Chapter 11
Population and Development

January 24, 2015

Take home messages for chapter 11

1. Total world population reached the 7 billion mark in 2011 and is predicted to stabilize somewhere between 9 billion in 2045 and 12 billion in 2100. Currently, 82% of the world population lives in the developing world (low and middle income countries) and 92% of world population growth originates in these countries
2. Population growth is a major issue in international development. It is generally considered to be excessive in developing countries with negative consequences on GDPpc, the provision of basic needs, and environmental sustainability.
3. The demographic transition is an upsurge in population growth associated with death rates falling ahead of birth rates, until birth rates also decline to catch up with death rates, allowing the population to stabilize again after a major quantitative jump.
4. The demographic dividend is a onetime opportunity for a low dependency ratio, permitting high rates of labor force participation and high rates of savings, both favorable to growth.
5. The determinants of total fertility rates (TFR) are associated with the economic advantages provided by children to parents as sources of income, insurance, and satisfaction. As parents' income rises, the income and insurance functions of children decline, reducing the demand for children. The satisfaction motive in the demand for children shifts from quantity to quality, implying a price effect that also contributes to reducing demand.
6. Supply-side contraception programs help reduce the gap between the actual demand for children and the desired demand.
7. Population policies to reduce fertility rates aim at reconciling private and social gains from family size. They can focus on both the supply side and/or on the demand side for contraception. If there are positive social externalities from higher TFR, pro-natalist policies can be used to boost family size. If there are negative externalities, family planning policies can deter large families.
8. Gender preference to the advantage of boys, especially in Asia, implies both large numbers of missing women and sibling rivalry to the detriment of girl welfare.

Population growth is both an asset and a liability for development. It is an asset in that a growing population is a source of youthful labor, social security contributions, and expanding markets. At the household level, children are sources of income and protection for their parents. Poor people typically prefer to have larger numbers of children as both a choice and a necessity. But it is also a liability. From a simple arithmetical standpoint, population growth subtracts from GDP growth in determining growth in per capita income. It also tends to be a source of declining land per capita and food insecurity, environmental degradation, congestion externalities, urban blight, and a drain on public goods and services. So, there are both positive and normative questions associated with population growth. Positive questions include: What are the determinants of fertility behavior? Why do countries go through a demographic transition with a phase of exploding population growth? Why is there a subsequent decline in population growth as per capita income rises? How do countries benefit from a one-time demographic dividend as fertility declines while the share of elderly people in the population is still relatively low? Normative questions include: How to reduce population growth if it is deemed

excessive? If contraception is the main instrument to reduce fertility, when is it more important to focus on the supply side or on the demand side of contraception?

Our thesis in this chapter is that children fulfill three functions for parents: they are sources of income, protection, and satisfaction. The transition from high to low fertility– the demographic transition–is associated with children losing their income and protection functions for parents, only maintaining their universal satisfaction function but increasingly through the quality as opposed to the quantity of children. Understanding the determinants of fertility is key to designing population policy. With world population reaching 7 billion in 2011 and continuing to grow to expectedly peak somewhere between 9 billion in 2045 and 12 billion in 2100, population policy tends to be a key, yet much-neglected, aspect of international economic development.

I. Definitions: Demographic concepts

We start with the definition of a number of concepts used in demographic analysis. The corresponding 2012 data for selected countries ranked by PPP-adjusted GDPpc are presented in Table 11.1.

Country	PPP-GDPpc (2012 US$)	Crude birth rate (per 1,000 people)	Crude death rate (per 1,000 people)	Infant mortality rate (per 1,000 live births)	Life expectancy at birth (years)	Total fertility rate (births per woman)
Niger	899	49.8	11.2	61.6	58.0	7.6
Ethiopia	1240	33.5	7.8	46.2	63.0	4.6
Sierra Leone	1610	37.1	17.4	109.6	45.3	4.8
Kenya	2189	35.5	8.5	48.8	61.1	4.5
India	5138	20.7	7.9	42.9	66.2	2.5
Nigeria	5535	41.5	13.5	76.6	52.1	6.0
Guatemala	7107	31.4	5.3	26.6	71.7	3.8
China	10945	12.1	7.2	11.7	75.2	1.7
Brazil	14574	15.1	6.4	12.9	73.6	1.8
Mexico	16178	18.8	4.5	13.1	77.1	2.2
Japan	35315	8.2	10.0	2.2	83.1	1.4
United States	51755	12.6	8.1	6.1	78.7	1.9

Table 11.1. Demographic indicators, selected countries, 2012
Data source: World Bank, World Development indicators, online

The *crude birth rate* (*b*) of a population is the number of live births per 1000 people per year. In 2012, it was 49.8 in Niger, 37.1 in Sierra Leone, 35.5 in Kenya, 33.5 in Ethiopia, 18.8 in Mexico, 15.1 in Brazil, 12.6 in the U.S., 12.1 in China, and 8.2 in Japan.

The *crude death rate* (*d*) of a population is the number of deaths per 1000 people per year. In 2012, it was 17.4 in Sierra Leone, 11.2 in Niger, 8.5 in Kenya, 7.8 in Ethiopia, 7.2 in China, 6.4 in Brazil, 4.5 in Mexico, 8.1 in the U.S., and 10.0 in Japan.

Note that the birth and death rates of a population depend on the age structure of that population. If the percentage of young people is very high, as would be the case in a low-income country the aggregate death rate can be lower in the low income country (such as Ethiopia with a crude death rate of 7.8) than in a high-income country (such as Japan with a crude death rate of 10.0), even though the death rate is higher in each age group than in the high-income country.

The *annual rate of natural increase* of a population (*r*) is the difference between the birth rate and the death rate: $r = b - d$. Based on the above statistics, in 2012 it was in percent 3.9 in Niger, 2.7 in Kenya, 2.6 in Ethiopia, 2.0 in Sierra Leone, 1.4 in Mexico,

0.9 in Brazil, 0.5 in China and the U.S., and –0.2 in Japan. Each year, 84.3 million people are added to world population, 82.6 in the less developed countries and 1.7 in the more developed countries. 98% of world population growth is thus located in the LDCs.

The *annual natural increase in population* is rN, where N is population size at the beginning of the year. The observed increase in population takes into account net migration and for that reason differs from the natural increase in population.

Other useful indicators of fertility are the following.

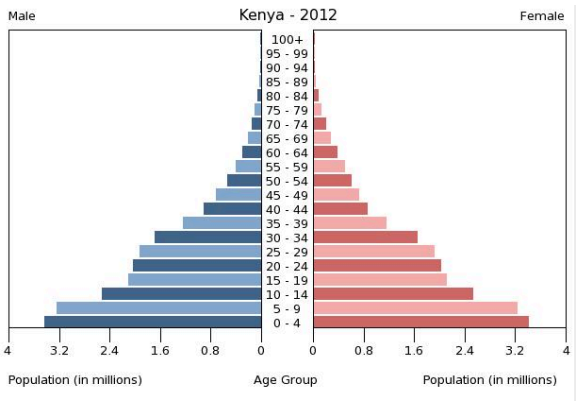
For deaths:

- The *infant mortality rate* is the number of deaths of children less than 1 year old per 1000 live births. In 2012, it was 109.6 in Sierra Leone, 77.6 in Nigeria, 46.2 in Ethiopia, 42.9 in India, 13.1 in Mexico, 6.1 in the U.S., and 2.2 in Japan.
- The *life expectancy at birth* is the expected number of years of life when born. In 2012, it was 45 in Sierra Leone, 63 in Ethiopia, 74 in Brazil, 77 in Mexico, 79 in the U.S., and 83 in Japan. The United States had the highest life expectancy in the world in the 1950s, but has by now fallen to 34th, ranking below countries such as Chile, Costa Rica, and Cuba. Life expectancy is higher for women (86.4 in Japan, 81.2 in the United States) than for men (79.9 in Japan, 76.4 in the United States), but there has been a tendency toward convergence among genders in the last decade.

For births:

- The *total fertility rate* (TFR) is the average number of children that will be born to a woman in a population over her reproductive ages (15 to 49). In 2012, it was 7.6 in Niger, the highest in the world, 6.0 in Nigeria, 4.8 in Sierra Leone, 4.6 in Ethiopia, 2.5 in India, and 2.2 in Mexico. For the world, in 2012, the TFR is 2.4.
- The *replacement fertility rate* for zero growth of a population is 2.1. Any population with a TFR inferior to 2.1 and no net immigration is declining in size.
- In the industrialized countries, the TFR is in most cases below replacement level. It is 1.9 in the U.S. (with 1.8 for white women and 2.4 for Hispanic women), below 1.5 in most European countries (1.4 in Italy and Germany, 1.3 in Spain, with France above the others with 2.0), and 1.4 in Japan. High-income countries such as South Korea (1.3), Singapore (1.3), and Taiwan (1.1) are also way below replacement rate. Brazil, as a middle-income country, has a TFR of 1.8. China, with its one-child policy, is a unique low-income country with a TFR of 1.7, largely below replacement rate.

