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The Social and Private Benefits of Reducing High Fertility in Low-income Countries:

Implications for Sub-Saharan African and Global Economic Prospects [1]

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Abstract

There is a large but scattered literature on the private and social benefits of reducing high fertility. This paper reviews the literature on three themes: (a) Do population dynamics affect poor countries' prospects of economic growth? (b) Can human innovation sustainably manage potential resource scarcities? and (c) Are there private benefits to lower fertility?

The literature indicates several benefits from lowering fertility. Lower youth dependency ratios help increase savings and investment. Private benefits include better maternal and child health, schooling, increased women's labor force participation, and higher household earnings. Population growth and increased per capita consumption add to pressure on global common property resources, which are inherently difficult to manage.

While family planning programs are only one policy lever to help reduce fertility, studies find them effective. These might help especially in the Sub-Saharan African region, where high fertility and institutional constraints to economic growth combine to slow rise in living standards.

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1 Introduction

In recent decades, there has been little policy attention to the private and social benefits of reducing high fertility in low-income countries. These have not been seen as compelling, despite many careful studies documenting them. This is partly because the studies are scattered across different subjects, such as family health, economic growth, and environmental change. It is also partly because an earlier literature argued that lowering fertility was largely irrelevant (or even counter-productive) to developing countries' prospects for economic growth.

This paper seeks to bring together the evidence on these issues, by reviewing the literature on three themes: (a) Do population growth, size and structure affect a developing country's prospects for economic development? (b) Can human innovation sustainably manage potential resource scarcities? and (c) Are there private benefits to having small families?

Section 2 reviews the relationship between population and economic growth. Opinions have swung back and forth on these relationships. Yet there has been a broad consensus that while policy and institutional settings are key in shaping the prospects of economic growth, population dynamics also play a secondary role in this.

Section 3 reviews the literature on whether population growth reduces resource availability. Some have argued that human innovation can overcome any resource constraint, and studies confirm this for some types of resources. Others find that there are serious challenges to sustainably managing the use of resources that are underpriced or free, such as global common property resources — pressures on which are exacerbated by increased consumption per capita and population growth.

Section 4 reviews the evidence for the private benefits to having smaller families. Studies show that this benefits households, especially in terms of health, schooling, and earnings.

Section 5 turns to the implications of continuing high fertility for Sub-Saharan Africa. This region has the highest population growth rates in the world today as mortality decline has far outpaced fertility decline. It also experiences institutional and other constraints to economic growth that make it more difficult to accommodate larger populations. We review some of the pressures building up in this region, and suggest that accelerating the demographic transition may help mitigate them.

If smaller family size has clear private and social benefits, what are the best policy levers to encourage this? Many factors are associated with smaller families, notably female education. Education has been found to increase wages (Duflo 2001, Schultz 2002), improve child health and schooling, increase female labor force participation, and lower fertility (Schultz 2002) especially by raising the age at first birth[1]. Educating populations bring social benefits of many kinds. However, the benefits of education are well-recognized (Schultz 2002). Much effort has been made to enhance education quality, reduce barriers to access, and to encourage parents to send their children to school with subsidies and incentives such as school meals and conditional transfer programs. Improved child survival can also help reduce fertility, but much programmatic effort is underway on this.

By contrast, there is little consensus on the private and social benefits of helping lower fertility through family planning programs, and even the effectiveness of these programs has been challenged.[2] Section 6 reviews the evidence on this, which indicates that well-executed programs are effective at lowering fertility. Section 7 concludes.

2 Do population size and structure affect economic growth?: the debates

Since the 1960s, economists have taken very different positions on the implications of population dynamics for economic growth. Many of these differences, as discussed below, have been driven by different analytical approaches. For example, some studies have focused on the projected trajectory of a single country while others have done cross-country regressions where it is difficult to control for differences in the policy and governance settings. And over the decades analytical techniques have evolved, yielding different results.

At bottom, there is little fundamental disagreement on the issue. There is broad consensus that policy settings that support growth are the key drivers of economic growth, while population size and structure play an important secondary role in facilitating or hindering economic growth.

2.1 Malthus' Original Idea

Malthus argued that population and resources maintain a homeostatic balance: if living conditions permit, the population will grow until it is restrained either by the "preventive check" of controlling reproduction or by resource shortages resulting in "positive checks" (famine, disease, war). This was based on the assumption that the supply of key factors of production such as land was largely fixed.

While this may sound like an extreme position today, it was not at the time Malthus wrote. Many studies by economic historians and historical demographers show that GDP growth and real wages were indeed stagnant or grew very slowly over centuries and even millennia. They also show that fertility control was exerted through methods such as postponing marriage, never-marrying, infanticide, and abstinence.[3] Galor and Weil (2000: 807) summarize the findings of several studies covering a wide geographical and historical range:

> "…Angus Maddison (1982) estimates that the growth rate of GDP per capita in Europe between 500 and 1500 was zero. Furthermore, Ronald D. Lee (1980) reports that the real wage in England was roughly the same in 1800 as it had been in 1300. According to Kang Chao's (1986) analysis, real wages in China were lower at the end of the eighteenth century than they had been at the beginning of the first century….. Edward A. Wrigley and Roger S. Schofield (1981) find that there was a strong positive correlation between real wages and marriage rates in England over the period 1551-1801. Negative shocks to population, such as the Black Death, were reflected in higher real wages and faster population growth (Livi-Bacci, 1997)….Finally, the prediction of the Malthusian model that differences in technology should be reflected in population density but not in standards of living is also borne out. As argued by Richard Easterlin (1981), Pritchett (1997), and Lucas (1999), prior to 1800 differences in standards of living among countries were quite small by today's standards; yet there did exist wide differences in technology. China's sophisticated agricultural technologies, for example, allowed high per-acre yields, but failed to raise the standard of living above subsistence. Similarly in Ireland a new productive technology—the potato—allowed a large increase in population over the century prior to the Great Famine without any improvement in standards of living (Livi-Bacci, 1997).

Galor and Weil (2000:826) conclude that "In early stages of development—the Malthusian Regime—the economy remains in the proximity of a Malthusian trap, where output per capita is nearly stationary and episodes of technological change bring about proportional increases in output and population".

Since Malthus' time, things have changed dramatically (Demeny 2011). The functioning of the "preventive checks" has been altered by technological advances which are available even in low-income settings. Advances in agricultural and industrial technologies can transform a society's productive capacity and allow it to sustain growing populations.

2.2 Models indicating that rapid population growth constrains economic growth

Mid-twentieth century models of economic growth indicated that increases in population growth constrain growth in income per-capita. The Harrod-Domar model (Harrod 1939, Domar 1948), showed that in the absence of diminishing returns to capital, growth in income-per-capita is affected negatively by population growth and positively by savings as well by increases in the output-capital ratio. Solow (1956, 1957) assumed that both capital and labor had diminishing returns, and illustrated that an increase in the population growth rate would translate into a growth of labor supply that would outpace the growth of capital formation and ultimately lower per-capita income.

Coale and Hoover (1958) modeled the relationship between population growth and economic development for one low-income country ─ India in the 1950s ─ characterized at the time by low GDP growth, low industrialization, and heavy reliance on subsistence agriculture. They concluded that population growth might adversely affect the prospects for economic development because of the population's (1) increasing size, as well as (2) its structure, with high and rising child dependency ratios. They argued that the combined effect of these two factors divert national resources away from investment in expanding production and increasing the capital/labor ratio ― to meet the growing needs for schools, health, housing, and other infrastructure needed to avoid compromising the future population's wellbeing and productivity. Similarly at the household level, they divert resources away from saving for productive investment, to meet current consumption needs.

These models were deeply influential, developing a consensus in development policy circles on the need to reduce the high rates of population growth rates in developing countries.

