.54
Sub-Saharan Africa	22	0.21	0.53	0.84	1.05

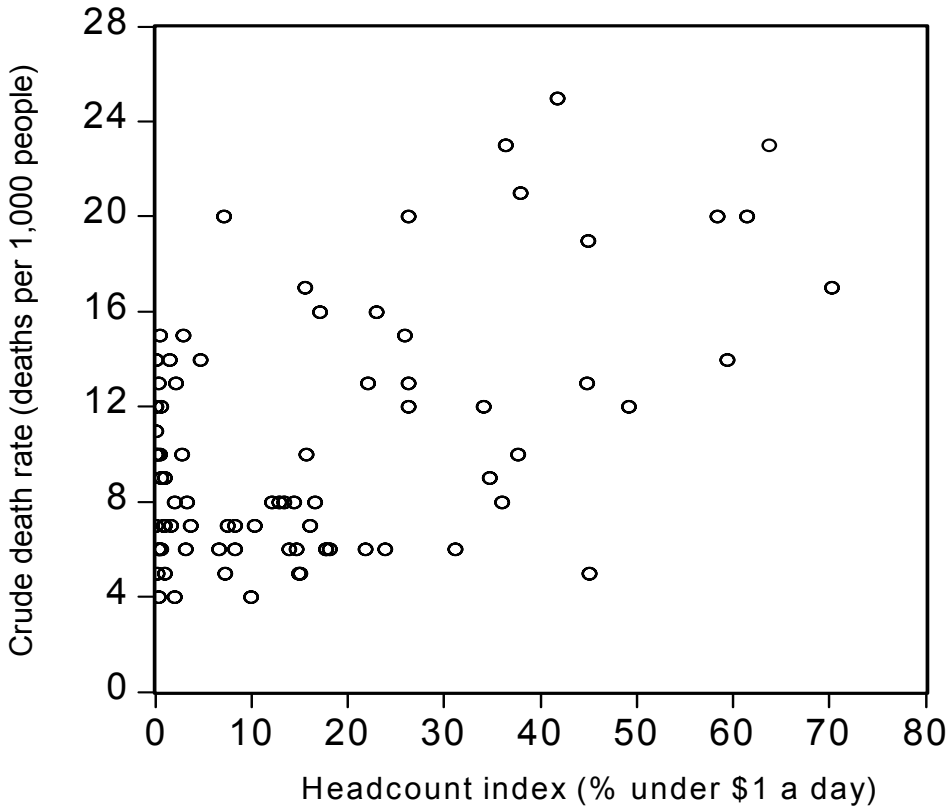
Notes: See Table 1.

Figure 1: Poverty incidence in the developing world 1981-2001



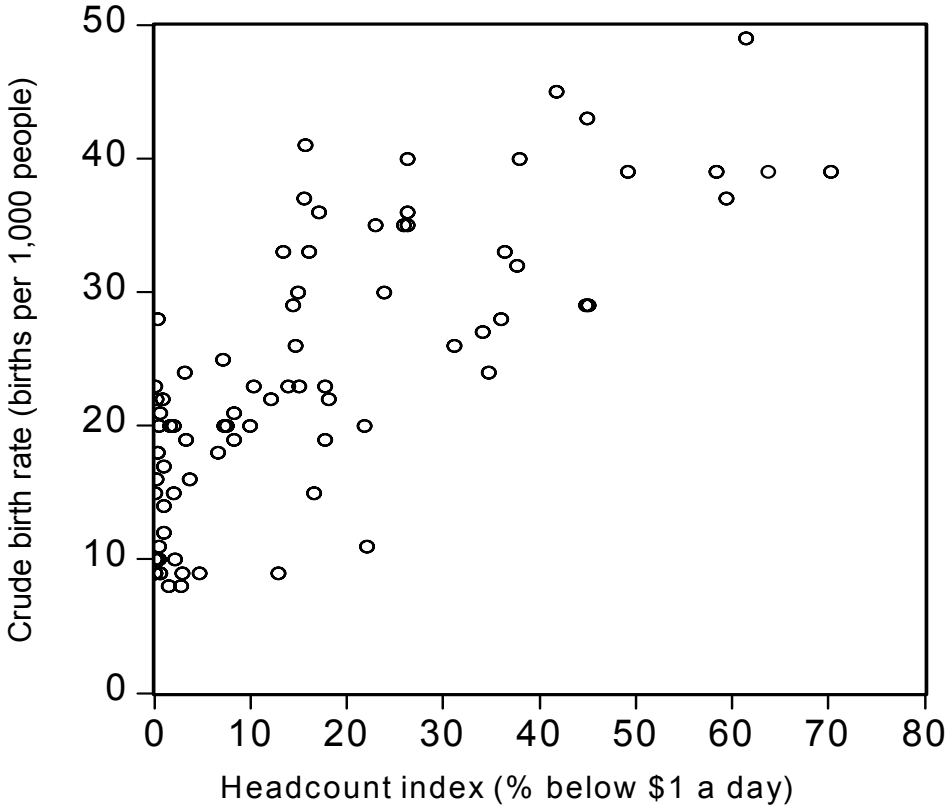
Note: The international poverty line is $32.74/month at 1993 Purchasing Power Parity (PPP) (using the World Bank's PPP rates for consumption), which is converted to local currency in 1993 and updated over time using the best available Consumer Price index for each country. Based on 450 national household surveys for 100 countries. The estimates around 2000 draw on a sample size of 1.1 million households. For further description and discussion of the data sources and estimation methods are discussed in Chen and Ravallion (2004), which is the source of this figure.

Figure 2: Crude death rates plotted against headcount index of poverty by country



Source: Country data assembled from World Bank (2004) and http://iresearch.worldbank.org/povcalnet.

Figure 3: Crude birth rates plotted against headcount index of poverty by country



Source: As for Figure 2.