Age-gender *population pyramids* are an effective way of visualizing population growth as affected by birth and death rates, and other events. The pyramid gives the number of people by gender and age group. Figure 11.1 shows the contrast between four population pyramids in 2012, with populations rapidly growing in Kenya, slowing down in China, stagnant in the United States, and shrinking in Japan. The corresponding demographic indicators are given in Table 11.2.


Male
Kenya - 2012
Female
100+
95 - 99
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70 - 74
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40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
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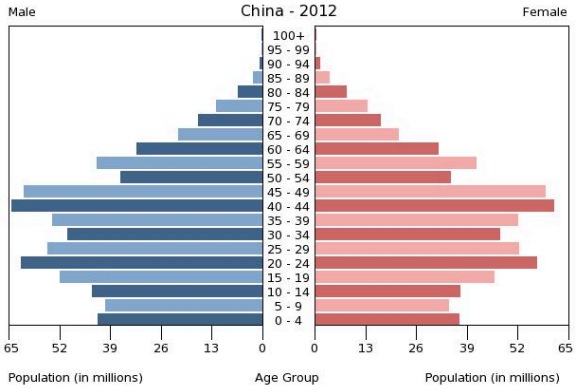
Population (in millions)
Age Group
Population (in millions)


Male
China - 2012
Female
100+
95 - 99
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80 - 84
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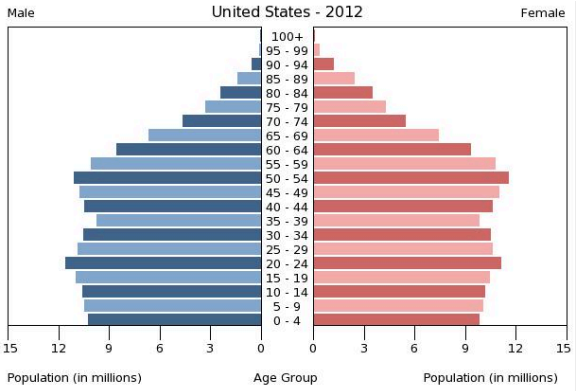
Population (in millions)
Age Group
Population (in millions)


Male
United States - 2012
Female
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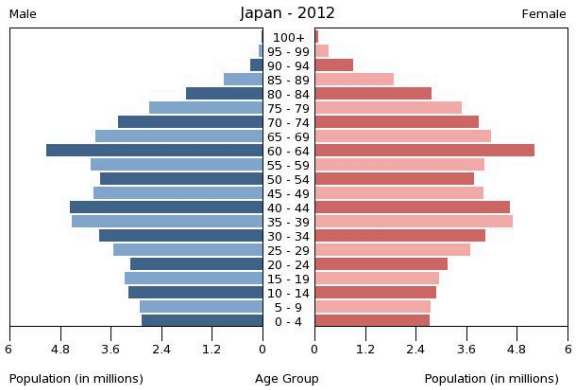
Population (in millions)
Age Group
Population (in millions)


Male
Japan - 2012
Female
100+
95 - 99
90 - 94
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0 1.2 2.4 3.6 4.8 6
Population (in millions)
Age Group
Population (in millions)

Figure 11.1. Population pyramids by age and gender for Kenya, China, the United States, and Japan, 2012
Data source: U.S. Census Bureau, International Data Base.
http://www.census.gov/ipc/www/idb/pyramids.html

	Kenya	China	United States	Japan
Total population (million)	42.0	1343.2	313.9	127.4
Youth 0-14 (million)	18.3	233.2	61.1	17.2
Elderly 65+ (million)	1.2	122.3	43.1	30.4
Working age population (million)	22.6	987.8	209.6	79.8
Youth dependency ratio	0.81	0.24	0.29	0.22
Elderly dependency ratio	0.05	0.12	0.21	0.38
Total dependency ratio	0.86	0.36	0.50	0.60

Table 11.2. Population dependency ratios for Kenya, China, the United States, and Japan, 2012
Data source: U.S. Census Bureau, International Data Base.
http://www.census.gov/population/international/data/index.html

A pyramid with a wide base and a narrow top, as in Kenya, characterizes a population with a high birth rate and a high death rate. As conditions improve, the birth rate declines and the base of the pyramid shrinks as in China. When life expectancy rises, the population pyramid becomes more like a tower as in the United States. Finally, the pyramid starts reversing, with the most numerous age group rising from 0 to 4 in Kenya to 60-64 in Japan.

Countries with high population growth rates have high *dependency ratios*. The dependency ratio is the ratio of non-working to working age population. The population of non-working age is defined as people 0-14 years old for the youth and people 65 years old and above for the elderly. The *youth dependency ratio* is the number of people 0-14 relative to the number of people 15 to 64. In countries with rapidly growing populations, about a quarter of the population can be 14 years old or under (e.g., 25% in Algeria). This places a high burden on the working age population. The *elderly dependency ratio* is the number of people 65 and above relative to the number of people 15 to 64. In slow growing populations with long life expectancy, the elderly dependency ratio becomes high, placing a new burden on the working age population. In Japan, 22% of the population is 65 years old or more.

The total dependency ratio can be high either because there are many young people, or because there are many old people, both relative to the number of working adults. The dependency ratio will thus be lowest when the population growth rate is declining while there are still few elderly people to support. This transition creates a one-time opportunity for a low dependency ratio, with as a consequence the possibility of high rates of labor force participation and high rates of savings. This "*demographic dividend*" was important in helping Taiwan and South Korea achieve high rates of savings and high rates of growth in the post-war period when they had their economic booms (Lee and Mason, 2006). As Table 11.2 shows, among the four countries compared, China is the one with the highest demographic dividend (a total dependency ratio of 0.36) compared to Kenya (0.86), the United States (0.5), and Japan (0.6). In Mexico, as can be seen in Figure 11.2 (left panel), the demographic dividend will be maximum in 2022. The total dependency ratio will fall from 92% in 1980, to 51% in

2022, and rise to 57% in 2050 as the population ages. In this case, an important determinant of the demographic transition is aging of the population. In Kenya (right panel), the demographic dividend will be maximum in 2035. The total dependency ratio will fall from 113% in 1980, to 44% in 2035, and rise to 48% in 2050. In this case, most of the action comes from the decline in the youth dependency ratio. As Sub-Saharan African countries enter in a phase of demographic dividends, an important question is whether this one-time opportunity to raise savings will be used to support an industrial takeoff, as it did in East Asia.

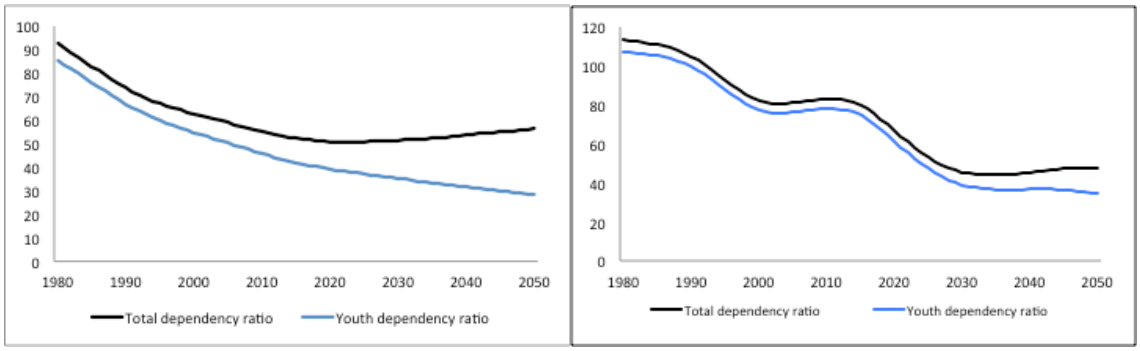

Figure 11.2. The demographic dividend in Mexico (left panel) and Kenya (right panel), 1980 to 2050
The elderly dependency ratio is the difference between the total and youth dependency ratios
Data source: U.S. Census Bureau, International Data Base.
http://www.census.gov/population/international/data/index.html

These contrasted statistics on TFR and age structure illustrate the world population dilemma. Population growth is generally considered to be excessive in poor countries, and too low in rich countries. The issue could be resolved by international migration, with the poor countries exporting surplus population to the rich ones, with mutual benefit. However, as we will see in Chapter 12, Labor and Migration, international migration, that was quite free in the 1850-1914 period, the "Age of Empires", is now severely restricted. We thus observe a situation where surplus labor accumulates in the poor countries, with the associated dramas of low investment in human capital, unemployment, and poverty. At the same time, labor shortages tend to occur in the rich countries and productive labor is in deficit to support an aging population.