2.3 Early empirical challenges to these models

The first challenge to the Coale and Hoover model was the lack of any significant correlation between rates of population growth and per-capita output across a sample of developing countries (Kuznets, 1967, reprinted in Kuznets, 1973:43). A spate of studies followed with similar conclusions (Lee 1983).

What seems to have attracted little attention was the fact that Kuznets very explicitly and carefully qualified the conclusions he drew from his work. He was careful to specify that technological improvements can increase production and help avoid the Malthusian "positive checks". He added that the technologically feasible may not be actualized, that there could be serious social and political problems involved in making the needed adjustments (Kuznets 1973:7, 45). He clarified that lower rates of population growth could enable more rapid growth in per capita output (Kuznets 1973:90).

Moreover, Kuznets did not know at the time of writing that world population was growing much faster than indicated by the UN medium projections he used, which were published in 1966. These projected a doubling of the population in the less-developed areas of the world between 1965 and 2000 (Kuznets 1973:7). In fact, this projection tallies with recent UN estimates[4]― but only because from the mid 1960s onwards the most populous developing countries undertook energetic and successful efforts to reduce fertility. This hindsight adds yet another qualification to Kuznets' already careful qualifications of his conclusion that:

> "…purely technological and economic factors allow sufficient margins, in most underdeveloped countries, to permit substantial and sustained economic growth, even with a significant rise in population ― at least for the proximate future of two to three decades." (Kuznets 1973:41)

Those building on Kuznets' work sometimes seem to think that he did not believe that population growth can hinder economic growth. Easterlin[5] summarizes Kuznets' position more accurately : "Kuznets saw

the basic obstacles to economic growth as arising from delays in adjusting social and political institutions, and viewed population growth, though an impediment, as of secondary importance".

A second challenge to the Coale-Hoover model came from studies exploring their prediction that higher dependency ratios would divert resources towards meeting growing needs for outlays in areas such as education. Schultz (1987) tested for this investment-diversion effect. He found that over the period 1969-1980, enrolment rates and number of years of schooling completed rose significantly in low-income countries, and that the relative size of the school-age cohort exerted no independent influence on the share of GNP allocated to education. Costs per pupil dropped, with rising class sizes per teacher, and decline in teachers' salaries. This suggests that the *quantity* of schooling can rise without diverting resources from other forms of investment despite growth in the school-age population. However, Schultz pointed out that reduced expenditures per pupil may have reduced the *quality* of schooling.

A third challenge to the Coale-Hoover model came from empirical studies that failed to confirm that high youth dependency ratios have a negative impact on savings and thereby on economic growth (National Research Council 1986:44-45, Kelley 1988:1707). However, Kelley (1988:1707) cautioned that these studies have serious methodological limitations, deriving not only from the limitations of cross-country analysis, but also from problems with specifying several key variables.

Kelley (1988:1700) cites a large number of studies that found weak or non-existent empirical support for the thesis that population growth hinders economic growth, based on cross-country correlations. However, he points out that this analytical approach does not reveal causation, and that "institutional variations among countries may mask the relationships".

The methodological problems with these early studies were carefully acknowledged by Johnson and Lee (1987:xi) in their editorial preface to the studies carried out on behalf of the National Research Council's Working Group on Population Growth and Economic Development:

> "The working group concluded that slower population growth would, on balance, benefit most developing countries and that the positive effects of slower population growth on economic development would be clearest in the poorest and most densely populated countries. But the working group also reported that drawing firm conclusions about the overall impact of slower population growth is difficult because the research base is inadequate. Studies completed to date are frequently based on limited samples and data of poor quality, as well as on only partial and occasionally inappropriate conceptual models and statistical techniques. Simply put, the scientific literature contains few adequate studies of the effects of slower population growth in developing countries."

Their conclusion that slower population growth would benefit most developing countries, especially the poorest and most resource-stressed, was much less clearly stated in the NRC's summary report on policy questions (NRC 1986:93). This influential report was widely interpreted as not supporting the view that family planning programs could do much to enhance the prospects for economic growth.

2.4 Recent empirical studies re-affirming the Coale-Hoover model

A spate of recent studies have re-affirmed different aspects of Coale and Hoover's thesis. These use a wide range of analytical methods (macro and micro), including updated approaches to cross-country regressions. Coale and Hoover's youth dependency hypothesis has received the most attention. This is that if a population has a high proportion of children to working-age adults — typical of populations with high fertility — the prospects for economic growth are diminished.

Higgins and Williamson (1997) find that high youth dependency ratios are associated with lower savings and investment. They found that "much of the impressive rise in Asian savings rates since the 1960s can

be explained by the equally impressive decline in youth dependency burdens. Wherever the youth dependency burden has fallen dramatically, Asian countries have relinquished their reliance on foreign capital." They found this effect to be stronger in East Asia than in South Asia, where the fertility transition has been less rapid.

Bloom and Williamson (1998) argued that rapid fertility decline in East Asia facilitated the rapid economic growth in this region by reducing the dependency ratio, "thereby expanding the per capita productive capacity of East Asian economies". They noted that this is a temporary window of opportunity, because continuing fertility and mortality decline will result in high proportions of old people relative to working-age adults. They also pointed out that the East Asia region was able to capitalize on this opportunity because they had built the policy and institutional settings needed to realize the growth potential created by this demographic windfall.

The gains from this demographic window of opportunity may be made permanent if they are invested in physical capital and human capital (Lee 2009). With good planning, it can be used to transform economies such that their growth potential remains high after the window has closed.

Moving to global macro-studies, Kelley and Schmidt (2005) conclude that higher dependency ratios (including both youth and old-age dependency ratios) have a significant impact on growth. They find that "Worldwide, the combined impacts of demographic change have accounted for approximately 20% of per capita output growth impacts, with larger shares in Asia and Europe." Earlier, they had found that dependency ratios impact on savings, from an examination of 65 less developed countries and 23 developed countries over time and cross-sectionally since 1960 (Kelley and Schmidt 1996).

Turning to the question of whether rapid population growth reduces growth in income per capita, Acemoglu and Johnson (2007) examine the data from 47 developed and developing countries over the period 1940-2000 and conclude that

> "Overall, the increases in life expectancy (and the associated increases in population) appear to have reduced income per capita." (Acemoglu and Johnson 2007: 975).

As Galor and Weil (2000: abstract) put it, the relationship between population growth and income growth changes as economies mature:

> "The economy evolves from a Malthusian regime, where technological progress is slow and population growth prevents any sustained rise in income per capita, into a Post-Malthusian regime, where technological progress rises and population growth absorbs only part of output growth. Ultimately…the economy enters a Modem Growth regime with reduced population growth and sustained income growth".

3. Does Population Growth Create Potential Resource Scarcities?

Some economists have argued that more rapid population growth may even help drive economic growth, by spurring technological innovation that can potentially stretch resources indefinitely. However, there is reason to believe that human ingenuity may have its limits.

3.1 Can human innovation stretch resources indefinitely?

The first to argue that population growth may have a positive effect on technological innovation was Kuznets (1960), who speculated on *a priori* grounds that if the proportion of geniuses in a population is constant, the larger the population the large the number of geniuses. He acknowledged that this was based on the assumption that the necessary resources would be available for education, training, and other capital investment, to maintain or increase per capita productivity — and that therefore this argument did

not hold for the developing world. Even for the developed world, he warned that there could be severe problems in adjusting to the implications of larger population size.

> "First, few if any of the points made are relevant to the underdeveloped countries. By definition, the latter suffer from an acute shortage of capital, not only for material investment but also for adequate raising and education of their younger generations….Second, even in the advanced and developed economies, population increase means further pressure upon limited natural resources, upon the supply of material capital, and above all, upon the capacity of the social and economic structure to adapt itself to it. All the factors cited in the current (and past) literature that make for the increased burden of larger populations—if higher per capita product is to be attained—are relevant here." (Kuznets (1960: 337-8)

Despite Kuznets' very cautious treatment of his thesis, subsequent studies underplayed his cautions and built on the possibilities he had raised to suggest that population growth was a positive force for economic development.

Boserup (1965) argued that rising population tends to induce agricultural innovation and lead to agricultural intensification, allowing greater productivity per unit of land to feed the larger population. This process of agricultural intensification has been widely observed, but it is less clear how much this raised per capita consumption before the Industrial Revolution brought radical new agricultural technologies. Yet as Galor and Weil (2000) note, many studies indicate that output per capita was nearly stationary for millennia preceding the Industrial Revolution.

Kremer (1993) argued that over the long sweep of history, "larger initial populations have had faster technological change and population growth". Klasen and Nestman (2006: 14-15) argue that SubSaharan Africa's low population density hampered technological change, but that this may change now with rapid population growth. They add, though, that modern technology can be diffused even without high population densities, but that technological uptake is still slow in the region.

Simon (1981, 1996) built on Kuznets' thesis to argue that human innovation assures that population growth has long-term benefits for living standards, in both developing and developed countries. Contrary to the evidence from the wide range of studies summarized by Galor and Weil (2000), Simon (1996: 580) asserts that the "standard of living has risen along with the size of the world's population since the beginning of recorded time…".

Simon argued that people and markets innovate in response to potential resource shortages, and therefore the resource base is effectively infinite. "There is no physical or economic reason why human resourcefulness and enterprise cannot forever continue to respond to impending shortages and existing problems with new expedients that, after an adjustment period, leave us better off than before the problem arose" (Simon 1996:580). He argued further that human activity was not responsible for environmental damage, and that "the trends toward greater cleanliness and less pollution of our air and water are even sharper than before" (Simon 1996:578).

For Simon, population growth helps resolve — not cause — resource scarcities and environmental problems. Simon and Boserup both argued that higher population densities can increase the economies of scale in providing productivity-enhancing infrastructure and services such as transport and extension services (Glover and Simon 1975; Boserup 1981).

Simon's arguments were supported by studies of the costs of some industrial resources. Potter and Christy (1962) for example, showed that mineral prices in the US actually fell by approximately 40 percent between 1870 and 1957, a period during which there was rapid growth in both population and industrial output. Barnett and Morse (1963) showed that the labor and capital inputs needed to produce scarce natural resources that included fuels, metals and non-metal minerals had more than halved over the same

time-frame. For such products, technological innovation is effective at responding to natural resource constraints.

Certainly the Industrial Revolution and subsequent technological innovation enabled a huge jump in productive capacity, enabling rising levels of per capita GDP and consumption. The manufacturing sector also allows much more scope than the agrarian for absorbing a growing labor force. However, policy and institutional settings shape the scope for benefiting from the new technical possibilities. Much of the developing world lagged behind the developed world in putting policies in place to encourage economic growth, but this has changed in recent decades and their pace of growth has picked up.

The very long view of history taken by those arguing that population growth triggers technological change (see above) discounts the deprivation faced by generations before the benefits of the anticipated technological change manifest themselves. It is striking how long it takes — even under the most conducive of circumstances — to improve living standards. China is a good example, since it has a political system that permits radical innovation. In 1970, the Chinese government instituted targets for the population growth rate, to be implemented by local authorities (Kane and Choi 1999:992).[6] Fertility plummeted from an average of 6.4 children per woman in 1968 to 2.7 in 1978, and further to 2.0 by 1992 (CPDRC 2009: Table 3-3). From the end of the 1970s, a series of economic reforms were instituted with a view to generate rapid economic growth. GDP per capita (in US$ Purchasing Power Parity terms) rose nearly 20-fold between 1980 and 2007 (IMF 2010a). Despite four decades of intensive reduction of population growth and three decades of blistering economic growth — neither easily replicable under most countries' political regimes — there are still significant levels of poverty in China. Almost a third of the rural population was consumption poor in at least one year between 2001 and 2004, using the dollar-a-day estimate in 1993 PPP dollars which is a low threshold by international standards (World Bank 2009: vi, 18). Using more average thresholds increases the estimated poor population substantially (Chen and Ravallion 2008).

3.2 Limits to innovation – managing environmental common property resources

A relentless demand for continuing adaptation and innovation is generated by the world's growing consumption needs, with increases in per capita consumption levels and population growth. Technological progress has certainly increased production, but this has not been without negative ramifications. Common property resources are under pressure from activity to meet rising consumption requirements. For example, fertilizer runoff has increased with agricultural intensification, creating low-oxygen "dead zones" in coastal oceans (Map 1).

While market forces and ingenuity can find ways to better manage the use of non-renewable resources that are clearly priced, it is proving more difficult to conserve common property resources such as oceans and the atmosphere. Even to understand the intricacies of environmental change is a challenging task for scientists — and organizing collective action to avert negative consequences is a challenging task for political leaders even at local levels, let alone national and global levels.

These factors combine to create a daunting list of needed adaptations and innovations, which are complex to develop as well as to implement. The World Development Report 2010 summarizes some of the measures needed just for sustainable food production (World Bank 2010a). To manage land and water resources to feed 9 billion people and protect natural systems, they point to the need for politically daunting measures, such as:

- building flexible international agreements
- pricing carbon, food and energy
- redirecting agricultural subsidies
- strengthening the policy environment for natural resource management.

As the World Bank (2010a) points out, food demand is rising with growth in incomes as well as in population size. Climate change will make it harder to meet that food demand. A huge increase in productivity will be needed at the same time as huge increase in regulation to protect natural systems. However, the report takes as given the projected rate of population growth, perhaps because it was outside its already enormous scope to discuss policies that might alter its trajectory.

Yet population size *is* amenable to policy, as we discuss below, and makes a big difference to the size of adjustments required on other fronts. Models vary, but the World Bank (2010a) estimates that to meet the growing demand for food between 2005 and 2055, agricultural productivity will need to rise by 64 percent under the assumptions of the "business as usual" scenario and by a further 80 percent under the assumptions of projected stresses arising from climate change (Figure 1). Yet the model indicates that if population remained constant at the 2005 level, agricultural productivity would need to rise only 25% under the "business as usual" scenario ─ i.e., more of the required productivity increase under the "business as usual" scenario is necessitated by population growth, than by increases in per capita consumption.

Conventional estimates of GDP growth are misleading on the sustainability of production possibilities, because they ignore the depreciation of natural capital (Arrow et al 2004, Dasgupta 2010).

> "Since GDP is the total value of the final goods and services an economy produces, it does not deduct the depreciation of capital that accompanies production—in particular, it does not deduct the depreciation of natural capital. In the quantitative models that appear in leading economics journals and textbooks, nature is taken to be a fixed, indestructible factor of production. The problem with the assumption is that it is wrong: nature consists of degradable resources. Agricultural land, forests, watersheds, fisheries, fresh water sources, river estuaries and the atmosphere are capital assets that are self-regenerative, but suffer from depletion or deterioration when they are over-used. (I am excluding oil and natural gas, which are at the limiting end of self-regenerative resources.) To assume away the physical depreciation of capital assets is to draw a wrong picture of future production and consumption possibilities that are open to a society." (Dasgupta 2010:6)

Moreover, "property rights to natural capital are frequently unprotected or ill-specified....(which) typically leads to their overexploitation, and so to waste and inequity" (Dasgupta 2010: 6).