II. Some data for the world population

Total world population reached the 7 billion mark in 2011, and is 7.2 billion in 2013.

The current prediction of the level at which world population is likely to stabilize is somewhere between 9 billion in 2045 and 12 billion in 2100. There has been a rapid decline in the rate of population growth at a world scale, from 2.1%/year in 1970 to 1.2%/year in 2010, and this decline has started to occur in the low-income countries as well where it fell from 2.6% to 2.2% over the same period (Table 11.3).

The decline in population growth rate can be appreciated using the number of years needed to double population size. It is measured as Ln2/*r*, where *r* is the population growth rate (see Chapter 1, What is Development?). At a world scale, it rose from 33 years in 1970 to 59 years in 2010. Time to double is lowest in Sub-Saharan Africa where it is 26 years, and highest in East Asia and the Pacific where it is 104 years. In spite of this decline, population growth remains a huge problem at a world scale as total population is still expected to increase at a minimum by two billion, nearly an extra 30% in an already crowded planet, before it stabilizes. Predicted population growth implies that food production will have to increase by 60% over the next 30 years. As we will see in Chapter 18, Agriculture for Development, this is a huge challenge in a world where unused land is very limited and climate change is threatening the sustainability of even existing yields.

	Population growth (r in annual %)					Number of years to double (LN2/r)				
	1970	1980	1990	2000	2010	1970	1980	1990	2000	2010
World	2.1	1.7	1.7	1.3	1.2	33	40	40	53	59
By income level										
Low income	2.6	2.5	2.7	2.4	2.2	27	28	26	29	32
Middle income	2.5	2.0	1.9	1.4	1.2	28	35	37	50	60
High income	0.9	0.8	0.7	0.5	0.6	76	85	94	136	114
By regions										
Sub-Saharan Africa	2.6	2.9	2.8	2.7	2.7	27	24	25	26	26
Middle East & North Africa	2.7	3.2	3.4	1.9	2.0	25	22	20	36	35
South Asia	2.3	2.4	2.2	1.8	1.3	30	29	31	39	51
Latin America & Caribbean	2.5	2.2	1.9	1.5	1.1	27	31	37	47	61
East Asia & Pacific	2.6	1.5	1.5	1.0	0.7	27	47	46	73	104

Table 11.3. Population growth rates and years to double
Data source: The World Bank, World Development Indicators, on line

Other important aspects of world population are the following:

i) 82% of world population lives in the *developing world* (low and middle income countries), and 92% of world population growth originates in these countries (Table 11.4). The world population problem is thus fundamentally associated with developing countries and, very importantly as we will see, with poverty in these countries. Projected to 2050 (Figure 11.3, left panel), world population will be 9.4 billion with 1.3 billion in the high-income countries and 8.1 billion in the developing countries, 86% of the total. The future regional distribution of world population is also stunning (Figure 11.3, right panel). Population in East Asia will peak in 2025 at 1.63 billion and subsequently decline to 1.51 billion. By contrast, high fertility will drive total population to 3.32 billion in South Asia and 1.81 billion in Sub-Saharan Africa, two regions where poverty is also extreme. In 2050, 1.81 billion of the world population will be located in the Least Developed Countries, with the highest rate of population growth.

	Total population (billion)	Share of total population (%)	Population growth (annual %)	Years to double	Share of total population growth (%)
World	7.12	100	1.2	60	100
Low income	0.85	11.9	2.2	31	23.1
Middle income	4.97	69.8	1.1	61	69.0
High income non-OECD	0.25	3.5	0.7	98	2.2
High income OECD	1.05	14.8	0.5	149	6.0

Table 11.4. Distribution of world population, 2013

Data source: The World Bank, World Development Indicators, on line

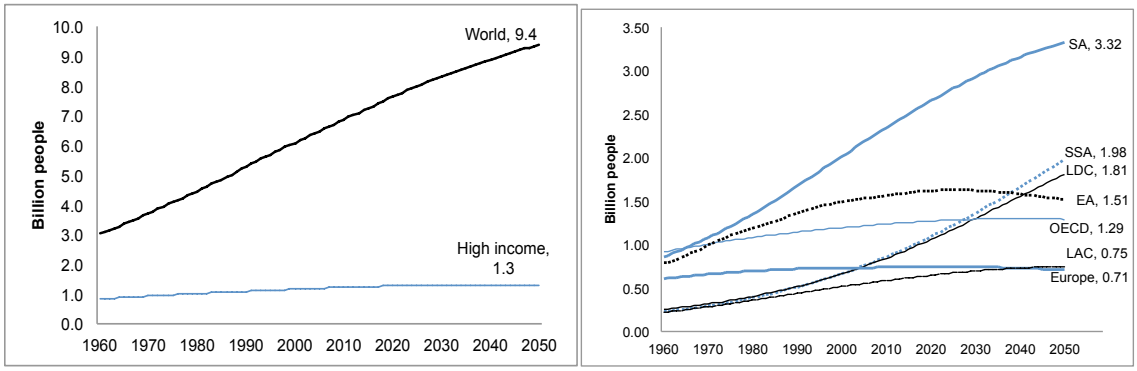

Figure 11.3. Distribution of the world population between world and high-income countries (left panel) and by regions (right panel), 1960-2050

Note: In the left panel, developing countries population is the difference between the two curves. In the right panel, LDC is the Least Developed Countries

Data source: US Census Bureau, on line

http://www.census.gov/population/international/data/worldpop/table_population.php

ii) World population is rapidly becoming *urbanized*. The world rate of urban population growth is 2.8%, and 50% of world population became urban by the end of 2008. In Latin America, the rate of urbanization is already 73%. While world population is becoming urbanized, world poverty remains predominantly rural.

iii) There are many *mega-cities* in the low and middle-income countries. Examples are Mexico City (18.1 million inhabitants), Mumbai (18), Sao Paulo (17.7), Shanghai (14.2), Lagos (13.5), and Calcutta (12.9). The rate of population growth tends to fall sharply with displacement of the population from the rural to the urban environment. The nature of poverty is also different in the urban than it is in the rural environment, calling on different types of anti-poverty interventions. In general, anti-poverty programs such as conditional cash transfers have been more successful in the rural than in the urban environment, as we will see in Chapter 14, Social Assistance Programs.

iv) The *incidence of AIDS* in Sub-Saharan Africa has had a huge toll on the population, with an estimated 7 million deaths since the beginning of the pandemics. In 2013, HIV prevalence was as high as 27% in Swaziland, 15% in Zimbabwe, 19% in South Africa, and 13% in Zambia. Largely because of AIDS, life expectancy at birth has fallen from a high of 59 years in 1990 to a low of 46 in 2004 in Swaziland, from 61 in 1985 to 43 in 2002 in Zimbabwe, from 62 in 1992 to 52 in 2005 in South Africa, and from 51 in 1978 to 41 in 1998 in Zambia (World Bank, World Development Indicators, online). AIDS has a high economic cost as deaths are concentrated among working-age adults. It is increasing the dependency ratio, leaving grandparents and the community in charge of orphans. In some villages in Zambia, as much as 30-40% of the children are orphans from both parents.

III. History of world population and demographic transition

Three demographic revolutions

The world population has gone through three demographic revolutions, each with huge spurts in population size:

During the *Neolithic period*, some 10,000 years BC, associated with the introduction of agriculture displacing hunting-and-gathering as the main source of food (Diamond, 1997). World population was estimated to then be around 1 million.

During the *agricultural and industrial revolutions* in today's industrialized countries, over the 1700-1880 period. World population reached for the first time 1 billion in 1800.

With the *health revolution* reaching the developing countries starting in the 1940s following the introduction of DDT to control malaria, polio vaccines, and antibiotics such as penicillin. By 1950, world population was 2.5 billion.

The demographic transition is a one-time population explosion that occurs as death rates fall ahead of birth rates. This explosion comes to an end when birth rates in turn decline, eventually converging again with death rates. This is illustrated in Figure 11.4 for the industrialized (left panel) and developing (right panel) countries. In the first, the demographic transition has been completed, with low birth and death rates, and a corresponding low population growth rate. In the second, the transition is still in progress, with a low death rate and a high birth rate, and a high population growth rate. As can be seen from these two figures, most population growth today is coming from the developing countries. The challenge in overcoming the population explosion in these countries is to reduce the birth rate, as death rates have already started to decline with diffusion of the health revolution.