Arrow et al (2004: Table 2) estimate how much "genuine wealth per capita" (including natural capital, human capital, and manufactured capital) changed during 1970-2000. The estimates are necessarily approximate, but they have been made carefully and the results are instructive. They find that while GDP per capita grew quite rapidly in all regions except in Sub-Saharan Africa, rates of growth in "genuine wealth per capita" were far lower. They *declined* sharply in Sub-Saharan Africa and in the Middle East and North Africa (by -2.6 and -3.8 percent per year respectively). They grew very slowly (well below 1 percent per year) in South Asia and the United States. They grew rapidly only in China, due to its low population growth and heavy investment in productivity. Revising the method to include more information on growth in human capital and institutional change, Dasgupta (2010: 9-10) derives far lower estimates of growth in genuine wealth per capita for China 1970-2000, and for South Asia he estimates a *decline* of between -0.4 percent per year (India) and -1.4 percent (Pakistan).

Rates of internal and international labor migration will rise with the pressures of environmental degradation and climate change (Laczko and Aghazarm 2009, World Bank 2010a: ch2). Even current rates of migration have proved difficult to manage politically in many countries, as local residents resent encroachment on their resources. It is likely to prove very daunting to accommodate accelerated in-migration, especially when receiving areas are under greater pressure themselves. This is just one of the challenges that increasing rates of population growth pose to societies' capacity to adapt their social, political, and economic institutions to respond to the new needs (Kuznets 1973:91, McNicoll 1984).

Human ingenuity has faced an uphill task at devising ways of managing common property resources – given the institutional and political challenges posed in aligning divergent interests. Markets are very poor at incentivizing people not to overuse resources that are un-priced or under-priced relative to social cost (Arrow 1969, Dasgupta 2001, Stern 2006), especially in the case of transnational common resources (Dasgupta et al 1997). The consequent negative externalities need to be addressed through collective action, but in the absence of strong mechanisms for mutual coercion it is very difficult to align the interests of different stakeholders to this end. Ostrom (1990) has argued that common property can be successfully managed by user associations in small communities if eight "design principles" are met, including the ability to effectively exclude unentitled parties. Such conditions clearly do not apply to global common resources.

The juxtaposition of all these daunting scientific, executive, and political challenges suggest that even countries which have so far adapted to growing needs may find it difficult to respond to these new kinds of demands (Demeny 2011). They place high demands on national and global institutional capacity, as evidenced by the slow progress made in decades of efforts to regulate carbon emissions.

Reducing the number of births may be one of the simplest ways of reducing pressure on common property resources. For instance, it is estimated that the effect of a 40% reduction in CO2 emissions per head in developed countries between 2000 and 2050 would be entirely offset by the increase in emissions attributable to expected population growth in poorer countries over this period, even assuming no change in emissions per head in these countries (Dyson 2005). Moreover, CO2 emissions per head have risen in countries such as China, India and Brazil in line with rapid economic growth. O'Neill et al (2010) estimate that slowing population growth could reduce carbon emissions significantly. Indeed it has been argued that the prevention of unwanted births today is likely to be one of the most cost-effective ways to preserve the planet's environment in the longer term (Birdsall 1994).

4. Are there private benefits to having small families?

Micro-studies support Coale and Hoover's thesis that at the household level, high fertility reduces investments in children. Some studies use twin births to minimize the potential confounding effect of endogeneity: namely, that parents who have larger numbers of children have different characteristics from those who have few children. Using this method, Rosenzweig and Wolpin (1980:239) found that in India: "exogenous increases in fertility decrease child quality and suggest that a decrease in family size brought about, say, by exogenous improvements in birth control technology, would increase schooling levels of Indian children". Rosenzweig and Zhang (2009) use the same approach to estimate the net effect of an extra child at parities one and two in China, and find that the extra child "significantly decreases the schooling progress, the expected college enrolment, grades in school and the assessed health of all children in the family".

In Matlab, Bangladesh, fertility decline was found associated with improvements in women's health, household earnings and assets, use of preventive health inputs, and children's health and schooling (Joshi and Schultz 2007). In Colombia, the family planning program was found to bring substantial socio-economic gains to women, especially if they had access to the program when young. Such women obtained more schooling, and were more likely to work in the formal sector. The study concluded that "(c)omparisons with other well-regarded development interventions suggest that these estimates may place family planning among the most effective (and cost-effective) interventions to foster human capital accumulation" (Miller 2010:711).

High fertility also contributes to high maternal mortality (NRC 1989). Abortions following unplanned pregnancies are a significant cause of maternal death. Secondly, the risk of maternal death varies widely with maternal age and birth order ─ it is high for younger teenage mothers, and rises sharply again at higher birth orders. Avoiding teen childbearing and having smaller families reduces maternal mortality risks. And women's mortality risk remains elevated for long after childbirth: a study in Bangladesh found that it is nearly twice as high as normal for up to two years after childbirth (Menken et al 2003).

That fertility reduction can help improve women's health is suggested by Figure 2, which shows how much female adult mortality improved (relative to male) in India concomitant with fertility decline. The comparison with men provides a rough control for overall health improvements. In the early 1970s, female mortality plummeted relative to males in the early childbearing years, picking up gradually over the lifecycle. By 1990, adult women's mortality relative to men's had improved sharply, not only in the childbearing years but also up to age 50, suggestive of reductions not only in maternal mortality but also in lagged mortality arising from maternal depletion and maternal morbidity from repeated childbearing. Note that these data predate the big donor thrust from the mid-1990s, aimed at improving reducing maternal mortality.

5. Implications for Sub-Saharan Africa

Sub-Saharan Africa is now the developing region closest to the scenario described by many as that in which rapid population growth is most difficult to accommodate because of slow productivity growth. As Weil and Wilde (2009:259) conclude from their study:

> "The Malthusian channel by which a high level of population reduces income per capita is still relevant in poor developing countries that have large rural populations dependent on agriculture, as well as in countries that are heavily reliant on mineral or energy exports."

Fertility rates remain high in much of Sub-Saharan Africa, with a regional average of 5.1 children per woman in 2008 ― matched outside the region only by 4 small war-torn countries[7] (World Bank 2010b: Table 2.19). Although fertility has declined in many countries in this region,[8] only a few have a TFR below 4.[9] High fertility also helps keep maternal mortality high ― Sub-Saharan Africa has an estimated 1:31 lifetime risk of maternal death, which is very high compared with other developing regions (WHO et al 2010: Table 2).

Between 1970 and 2005, the population aged below 15 years grew by 150 percent in Sub-Saharan Africa as a whole, and by over 200 percent in the high-fertility country of Niger ― compared with 30 percent for Asia, and 36 percent for Latin America (Figure 3). As a result, Kelley and Schmidt (2005) find that unlike other regions, Africa has as yet benefited little from the impact of reduced dependency ratios on per capita output growth.

This region is estimated to have depleted "genuine wealth per capita" quite rapidly during 1970-2000 (Arrow et al 2004, Dasgupta 2010):

> "Population growth implies significant differences between the initially estimated growth rate of genuine wealth… and the growth rate on a per capita basis…. At an annual rate of decline of 2.6 percent in genuine wealth per annum, the average person in the sub-Saharan Africa region becomes poorer by a factor of two about every 25 years." (Arrow et al 2004: 164-5)

Although it has an enormous wealth of resources, including land and minerals, policy environments in many countries have not been conducive to rapid growth in average living standards. GDP per capita has been rising slowly. Growth in real GDP per capita during 1960-2004 was only 24% in the Sub-Saharan African region, compared with 108% on average in low-income countries, and 685% in the East Asian

region (Figure 4). The region as a whole shows low growth despite rapid growth in some countries, including Botswana and Mauritius. This is because several populous countries show low growth: population growth rates from 1960-2004 were higher for countries with large- and medium-sized populations than for those with small ones (World Bank 2007a:33-35).