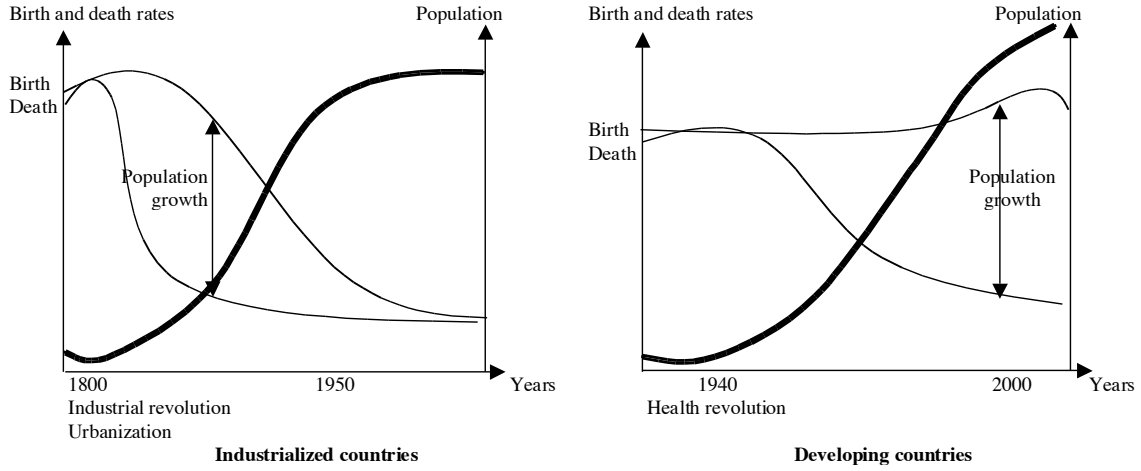

Figure 11. 4. The demographic transition in industrialized and developing countries
Birth and death rates in thin lines; total population in heavy line

IV. Causes of population growth

What explains population growth? For Malthus, population growth was held in check by food availability. For modern demographers, population growth can be explained by the calculus of economic advantage made by a couple in deciding how many children it

wants to have. Ability to not exceed this desired number in turn depends on availability of contraceptive methods.

1. Malthus: The dismal economics of hunger

For Reverend Thomas Malthus, who wrote in 1798 *An Essay on the Principle of Population*, the "passion between the sexes" always pushes population growth ahead of growth in food supply. As a consequence, population growth is held in check not by demographic restraint but by food scarcity and famines. This is because population grows at a geometric (multiplicative) rate while food grows at an arithmetic (additive) rate, as shown in Figure 11.5. Whenever the population growth rate exceeds the food availability growth rate, people die due to "gigantic inevitable famines, wars, epidemics, pestilence, and plagues", in Malthus' own words. Whenever the food availability growth rate exceeds the population growth rate, the "passion between the sexes" makes population grow back to the brink of famine. There is hence a stable equilibrium, where the growth in food availability determines the growth of population.

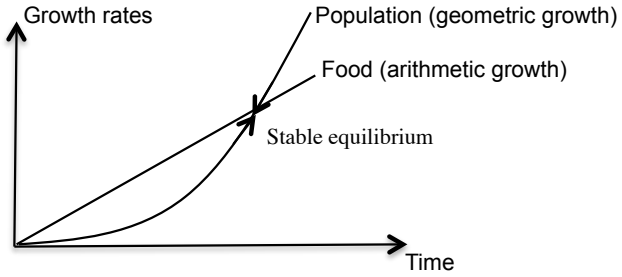

Figure 11.5. Malthusian population equilibrium: The dismal economics of hunger

The Malthusian position on the inevitability of starvation as population runs against the limits of food availability is still present in modern times. Paul Ehrlich (1968) in his book, *The Population Bomb*, thus predicted the inevitability of "famines of unbelievable proportions", with "hundreds of millions of people starving to death" in the 1970s and 1980s due to overpopulation. For him, the policy implication was not on the side of technology, but on the need to rapidly bring the world population under control, reducing the growth rate to zero or turning it negative. He suggested that foreign aid to countries such as India with insufficient programs to limit population growth should be canceled, as any economic gain would be eliminated by population growth.

Other modern time neo-Malthusian positions include the report of the Club of Rome, *The Limits to Growth* (Meadows et al., 1972). Prediction was that exponential growth in population, industrialization, and pollution, with slow growth in food production and given known reserves of resources such as petroleum and iron, would lead to exhaustion of resources and bring growth to an end. Using a world growth model, the Club of Rome predicted that petroleum resources would be exhausted by 1992 and iron by 2065. Even with successful exploration for energy and minerals, exhaustion would occur by 2070.

But Malthusian predictions have been criticized, and proven wrong by events. Fertility has declined due to changes in the logic of family size and the availability of contraceptive methods, and there has been much technological change in food production, allowing food availability to also grow exponentially. Although world population continues to grow and tensions still exists for food supply to keep up with population, food is no longer a global constraint on population. Technological and institutional innovations have been important instruments to countervail Malthusian predictions of doom. The Green Revolution averted mass famines in India at the time of Ehrlich's predictions. Sen (1981) showed that the Bengal famine of 1943 where three million people died was not due to lack of food relative to population, but to lack of means for many people to access available food. Poverty, rising food prices, and inadequate food distribution systems were thus to blame rather than population explosion and absolute food scarcity. He argued that countries with democratic forms of governance and a free press have basically never suffered from extended famines. Thus, while local famines and resource scarcity (for example in Rwanda where land scarcity likely contributed to the genocide) can be induced by population growth, markets (with prices signaling scarcity and inducing response) and states (though public goods and social protection) are likely to help avert neo-Malthusian doom through technological and institutional innovations.

Growth theory has also been used to explain how an economy can shift away from a Malthusian world where income per capita is held stagnant by population growth, to a Solow world where population can grow without implying a decline in per capita income. Hansen and Prescott (2002) propose a model with two technologies. A Malthus technology where output is a function of technology, land, labor, and capital, and a Solow technology where output is a function of technology, labor, and capital, but not of land. If land is in fixed amount, and population growth responds to income (as in Malthus), then population growth will bring down wages and land rents increase with population growth, two regularities observed in the pre-industrial world, say England before 1800. Once TFP has become sufficiently important, the Solow technology becomes more profitable than the Malthus technology. Decreasing returns to labor (with fixed land) is replaced by constant returns to scale as in the Solow production function. Labor productivity can now increase even with population growth. Population growth is no longer a factor of stagnant real wages. Key to the story is that technological innovations started to occur when the Malthusian world was still prevailing. History confirms that much technological progress indeed occurred before 1800, allowing labor productivity to rise and making the Solow world superior to the Malthusian world. Rising labor productivity gives value to investment in education, and can in turn induce a demographic transition due to the fact that children are no longer important productive assets for subsistence production (Rosenzweig and Evenson, 1977), and that the quality of children primes over quantity (Galor and Weil, 2000).

2. Determinants of decline in fertility

The decline in the total fertility rate (TFR) can come from an increase in the age of marriage or from a decline in marital fertility. The latter is the most important. To

construct an economic reasoning as to how incentives can affect fertility rates, three pre-conditions must hold:
i) Fertility outcomes are subject to willful choice:
People know what they are doing when they engage in sexual behavior in terms of implications for family size, at least at nearly all times.
ii) Fertility decisions are determined by the calculus of advantage (utility maximization):
Economic gains and costs are rationalized into fertility decisions.
Social norms associated with fertility patterns provide guidelines about the rationale for fertility decisions. In other words, this calculus does not have to be made each time when it matters, it is ingrained in what is culturally accepted as fertility norms, even though there may exist long lags in the adjustment of these cultural norms to changes in economic context. Large families may thus be associated with social status, and this source of status may persist for a long time after the economic rationality for large families has declined.
iii) Some methods of fertility control are available, ranging from inefficient to more efficient. This allows a couple calculating economic advantage in fertility decisions to adjust the actual number of children they will have to the desired number since desired family size is overall less than actual family size without fertility control. Lack of access to more efficient methods of fertility control implies that the actual number of children may be further in excess of the desired number.

3. Calculus of economic advantage

In deciding how many children to have, parents consider three types of benefits they can derive from having a child: income, insurance, and satisfaction.

i) *A child is a source of income*. Children are assets that can provide services to parents at home and in the fields and factories. Child labor brings wage earnings to the household. Because there are rearing and maintenance costs before benefits are accrued, a child will be a valuable asset to have if:
PVBenefits (services, income) > PVCosts (rearing, feeding),
where PV is present value calculated at the discount rate that characterizes this particular household.

ii) *A child is a source of insurance*. A large number of children allows a household to diversify its sources of income for risk management, receive transfers from children for risk coping following a shock, provide sheer physical protection to parents, and offer them old-age protection.

The protection function of children implies that parents will want to have children to care for them when they are old. The risk that children will die determines how many children parents should have to make sure that at least one of them will be there to help. Say that $\bar{P}$ is the desired probability of having at least one child to look after you at old age, for example 95%. Let q be the probability that a child will die (or more generally will be unable or unwilling to assist parents in their old age). If you have one child, the probability that he will be there to help at old age is P <<w= $1 - q$. If you have two

children, the probability that at least one will be there to help is $P = 1 - q^2$. The optimum number of children n to have to achieve your protection objective $\bar{P}$ is thus $\bar{P} = 1 - q^n$. Solving for n gives $n = \ln(1-\bar{P}) / \ln q$. Numerical examples are given in Table 11.5. If $\bar{P} = 0.95$ and the death rate of children is 1/2, then $n = 4$. If the death rate falls to 0.3, then you only need 2 children. Reduced mortality thus allows parents to meet their protection objective with a smaller number of children. If social protection increases and the protection objective from children falls to 0.9, then you only need 3 children instead of 4 with a 50% mortality rate.

Protection objective Pbar	Probability of disappearance of a child q	Desired number of children n
0.95	0.5	4
0.95	0.3	2
0.95	0.1	1
0.9	0.5	3
0.9	0.3	2
0.9	0.1	1

Table 11.5. Desired number of children to achieve a protection objective

Other factors can affect the desired number of children parents must have to secure their protection objective. q, the probability that a child will not support you (not be there, not be willing, or not be able), can fall with the child's income. This explains why people in richer countries will need to have fewer children to secure protection, and conversely why they need to have more in poorer countries. q can rise with loss of a child's sense of responsibility toward parents. If social change or migration implies a loss of family values toward aging parents, then parents need to have more children to achieve their protection objective. Parents may not be able to predict future declines in child mortality, implying permanence of large families for protection, larger than needed.

$\bar{P}$ can also change, affecting n. If parents are more risk averse, perhaps because they are poorer, their target $\bar{P}$ rises, and so does n. If parent's own mortality risk declines, longer life expectancy can raise $\bar{P}$. And if other sources of protection become available, such as public social assistance programs, $\bar{P}$ falls, and so does the required number of children.

iii) *A child is a source of satisfaction*. Children have been compared to "durable consumer goods" (Blake, 1968). They provide utility to parents in many different ways, and compete in the household's budget constraint with other goods and services. There are important trade-offs between quantity and quality of children, with a choice to be made between a larger number of less educated children and a smaller number of better educated ones.

Reduced child mortality also contributes to the shift in satisfaction from quantity to quality. This is because a longer life expectancy encourages higher investment in child quality as the payoff on this investment is enhanced. Jayachandran and Lleras-Muney

(2009) analyze how the sudden drop in maternal mortality in Sri Lanka between 1946 and 1953, extending the life expectancy of girls as maternal mortality was a major killer of prime-age women, increased girls' education relative to boys' more in districts with larger maternal mortality declines. They find that for every extra year of life expectancy, literacy increased by 0.7 percentage points (2%) and years of education increased by 0.11 years (3%).

Hypotheses on total fertility rates: Price and income effects

The total fertility rate is determined by the demand for children. How does this demand vary with income? The empirical regularity we observe is that the TFR declines as income rises. An inferior good is one the consumption of which declines as consumer income rises. Bologna, frozen dinners, and canned goods are the classical examples. Does this mean that children are inferior goods? Hopefully not.

The answer to this puzzle was provided by Gary Becker (1981). It comes from a price effect as income rises: better-off parents prefer higher quality and hence more costly children (in terms of health, education, access to material goods, asset endowments, etc.), implying that observed demand declines with income through the price (cost) effect. An important component of the price effect is the rise in the opportunity cost of parents' time spent in raising children as income rises. In Figure 11.6, we see that an income effect increases the demand for children. Children are normal goods. However, the rise in the price of children associated with quality reduces the magnitude of this income effect (Figure 11.7, Panel 1). There may additionally be a change in tastes, whereby the consumption of other goods is increasingly preferred to having more children. This further reduces the demand for children (Panel 2). Finally, the price of consumer goods typically falls with technical progress and trade opening, further contributing to a decline in the demand for children (Panel 3). The net effect of rising income (positive), and rising price of children, changing tastes, and falling prices for consumer goods (all negative) may well be a decline in the demand for children as income rises.

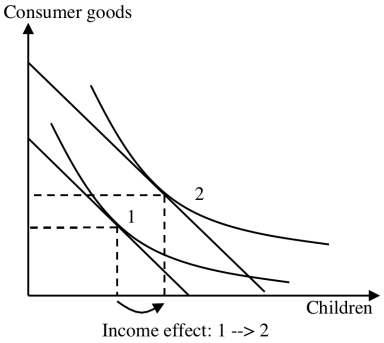

Figure 11. 6. Income effect on the demand for children

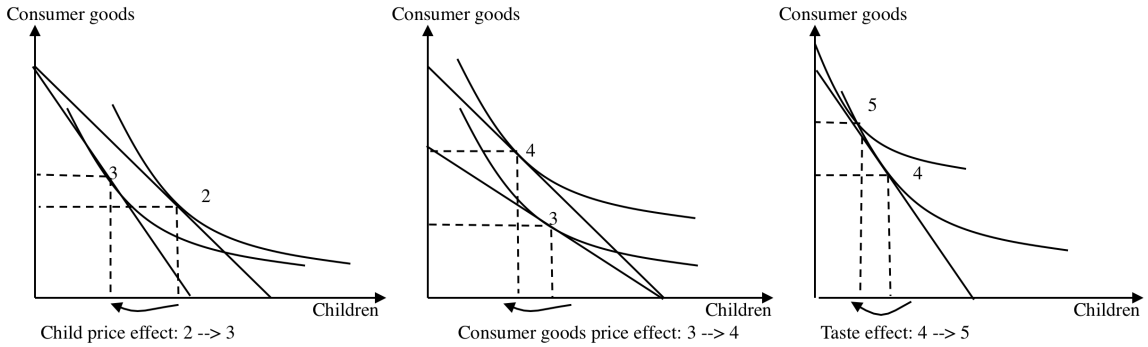

Figure 11.7. Child price, consumer good price, and taste effects on the demand for children

This net effect is illustrated in Figure 11.8. The demand for children increases as a function of income. Children are normal goods. However, as income rises, so do the price of children and the taste for child quality, shifting the income function downwards. If this price and taste effect is sufficiently large, the net effect is a declining observed demand for children, making them look like inferior goods.

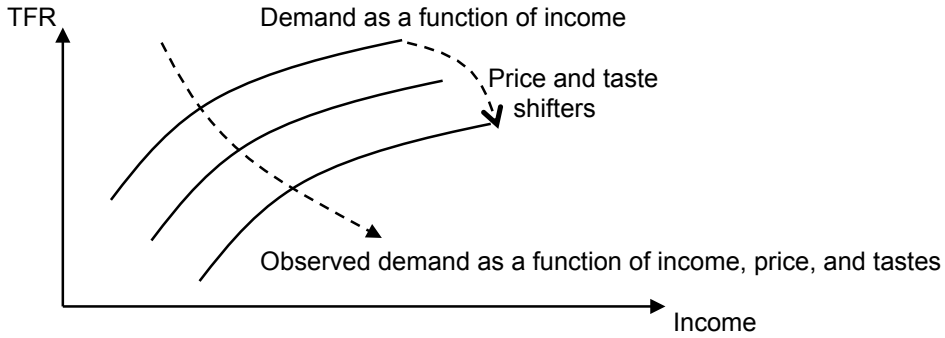

Figure 11.8. Children as normal goods

We can now return to the regularity of the demographic transition described in Figure 11.4 and ask what was the main determinant of the fall in birth rates that triggered demographic transitions? There are two main potential determinants: rising incomes that induce a change in fertility decisions following the Becker hypothesis of a price effect coming from the opportunity cost of raising children and change in the demand for children from quantity to quality that rise with income.

Galor (2010) shows that demographic transitions occurred across Western European countries at the same time starting in 1870 even though they had very different levels of per capita income. By then, England was much richer than France and Germany, yet all had sharply declining birth rates. What happened, at that time, that was common to all countries was technological progress that increased the demand for human capital. This in turn shifted the demand for children from quantity to quality. The result was a decline in fertility rates and demographic transitions. According to Galor, the impact of technological change on the demand for child quality was thus the key determinant of fertility declines and transitions to sustained growth, not income effects.

In the current period, the observed demand for children also shifts downward with the availability of contraception. This is because the availability of contraceptive devices reduces unwanted fertility. As supply-side contraception programs in Bangladesh have demonstrated, this shift in demand induced by supply-side availability of cheap and safe contraception can have a large effect on TFR even as income remains low. In that country, the TFR fell from 6.3 in 1975 to 3.4 in 1994, largely as a consequence of increased availability of contraception (Kanti, 1997). This is illustrated in Figure 11.9 where supply-side programs shift downward the demand for children from actual (without contraception) to desired (with contraception), bringing down the TFR. Demand-side programs in turn allow to travel along the downward sloping desired demand as GDPpc rises.