Agricultural production per capita was stagnant during 1960-2005, whether measured in overall food production per capita (Figure 5) or cereal yields per hectare (World Bank 2007b:Fig 2.1) ― in sharp contrast to rapid growth in these indices in Asia and Latin America. Agricultural stagnation is an especial problem because a large proportion of the people depend on it for a livelihood: agriculture in Sub-Saharan Africa employs 65 percent of the labor force and generates 32 percent of GDP growth.[10]

Productivity growth in agriculture has been hampered by policies discouraging innovation by smallholders. In a seminal study, Bates (1981) showed how in many countries, policies have depressed the prices smallholders can obtain for their output, and limited their access to subsidies for agricultural inputs and credit. This reduces smallholders' incentives to invest in their land, and to grow more than they need for subsistence. By contrast, elite farmers with political connections are given access to highly beneficial terms.[11] Djurfeldt et al (2006:10) note that "The result was a dual structure comprising, on the one hand a small group of 'modern' often well-connected and sometimes absent, commercial farmers and estate owners and, on the other hand, a vast majority of low-productivity, semi-subsistence oriented smallholders growing traditional varieties using only small amounts of fertilizers and improved seeds." Added to this are investment disincentives in areas with insecure tenure arising from traditional patterns of communal landownership (Besley 1995, Otsuka and Place 2001).

Rates of technological uptake are low (World Bank 2007b:52-55). The use of modern inputs such as fertilizers, improved varieties of cereals, and irrigation are far lower in Sub-Saharan Africa than in other developing regions. Soil degradation is widespread. This contrasts with the policies that helped most Asian countries to increase agricultural production by providing credit, support prices, and input subsidies to farmers, as well as by investing in research and development and in infrastructure such as roads and irrigation. The good news is that policies may be improving. Djurfeldt et al (2006:10, 62) note that there are indications of policy shifts that will improve incentives for smallholders to invest in their land and enhance productivity. Agricultural taxation has fallen in several countries (World Bank 2007b:100).[12] A study in Machakos, Kenya finds that with improved agricultural policies it is possible to raise productivity and reverse soil degradation (Tiffen et al 1994).

Meanwhile, population pressures are growing on the land. Jayne et al. (2003) found that almost a quarter of rural households in Ethiopia, Kenya, Rwanda, Mozambique and Zambia were virtually landless and had little non-farm income to supplement their livelihood. Aggregate availability of cropland per agricultural person fell by 40 percent between 1960 and 2003 (World Bank 2007b:63). Land quality is another issue ― although cropland availability was still double that of Asia in 2003, population densities on the land are similar to those of Asia when adjustment is made for land quality (World Bank 2007b:55,63). The land-quality-adjusted population density in Kenya was estimated in the 1980s to be higher than that in Bangladesh (Binswanger and Pingali 1988, cited in World Bank 2007b:55). In response to population pressure, people are degrading land through over-cropping and over-grazing, and expanding into more fragile lands (World Bank 2007b:55). The FAO (2003) estimates that the demand for food will increase by 2.9% per year, heavily fuelled by population growth of 2.4%.

Other pressures are also building up. Africa is one of the regions projected to be most severely affected by drought and temperature rises due to global warming. Water availability will shrink significantly, especially in the South, West, and North of the continent (World Bank 2010a:137). Land degradation and drought have already caused much movement of people seeking livelihoods elsewhere, and the Sahel is especially at risk.

Demographic, economic and political pressures ─ population growth, land degradation, government crises ─ generate conflict. And in turn conflicts create further economic and political pressures. Conflicts over land and livelihoods are intensifying in many countries (Peters 2004, Green 2010). Mamdani (2001: ch 6,7) points out that rapid population growth was one of the factors underlying the Rwanda genocide, generating resentment among locals who experienced heavy in-migration of people seeking areas with richer land. Large flows of refugees and other migrants create pressures for the receiving areas: Hatton and Williamson (2003:474) estimate that for every two refugees, one local is pushed out of the home labor market.

These pressures generate much migration in the region (Hatton and Williamson 2003). Most of this migration is within the region, within-country and between-country. People migrate to other rural areas where sometimes competition for land generates conflict, and to cities where slow growth in infrastructure and jobs make urban poverty a serious issue. And the pressures for international out-migration are projected to continue to mount (Hatton and Williamson 2003).

Yet things could really change. As the case of Botswana shows, with good management the region's enormous mineral wealth and other natural resources can be tapped to create social and physical infrastructure and generate employment for the large cohorts of young people. Some of the wealth could be invested in expanding the manufacturing sector, which can absorb large amounts of labor. Such measures could offset demographic pressures and enhance living standards. In many settings though, this wealth has been viewed as having been turned into a "resource curse", facilitating elite capture and reducing the need for the political leadership to maintain their legitimacy by building institutions for a developmental state (Collier and Goderis 2007, Unsworth and Moore 2010).

Despite many successes, most countries in this region face challenges to growth arising from institutional constraints of various kinds. Tackling these constraints to growth is urgently required. In addition, most countries would benefit from strengthening family planning programs, to ease the currently high momentum of population growth that further constrains the prospects for improving standards of living.

6. Do family planning programs help lower fertility?

In a highly influential paper, Pritchett (1994a) argued that family planning programs have little impact on fertility:

> "Ninety percent of the differences across countries in total fertility rates are accounted for solely by differences in women's reported desired fertility…. The results contradict theories that assert a large causal role for expansion of contraceptive use in the reductions of fertility." Pritchett (1994: abstract)

Many have taken Pritchett's study as indicating that effort on family planning programs is ill-spent, but he later concludes that his estimates imply that strengthening a family planning program substantially (by 50 points out of a scale of 0-100) would reduce fertility by one birth (Pritchett 1994b: 626). Bongaarts (1997) estimates the corresponding fertility reduction at 1.4 births, but even Pritchett's lower estimate amounts to a very large difference in population momentum and size ― if one birth less per woman was sustained in Sub-Saharan Africa over the projection period 2010-2050, the UN (2009) estimates that there would be half a billion fewer people in that region.[13]

The crucial gap in Pritchett's argument is that he assumes that family planning programs work only on the supply side, and overlooks their important role in reducing desired family size. He conducts cross-country regressions of the Total Fertility Rate against contraceptive prevalence and against family

planning effort, but in both cases he *controls for desired fertility* (Pritchett 1994: Table 3). As he says (1994:41-42), he does not focus on the determinants of desired fertility, and concludes that reducing fertility has little to do with manipulating contraceptive supply. This is missing much of the point, as mass media outreach to reduce desired family size is a major component of family planning programs. Studies have shown that the mass media is very effective at reducing fertility (La Ferrara et al 2008; Jensen and Oster 2009).[14]

Evaluating the impact of family-planning programs is challenging, because they are rarely randomly placed and uniformly executed. However, many studies indicate that family planning programs affect fertility. Schultz (2009: 4) notes that several careful evaluations of family planning programs (including in Taiwan, Colombia, and Indonesia) find a positive association between "the regional intensity of program treatment and the regional level of fertility" in a country.[15] While some studies are simple cross-sectional analyses, others have gone further to analyze panel data and include fixed effects for regions and time. However, the estimated program impact may be biased by nonrandom placement ─ for example it could be over-estimated if program effort is directed more towards areas with greatest demand, and under-estimated if effort is directed more towards areas with the greatest need.[16] In Indonesia, the program was found to have helped reduce fertility, and this effect was if anything under-estimated because the authors found that "the government targets resources to areas of low contraceptive use and dynamically updates those allocations on the basis of program performance" (Molyneaux and Gertler 2000:82-83).

Rigorous randomized experiments of family planning programs are not available. The Matlab program in Bangladesh approximates a randomized trial, since half the villages studied for the period 1974-96 received more intensive family planning and maternal and child health program inputs, while the other half received regular government program inputs. The first set of villages showed more rapid fertility decline after the program began, and maintained 15 percent lower fertility 1982-96 (Joshi and Schultz 2007:30). This difference is especially striking given that fertility was falling rapidly across the country. Similar results emerge from an evaluation of Colombia's family planning program, which exploits differences in timing of the introduction of the family planning program to estimate the impact of contraceptive availability on fertility (Miller 2010:717).[17] The program is found to have lowered fertility by about 10 percent ─ again, despite the fact that fertility was declining rapidly across the country. As described above, this was also associated with considerable private benefits to families.

These evaluations may tend to under-estimate the impact of family planning programs, insofar as their measures of program effort are more likely to pick up variation on the supply side. Mass communication efforts to reduce desired family size are likely to reach people regardless of whether they live in areas with higher or lower supply-side program effort. However, as mentioned above, without randomized trials it is difficult to assess whether on balance evaluations tend to over-estimate or under-estimate program effect.

7. Conclusions

The argument that has raged for half a century over the relationship between population and economic development has distracted people from recognizing that there is in fact little disagreement over the bottom line. There is wide consensus that appropriate policy environments and technological advances are key to improving standards of living ─ and that population dynamics play an important secondary role in this process.[18] A combination of policies is in order, as the World Bank put it:

> In short, policies to reduce population growth can make an important contribution to development (especially in the long run), but their beneficial effects will be greatly diminished if they are not supported by the right macroeconomic and sectoral policies. At the same time, failure to address the

> population problem will itself reduce the set of macroeconomic and sectoral policies that are possible, and permanently foreclose some long-run development options. (World Bank 1984:105)

There are clear social and private benefits to lowering fertility in low-income countries. Recent studies show that low dependency ratios (resulting from fertility decline) create a major window of opportunity for savings, increased productivity, and investment in future growth. The more rapid the fertility decline in a region, the greater the window of opportunity, though its duration will be shorter because the proportion aged will rise sooner. They also indicate that rapid population growth can be a constraint on economic growth, especially in poor countries with policies that do not encourage rapid rise in productivity. In terms of private benefits, they find that lower fertility is associated with better child health and schooling, reduced maternal mortality and morbidity, increased women's labor force participation, and higher household earnings. This is quite aside from the intrinsic human right of being able to control one's own fertility.

Hopefully these recent studies will put this debate to rest. Meanwhile, the debate has helped discourage donors from investing in family planning programs. While these are by no means the only policy lever to help reduce fertility, they are an effective but neglected lever. This has been a missed opportunity, especially for the Sub-Saharan African region, where fertility remains high and pressures on resources have been increasing. Much of the growth achieved by countries in this region is diluted by population growth. Through careful effort, Tanzania has achieved 6-7 percent real GDP growth over the past decade, but the effect of this on a per capita basis is almost halved by population growth (IMF 2010b:5).

The developing world offers sharply contrasting models. At one end of the spectrum is the East Asian region, where policies highly conducive to rapid economic growth were boosted by low dependency ratios resulting from rapid fertility decline. These countries are using these favorable conditions to build up human and physical assets, thus transforming their economies and locking in high growth potential even after the demographic "window of opportunity" closes and the population starts aging. At the other end of the spectrum is Sub-Saharan Africa, characterized by high fertility and low growth in income per capita. The fact that many countries in this region have shown some fertility decline suggests interest in reducing fertility, and family planning programs can build on this. Ideally, this would be combined with efforts to increase schooling especially for females, which is associated with many benefits including lower fertility.

Rapid population growth exacerbates an even less tractable problem ─ environmental change and the management of global common property resources, whose depreciation will affect the sustainability of production possibilities. While changing consumption patterns with rising incomes is a strong driver of pressure on these resources, population growth is also key (Figure 1). Managing global common property resources has proven to be politically very challenging and ridden with difficulties. Family planning programs are far simpler to design and implement. The most feasible way to begin to reduce mankind's ecological footprint may be to reduce the number of feet being born.

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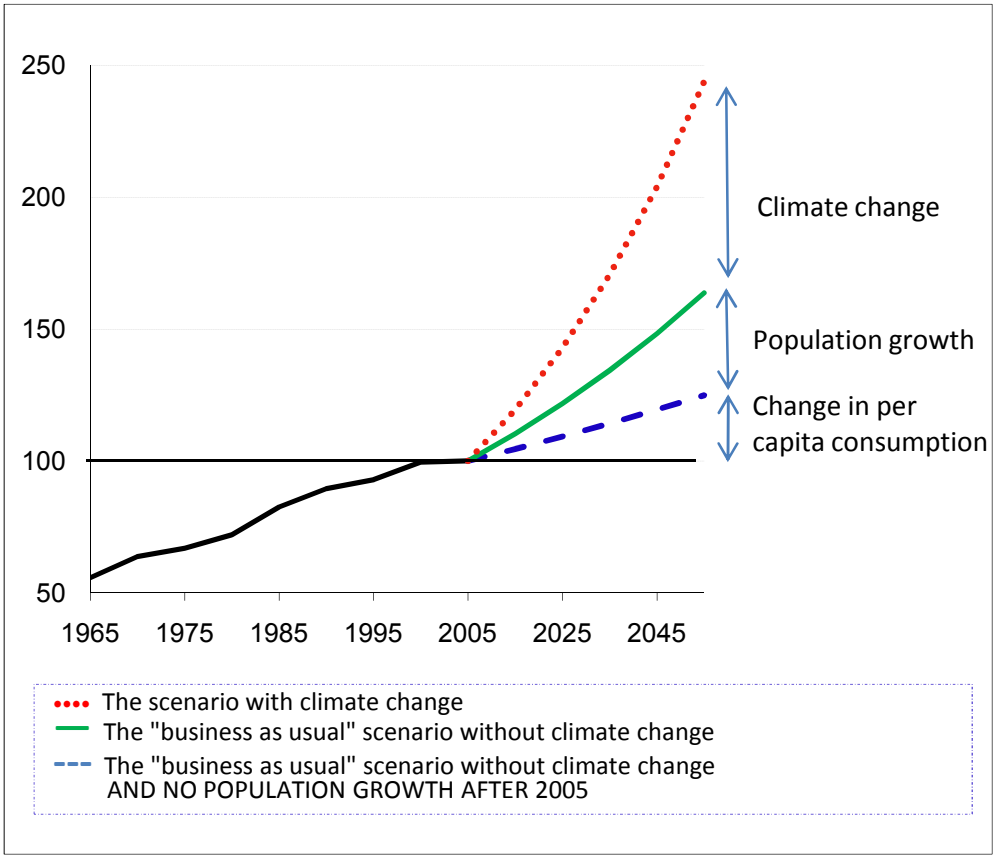
Figure 1: Required growth in agricultural productivity under different assumptions of climate change and population growth

Population growth and climate change mean that increases in agricultural productivity must accelerate to meet the growing food demands as incomes rise



Source: World Bank (2010a) *World Development Report 2010*: Figure 3.5 (derived from Lotze-Campen et al 2009). We thank Dr Lotze-Campen for disaggregating the "business as usual" scenario into two estimates: (1) with population held constant at the 2005 level, and (2) the WDR 2010's "business as usual" scenario, which includes anticipated population increase to 9 billion by 2055.