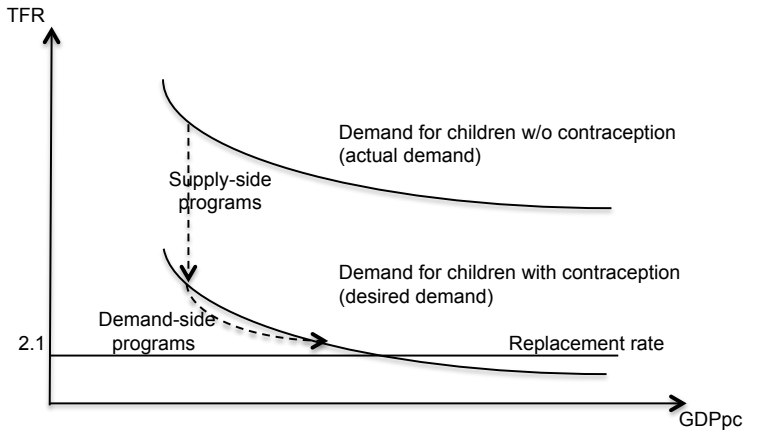

Figure 11.9. Effects on TFR of supply-side and demand-side contraception programs

Does the supply side matter? Across countries, we can observe in Figure 11.10 a strong negative relation between availability of contraceptive methods and TFR. This would suggest that supply-side policies are important in bringing down the fertility rate. However, this is just a correlation, with no implication about causality between contraceptive prevalence and TFR. This is because causality can run on the supply side (availability of contraception brings down the TFR, as expected in Bangladesh) as well as on the demand side (demand for low TFR induces the plentiful availability of contraception, as for example in Western Europe). There is also spurious correlation with many determinants of both access to contraception and fertility such as per capita income, education of women and men, and the degree of urbanization of the population. Reading causality in Figure 11.10 would simply be wrong. We need to rely on randomized control trials or on natural experiments with the rollout of contraceptive devices over time and space to resolve the causality problem.

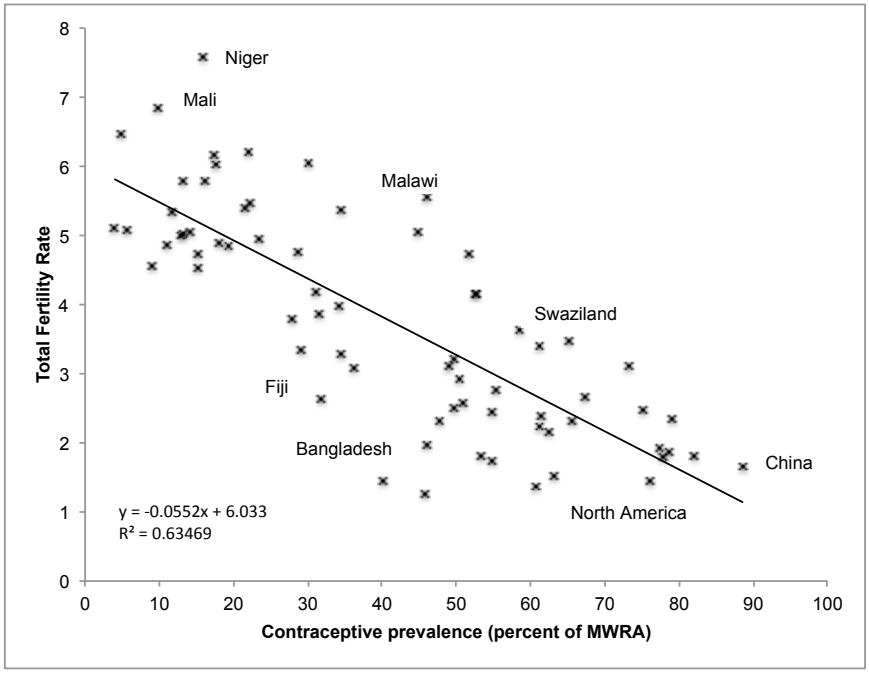

Figure 11.10. TFR and prevalence of contraceptive use across countries, 2012-2014
MWRA is Married Women of Reproductive Ages
Source: World Bank, World Development Indicators, on line

Miller (2010) used the rollout of the PROFAMILIA family planning program in Colombia as a natural experiment to identify the role of the supply side of contraception on fertility. He finds that family planning services were responsible for only 10% of the decline in fertility during Colombia's demographic transition. Most of the action on TFR was thus on the demand side. Availability of family planning services was however important in helping young women postpone the age of marriage and achieve substantially higher levels of education and participate more to the labor force. Using the rollout of the Green Revolution in India as another natural experiment, Rosenzweig (1990) similarly finds that availability of family planning programs to reduce the cost of fertility control made only a small contribution to the decline in fertility compared to demand-side effects.

Another source of doubt about the role of the supply side in bringing down the TFR is that the European countries achieved their demographic transitions without access to modern contraceptive methods. Demand for low fertility and use of traditional methods may thus suffice. However, this may be at a considerable utility cost in meeting the desired demand for children, and take a long time to achieve the necessary cultural change, both of which are reduced by availability of contraception. But this experience also suggests that the demand-side may, overall, be the main determinant of a decline in TFR.

We can conceptualize how changes in the determinants of desired demand for children lead to a demographic transition. We argued that children are sources of income, insurance, and satisfaction for parents. These three determinants of desired demand

change as income rises and as other transformations occur such as urbanization, rising economic opportunities for women and their empowerment in fertility decisions, and the rising role of education in securing a child's future success. A demographic transition would then be associated with the following changes in the functions of children:

Children lose their function as a source of income for parents.

Children lose their function as a source of insurance for parents.

Children never lose their function as a source of satisfaction for parents, but quality of children is increasingly valued over quantity, leading to a decline in TFR through a price and taste effect.

These three negative effects on the demand for children induce a decline in birth rates, and a demographic transition where low birth rates finally catch up with low death rates. We explore these three effects in what follows.

V. Economic determinants of desired total fertility

In the following, we attach signs to the variables that can be expected to determine the importance of the three functions fulfilled by children that affect the desired TFR. There exists a large empirical literature that relates TFR across households to determinants of fertility behavior, classified here between satisfaction, income, and insurance.

1. Satisfaction function of children

The price and income effects derive from the analyses of Gary Becker (1981) at the University of Chicago; the role of culture from the work of Richard Easterlin (1967) at the University of Southern California.

Sign on TFR	Determinants
+	Parents' income (children are not an inferior good) = income effect (Blake, 1968)
–	Child quality (which increases with income) = direct price effect (Becker, 1981)
–	Consumption of other goods and services (which increases with income) that compete with expenditure on children = cross-price effect
–	Opportunity cost of parents' time (which increases with income, and also with opportunities for women to work, female education, and urbanization) = price effect
+	Culture of large families (machismo, religious values). Cultural norms reflect both the current and past economic value of children, creating a path dependency effect (Easterlin, 1967). People may also lag in processing information on the decline in death rates that would lead them to have fewer children.

2. Income function of children

Sign on TFR	Determinants
+	Opportunities for child labor: on-farm work, employment in rug and brick factories, absence of child labor laws, culture of child labor (Basu and Van, 1998), no compulsory education laws or lack of enforcement
+	Easy substitution of parents' labor by child labor: children as suppliers of z-goods (fetching water and firewood), herding animals, care of younger siblings by older girl
+	Direction of inter-generational income transfers goes from young to old: Remittances, intra-household transfers, care of elderly parents (Lee, 1990)
+	Children are used to compensate for market failures in credit (for example through remittances),

	provide parents with residual claimant labor (which is cheaper and more trusted than hired labor that requires supervision, Wydick (1999))
–	Autonomous income gains (randomized cash transfers to young girls in Malawi) lower fertility rates (Baird et al., 2011)
–	Technological change (rollout of the Green Revolution in agriculture) increases the return to investment in human capital. This induces more investment in schooling (quality effect) and lowers fertility (Rosenzweig, 1990)
–	Farm size, mechanization, use of enclosed fields for grazing animals, private property rights (instead of community allocation of land according to need) reduce the income function of children

3. Insurance function of children

Sign on TFR	Determinants
+	Threats of violence and expropriation: children help protect against physical insecurity, against expropriation from slum dwellings without property rights.
+	Children to compensate for market failures in insurance and to deficits in access to social safety nets programs
–	Access to social security programs (contributory pensions), access to insurance services (flexible credit, health and life insurance), and access to social assistance programs (non-contributory pensions, social safety nets). Increased security of property rights (Field, 2003)

Increased investment in the quality of children can come from longer life expectancy that increases the present value of returns in educational investments. This was studied by Jayachandran and Lleras-Muney (2009) in Sri Lanka in the 1946-53 period when there was a rapid decline in the maternal mortality rate (MMR) due to greater availability of health care and improved transportation to hospitals for delivery. At that time the TFR was 5 and the lifetime risk of a woman dying in childbirth was 9%. The MMR declined from 1.8 per 100 live births to 0.5, implying an increase in life expectancy at age 15 of 4.1%. Investing in the human capital of girls was thus significantly increased. Since boys were not affected by this change, they serve as a control for the increase in life expectancy for girls. The authors use a triple difference approach by districts (some benefited by the health improvements and others not), time (before and after the MMR decline), and gender (girls as treatment vs. boys as control). The individuals considered treated are girls aged 2 to 11 in 1946 whose educational achievement could thus be affected by the gain in life expectancy. Results show that for every additional year of life expectancy, girl literacy increased by 2% and years of education by 3%.

VI. Population policy

We now turn to normative analysis: how can population policy be designed to affect the TFR? There are two contrasted situations according to whether the current level of population growth is seen by policy-makers as a positive or a negative factor in their development program. As seen in Figure 11.11, parents decide on their optimum number of children by equating the private marginal cost (slope of the private cost function) and the private marginal benefit (slope of the benefit function) of a child. If there are no externalities to child bearing (i.e., all cost and benefit implications of this additional person are either borne by the parents or transmitted to society through markets), the

private optimum fertility decision coincides with the social optimum. If there are positive externalities from having children, the socially optimum family size is larger than the private choice. If there are negative externalities, it is lower. In the first case, policy-makers may want to use policy instruments to increase the TFR, in the second to decrease it (Lee, 1990). We consider each in turn.

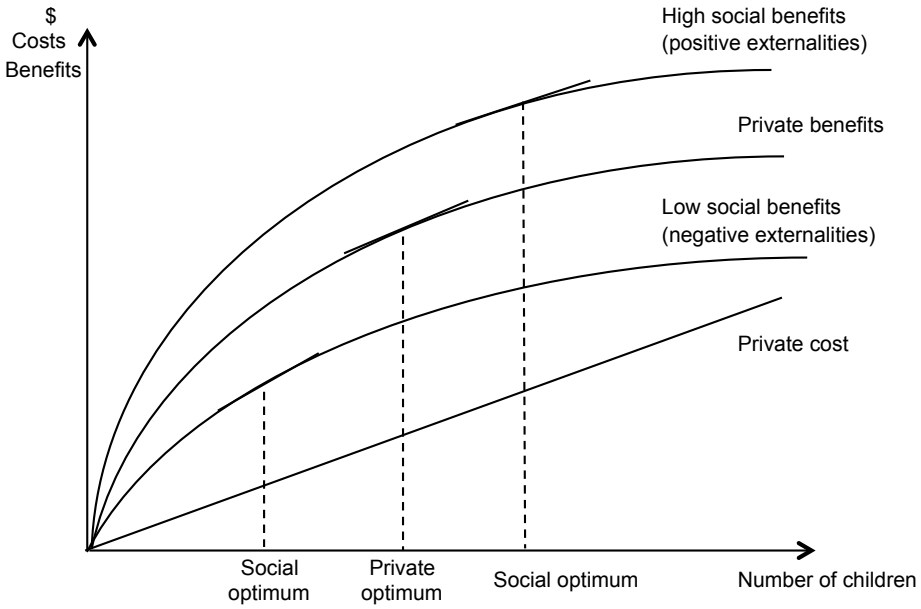

Figure 11.11. Private and social benefits and fertility decisions

6.1. Policies to increase the TFR

This is the case when social benefits from children exceed private benefits, and policy makers act on behalf of the social good. Parents have fewer children than socially desirable, and population policy has the objective of increasing the TFR. Many Western European countries have introduced pro-birth policies to induce parents to have larger families.

Reasons why a higher TFR may be seen as socially desirable include the following: the need for a faster growing labor force to sustain a higher GDP growth rate when there are restriction on international migration, empty or underused geographical areas that can be settled (e.g., the Brazilian Amazon under the military regimes), cost spreading of public goods such as infrastructure (e.g., in the Democratic Republic of the Congo, with vast empty spaces that are highly costly to connect), national defense requiring more soldiers and economies of scale in defense expenditures, increase in the domestic market size, and social-security with pay-as-you-go becoming increasingly costly due to population aging (as in Western Europe and the United States). Inter-generational transfers through public expenditures on health, education, and pensions create large positive externalities in the industrialized countries.

Policy instruments are designed to create private incentives for parents to have more children. These transfers are justified as a way to internalize in parents' choices the positive externalities that an additional child generates. They include cash transfers to large families such as family allowances in Western Europe, and other rewards such as lower prices paid in using public services for parents with larger families. An effective way of inducing parents to have more children is also in helping reconcile work and family-raising for women through the provision of public or subsidized child care facilities.

6.2. Policies to decrease the TFR

This is the case when the social benefits from an extra child are lower than the private benefits. An additional child creates a gain for the parents but a negative social externality. Family size is larger than socially desirable, and population policy has the objective of reducing the TFR. Family planning programs, focusing both on increasing the supply side of contraception and on reducing the desired demand for children have this objective.

Reasons to desire a lower TFR include the following:

- A high population growth rate reduces the per capita income gains from GDP growth through the "population tax" we saw in Chapter 2, State of Development.
- There exist large reservoirs of rural surplus labor, contributing to continued poverty in spite of industrialization and growth. Population growth postpones the Lewis turning point in the classical dual economy model that we saw in Chapter 8, Explaining Economic Growth. Real wages will not start rising with growth until surplus labor has been eliminated.
- High youth dependency ratios result in low savings rates, postponing the growth benefits of a "demographic dividend" discussed earlier in this chapter.
- It is difficult to meet the public goods needs of a rapidly growing population in health, education, infrastructure, and housing
- There are congestion externalities in urban environments such as over-crowded slums and traffic jams that will be discussed in Chapter 12, Labor and Migration.
- Environmental stress associated with population density leads to lower growth and high negative externalities on wellbeing such as air and water pollution that will be discussed in Chapter 15, Sustainable Development.

As seen in Figure 11.9, policies to decrease fertility can focus on both the supply and the demand sides of fertility decisions. We consider them in turn.

1) Supply side population policies

They consist in increasing the availability of contraception and reducing its price if there is a gap between actual and desired demand for children. This is the approach that was effectively pursued in Bangladesh. Justification for a subsidy to family planning services is that there are positive social externalities from smaller family sizes. Targeting the

subsidies on the poor is additionally justified by existence for them of a liquidity constraint in accessing contraception.

Pritchett (1994) analyzes empirically whether the TFR across countries is explained by the gap between actual and desired fertility (that can be reduced by increased availability of family planning services) or by desired fertility that dictates the number of children a woman will have. He finds that unwanted fertility plays only a minor role, and that fertility desires explain 90% of observed differences in fertility outcomes. High fertility is thus explained almost completely by a high desire for children. The correlation between contraceptive prevalence and TFR observed in Figure 11.10 may not run causally from contraception to TFR, but from desire for low fertility inducing a supply of contraceptive services. Reducing fertility thus requires first and foremost reducing fertility desires (demand side), only secondarily reducing unwanted fertility (supply side).

2) Demand side population policies

They consist in inducing households to decrease their desired demand for children. There are three main instruments for this.

- The first is to decrease poverty (Mamdani, 1972). This is because rising incomes decrease demand for the income and security functions of children, and shift the satisfaction function of children from quantity to quality. Based on this logic, anti-poverty programs create the side benefit of potentially reducing the TFR. Using an RCT approach, Baird et al. (2011) find that cash transfers reduce fertility through the channels of extended schooling, reduced teenage pregnancy, and postponement of age of marriage.
- The second is to increase the effective price of children by offering parents a trade-off with other benefits:

One option is to offer a higher quality-quantity trade-off in raising children. This derives from greater opportunities for parents to invest in the quality of their children, for instance through access to higher quality education. Another option is when better health services contribute to extending the life expectancy of children, reducing the demand for larger numbers and also increasing the value of investing in child education (Jayachandran and Lleras-Muney, 2009).

Female education, changes in women's reproductive rights, and increased employment opportunities for women also have powerful effects on fertility decisions. Many of these benefits come with urbanization. In all cases, they raise the opportunity cost of child rearing. Using distance to a university as a determinant of access to education, Currie and Moretti (2003) find that better educated women tend to have better cared for babies. Using a natural experiment in India where a large Indian textile firm changed workers contracts from fixed-term to daily employment, Sivasankaran (2014) finds that longer duration of employment under fixed-term contracts had the effect of inducing delayed marriage and reduced desired fertility.

- Finally, improved social services such as social protection and social assistance also reduce the demand for children in their insurance function.