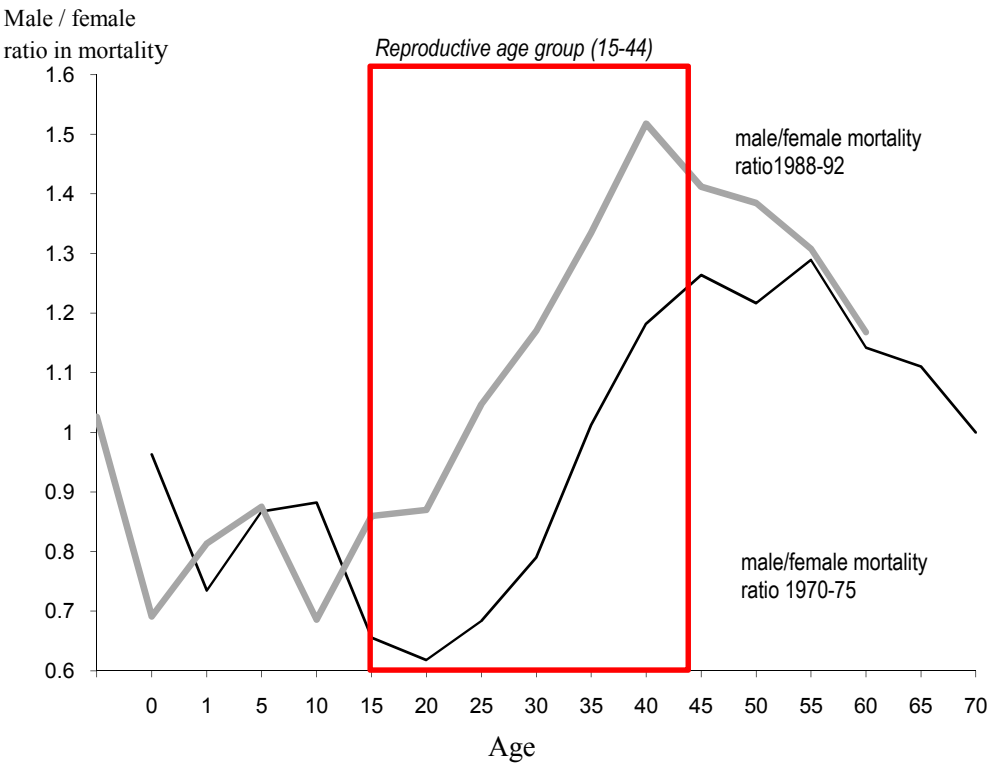
Explanatory note from the original figure in the WDR 2010:

"The figure shows the required growth[19] in an agricultural productivity index under two scenarios. In this index, 100 indicates productivity in 2005. The projections include all major food and feed crops. The green line represents a scenario without climate change of global population increasing to 9 billion in 2055; total calorie consumption per capita and the dietary share of animal calories increasing in proportion to rising per capita income from economic growth; further trade liberalization (doubling the share of agricultural trade in total production over the next 50 years); cropland continuing to grow at historical rates of 0.8 percent a year; and no climate change impacts. The orange line represents a scenario of climate change impacts and associated societal responses (IPCC SRES A2): no CO2 fertilization, and agricultural trade reduced to 1995 levels (about 7 percent of total production) on the assumption that climate change-related price volatility triggers protectionism and that mitigation policy curbs the expansion of cropland (because of forest conservation activities) and increases demand for bioenergy (reaching 100 EJ [10^{18} joules] globally in 2055)."

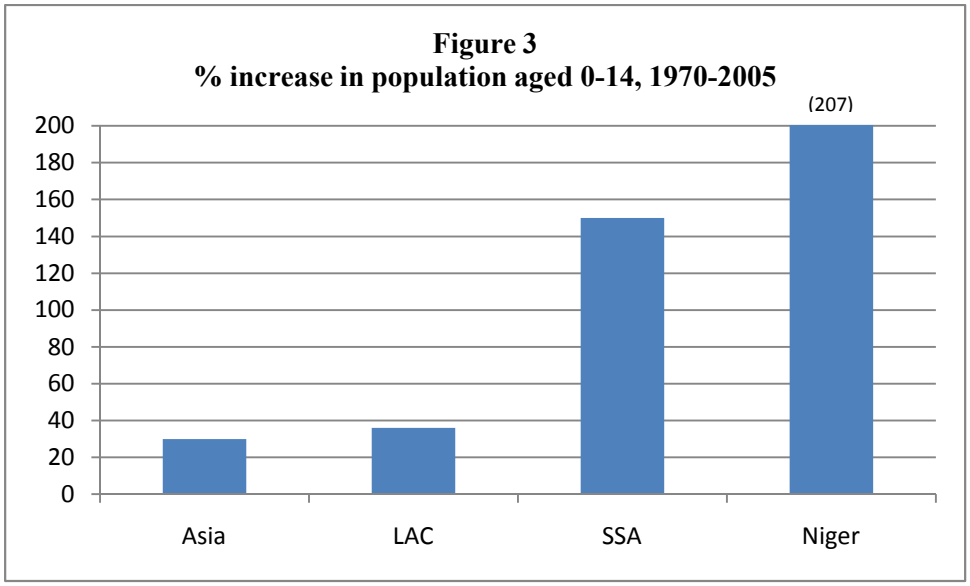
Figure 2

Fertility Decline Helps Improve Women's Health: adult women's mortality fell faster than men's

Trends in the Ratio of Male to Female Mortality, India, 1970-1990

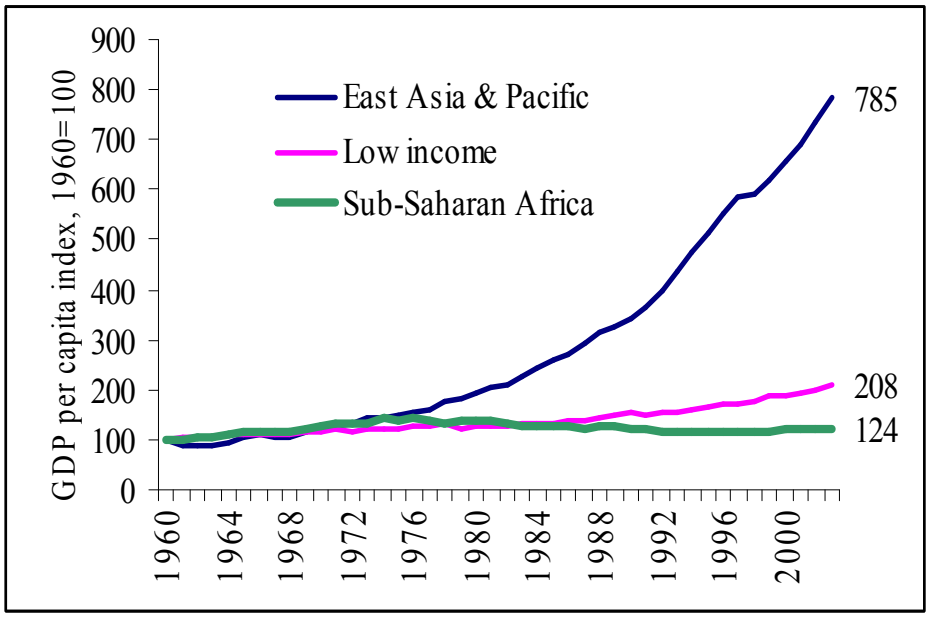


Source: Government of India, Sample Registration Bulletin 16(1), June 1982, and SRS Based Abridged Life Tables 1988-92, New Delhi: Registrar-General of India.



***Source*:** Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, http://esa.un.org/unpp, Tuesday, August 24, 2010; 4:37:08 PM.

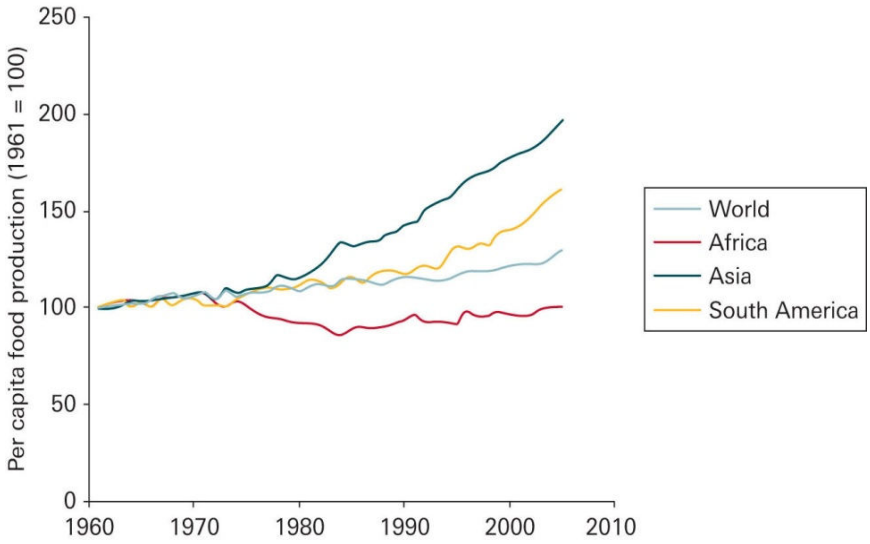
Figure 4 Growth in GDP per capita, 1960-2004



Source: World Bank 2007b: Figure 2.5, derived from the World Bank World Development Indicators database.

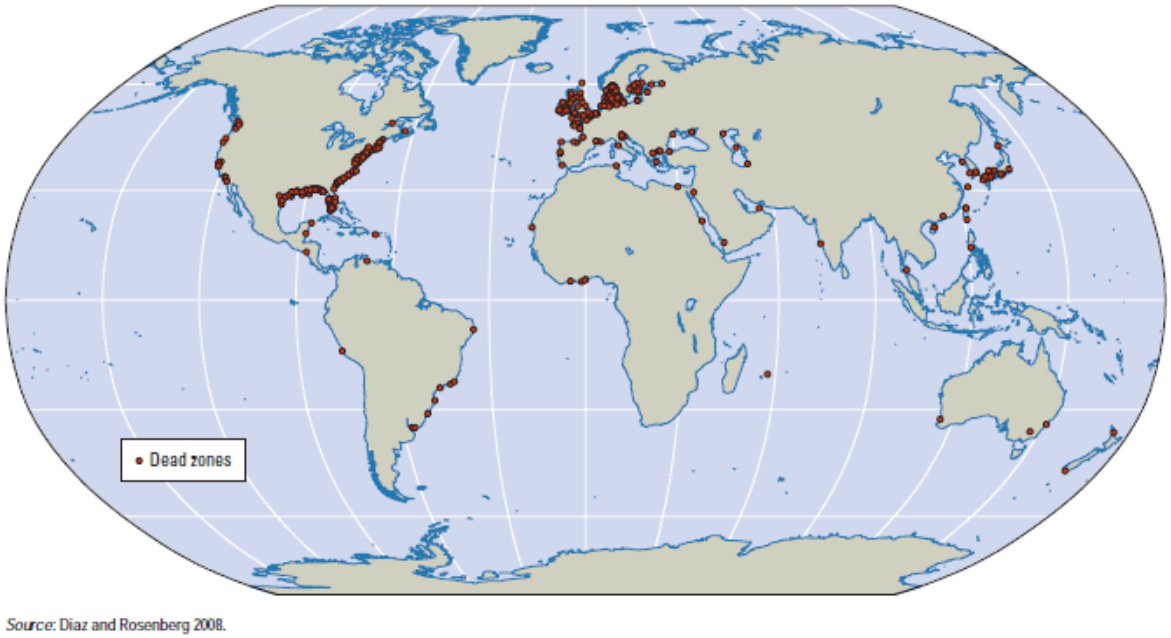
Note: GDP per capita index 1960=100.

Figure 5: Changes in per capita food production, 1961-2005



Source: The Royal Society 2009: Figure 1.4

Map 1: Intensive agriculture in the developed world has contributed to the proliferation of dead zones



Source: World Bank (2010a) *World Development Report 2010*: Map 3.4 (derived from Diaz and Rosenberg 2008).

Explanatory note from the original figure in the WDR 2010: "In the developed world intensive agriculture has often come at high environmental cost, including runoff of excess fertilizers leading to dead zones in coastal areas. Dead zones are defined as extreme hypoxic zones, that is, areas where oxygen concentrations are lower than 0.5 milliliters of oxygen per liter of water. These conditions normally lead to mass mortality of sea organisms, although in some of these zones organisms have been found that can survive at oxygen levels of 0.1 milliliter per liter of water."

Endnotes

[1] It is associated with later entry into union and higher age at first birth in settings as varied as Guatemala, Indonesia, and Nigeria (Behrman et al 2006; Breierova and Duflo 2004; Osili and Long 2008).

[2] For example, expanding access to family planning services was introduced into the Millenium Development Goals many years after these goals were initially adopted.

[3] This is indicated by many studies across Europe, Asia, and Africa. See for example Scrimshaw (1984), Das Gupta (1995), and the papers in Page and Lesthaeghe (eds) 1981 and Tsuya et al (eds) 2010.

[4] *Source*: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, http://esa.un.org/unpp, Tuesday, August 24, 2010; 4:37:08 PM

[5] http://www-bcf.usc.edu/~easterl/papers/SimonKuznets.pdf

[6] Contraceptive and abortion services were extended to the rural areas. "At local level, collective incomes and allocation of funds—for health care, welfare, and schools, for example—made it possible for couples to understand the effect of their personal family choices on the community. They also made it possible for the community to exercise pressure on those who wished to have children outside the agreed plans." (Kane and Choi 1999:992)

[7] These are Afghanistan, Timor-Leste, West Bank & Gaza, and Yemen.

[8] The decline began in the late 1960s and 1970s in urban areas, and about 10 years later in rural areas (Garenne and Joseph 2002). Some cities are at or below replacement levels (Garenne 2008). However, the fertility decline stalled in many countries, even in Ghana and Kenya which had shown significant decline (Garenne 2008:26).

[9] McNicoll (2011) argues that the slow pace of fertility decline in Nigeria (and perhaps also other countries in the region), as compared with Indonesia, is partly attributable to differences in institutional legacies from the past.

[10] WDR 2008 press release (http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:21517663~pagePK:64257043~piPK:437376~theSitePK:4607,00.html)

[11] Bates (1981:59):"Using political connections to secure land, publicly subsidized credit and forgiveness of debts, publicly subsidized and allocated fertilizer, and highly favorable terms for the importation and financing of capital equipment, influential members of the urban elite with close ties to the managers of the public bureaucracies have thus entered into food production in the northern savannah areas. . . . A major consequence of government efforts to promote food production in this area has been the development of disparities of wealth, social status, and political power within the savannah region. When similar policies have been adopted elsewhere in Africa, the consequences have been much the same."

[12] There may be a small uptick in GDP per agricultural person (World Bank 2007b:54), though this is barely detectable when the overall population is included --- so it may be partly an artifact of rural out-migration.

[13] This is the difference between the high and the low variant of the UN population projections.

[14] DellaVigna and Kaplan (2007) show that mass media shape voter behavior. They examined the effect of Fox News, which was introduced between 1996-2000 in about 20 percent of US towns. It was found to significantly increase the Republican share of the vote in these towns between the 1996 and 2000 Presidential elections.

[15] These include Schultz, 1973, 1992; Rosenzweig and Schultz, 1982; and Molyneaux and Gertler, 1994.

[16] Government programs may prioritize high-demand areas if their primary objective is to meet voter preferences. They may prioritize low-demand areas if their primary objective is to reduce population growth.

[17] Miller (2010:711-5) argues that program placement did not prioritize areas with either higher or lower demand. Schultz (personal communication) observed that the program prioritized high demand populations, and that therefore Miller may have over-estimated the impact of the program. Rosenzweig and Schultz (1982) found evidence of the Colombian program's effectiveness in a cross sectional association between the regional intensity of program treatment and the regional level of fertility in Colombia (Schultz 2009:4).

[18] Of course, countries with fertility levels far below replacement have the opposite problem of a shrinking laborforce, and shrinking tax base to support the aged.

[19] The original explanatory note said it was the required annual growth, Dr Lotze-Campen corrected this by deleting the word "annual".