The role of culture in shaping the demand for fertility

Fertility demand can also be influenced by changing parents' perception of benefits from smaller families. Total fertility rates have declined rapidly in Brazil--from 6.3 in 1960 to 1.9 by 2010--with very little government intervention. Preferences for smaller families developed thanks in part to declines in child mortality and changes in women's opportunities. However, culture also played a role. The popularity of television soap operas (*telenovelas*) featuring families with only 2 children seems to have played a large role in changing fertility desires. To show this, La Ferrara, Chong, and Duryea (2012) use as an identification strategy differences in the timing of entry of Rede Globo into different regional markets, the network with a monopoly on telenovelas. Using Population Census data for the period 1970-1991, they find that women living in areas covered by the Globo signal had significantly lower fertility. They also find that the effect was strongest for women of lower socioeconomic status and for women in the central and late phases of their fertility cycle, consistent with the decision on stopping behavior.

Mini-dramas for radio, television, and movies were also used in Bangladesh to appeal to and change opinions of male audiences regarding family planning, including a soap opera that was written specifically to glamorize the role of family planning outreach workers (Manoff, 1997). The Bangladeshi family planning program was a resounding success, reducing TFR from 6.3 in 1970 to 2.7 in 2007. Though the program included significant supply side interventions, including many new clinics and thousands of outreach workers, the role of media in changing fertility desires was indispensable.

Demand can also be affected by a change in intra-household bargaining between wife and husband over the use of contraception. Ashraf, Field, and Lee (2014) used a randomized control trial in Zambia to test whether is it useful to involve men in decision-making regarding the use of contraception. They contrast a treatment where both husband and wife are offered access to injectable hormonal contraception to one where the woman alone is made the offer. This form of contraception is perfectly observable only to the woman as it is a one-time event that she can experience alone. They find that getting men involved reduced demand for contraception by 19% and increased the likelihood of giving birth by 27%. Allowing women alone to gain access to concealable contraception is thus a better approach to reducing excess fertility. They find, however, that this had a long term cost on harmony of the household, with more mistrust and tensions in the household, and lower happiness and health for the woman, as a psychological cost of making contraceptives concealable by the woman. Giving some control to men over contraceptive decisions may thus lessen the marital tensions created by moral hazard in the use of unobservable contraceptive methods.

3) Reconcile social objectives and private rationalities

One of the most difficult aspects of population policy to lower TFR is in aligning social optimality and private desires for children. In some countries, this has been done coercively (Sinding, 2007). China, with the largest population in the world, imposed in 1979 the one child policy enforced by social sanctions attached to having a second child, such as monetary fines, loss of job, and loss of access to public services. As coercion is

now being relaxed, allowing couples to have two children if one parent was an only child, it appears that the high cost of children, with an extraordinary premium on quality, may not result in a return to larger families. India under Indira Gandhi also used coercion in 1976, with loss of access to public services for larger families and forceful sterilization on the poor beyond a threshold family size. This policy was violently opposed and could not be sustained. In Indonesia under Suharto, couples refusing to comply with family planning and birth limits faced restrictions on access to micro-credit, loss of education subsidies for civil servants, and even forced trans-migration to rural areas.

Most countries are seeking to reduce the gap between actual and desired demand for children through more effective supply-side policies and through incentives on the demand side. Increased availability of contraception can be quite effective if the gap is large. Bangladesh was successful in reducing demand without income change. Most importantly, countries that want to reduce the TFR are seeking to reduce the desired demand for children. Income and price effects, as well as changes in the culture of large families and information on reduced child mortality, offer a broad range of policy instruments for this purpose. In the late 1970s and early 1980s, Bangladeshi women received cash payments as reimbursements for sterilization procedures, an approach that has, however, been criticized in the context of extreme poverty limiting a woman's actual wishes.

A stalled fertility transition in Sub-Saharan Africa?

In 1950, there were two Europeans for every African. If present trends continue, there will be two Africans for every European by 2050. Comparing African countries to other countries when they were at the same stage of fertility transition (such as Asian and Latin American countries during the 1970s), TFRs are comparable, but the recent pace of fertility decline is slower. Many African countries seem to have stalled, with TFRs stuck at 5. The reason for the stall may be twofold: (1) Africans have larger ideal family size than was observed in other countries at this stage of transition, and (2) despite large ideal family size, unmet needs for contraception remain high. It is likely that both demand side interventions to change ideal family size and supply side interventions to increase the availability of contraceptives will be required for the African fertility transition to progress (Bongaarts and Casterline, 2013).

VII. Other issues in population and development

1. The debate on "missing women"

The ratio of men to women is expected to be about equal to 1. It is in fact a little higher for boys, reaching 1.05, but this is compensated by a slightly higher infant mortality for boys, bringing the natural sex ratio to about 1. In Western countries, the ratio of men to women is 1. In recent history, this has not been the case in several Asian countries. The ratio is 1.07 in China, 1.08 in India, and 1.11 in Pakistan. This deficit of girls has been attributed to the recent availability of ultrasound diagnostics that help reveal the sex of the child before birth. Boy preference, enhanced in China by the one-child policy, induces abortions that can now be selective against girls. Excess mortality of young girls

can also be due to purposeful neglect. Boy preference is associated with the differential role that boys are expected to play in earning income and receiving inheritance, while girls are burdened with the need to be provided with expensive dowries at the time of marriage. Sen (1992) thus estimated that there are some 60 to 100 million "missing women" in Asian countries. Bardhan (1974) finds rationality for selective girl neglect by comparing Northern to Southern India: the imbalance in sex ratios is high in the North, but small in the South. In the North, wheat is mechanized and requires largely heavy manual labor provided by males; in the South, rice is transplanted and harvested manually and intensive in female labor. This difference creates better employment and earning opportunities for women in the South, suggesting an explanation to the observed sex imbalances. Missing women are thus not due to biological factors but to adverse economic incentives ingrained in cultural norms.

Missing women may create an unexpected incentive effect, affecting economic growth. Columbia professor Wei (2011) argued that fierce competition among men on the marriage market has been a powerful incentive to effort, risk-taking, saving, and investment. He uses an instrumental variable approach to households' demographic status by exploring regional variations in the financial penalties for violating official birth quotas and in the proportion of the local population that is legally exempted from the family planning policy. According to him, imbalance in the sex ratio may have added as much as 2% to China's annual GDP growth.

2. Sibling rivalry

If parents face constraints in the time or financial resources available to them to spend on their children's education and health, and if there is a preference for boys, then the demographic composition of the household will affect investment in human capital for each child (Morduch, 2000). At any given number of siblings, the investment in human capital will increase with the percentage of sisters a child has, both boy and girl. Boys compete with other boys for resources, and girls compete with boys. As a consequence, both genders benefit from having less other boys in the family. The best environment for human capital investment in girls is a family with girls only. For investment in boys, it is a family with sisters only.

Note that if there are positive spillover effects from boy consumption, then a girl may benefit from having a brother. This would be the case for the consumption of household public goods, as opposed to private goods. Vaccination may be such a case, where taking her brother to be vaccinated may increase a sister's likelihood of being vaccinated as well (Jones, 2014).

There is also an interesting family size effect on girls (G) when there is boy (B) preference. Couples will stop having children once they have had a boy, but continue to have more until they have one. Family compositions will then be: B, GB, GGB, GGGB, etc. You can see that this implies that girls are in larger households than boys. If child welfare declines with family size, then boy preference implies that girls are on average in larger households and with less access to household resources than boys.

These examples show that demographic composition matters for child welfare outcomes in ways that are easy to observe and eventually quite important.

VII. Concepts seen in this chapter

Crude birth and death rates
Population growth rate.
Total fertility rate (TFR)
Life expectancy at birth
Doubling time
Population pyramid
Demographic dividend
Pay-as-you-go in Social Security
Demographic transition
Malthusian population trap
Income function of children
Insurance function of children
Satisfaction function of children
Becker quantity-quality tradeoff in the demand for children
Population policy: supply side vs. demand side
Boy preference and missing women
Sibling rivalry

VIII. Review questions: Population and development

1. Define the total fertility rate (TFR).
2. Explain the phenomenon of a "demographic transition". How does it help explain rapid population growth in particular historical periods?
3. Explain the phenomenon of the "demographic dividend". How does it come about and what potential advantages does it offer for growth?
4. Determinants of fertility behavior: what roles for the economic, insurance, and satisfaction functions of children in explaining the TFR? How do these roles change through the demographic transition?
5. What are the relative roles of supply of contraception and demand for children in determining observed total fertility rates?
6. How does Becker explain the demand for children? Are children inferior goods? How do price effects come about? Explain the quantity-quality trade-off in the demand for children and how this affects the TFR.
7. If population growth is judged excessive, what can be done to reduce it? Distinguish between supply-side and demand-side interventions.

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