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Chapter 2

1) In mid-2010 the world population was estimated to be 6.89 billion, with the population of sub-Saharan Africa estimated to be .85 billion. Assuming that the world population grows at the annual rate of 12 per thousand, while the population of sub-Saharan Africa grows at an annual rate of 25 per thousand (the annual average population growth rates for the 2000-2010 period), when would the population of Sub-Saharan Africa constitute 50 percent of the world total? At that time (the nearest year), what would be the size of the world population? Discuss whether you think this is likely to happen.

A: The populations of sub-Saharan Africa (P_{SSA}) and the world (P_W) projected for year T are respectively: $P_{SSA} = .85e^{.025T}$ and $P_W = 6.89e^{.012T}$. Setting $P_{SSA} = .5P_W$ and solving for T gives T = 107.7 or approximately 108 years. In the year 2118 the projected populations of sub-Saharan Africa and the world would be respectively 12.6 billion and 25.2 billion.

This is unlikely to happen due to sub-Saharan African countries, like other regions of the world, completing their demographic transitions and reducing fertility rates to replacement level or even below. Moreover, the carrying capacity of the world is likely to be well below 25.2 billion. The world population is expected to stabilize at below 10 billion by the end of the twenty-first century.

2) Given the 'iron law of wages' model below, where the crude birth rate (CBR) and crude death rate (CDR), expressed per thousand mid-year population, are respectively increasing and decreasing functions of real per capita income (y), CBR = 10 + .06y and CDR = 50 - .04y, and the Z schedule, representing the trade-off between population size, P (in thousands) and real per capita income: P = 200 - 0.2y:

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a) On two separate graphs, plot the CBR and CDR schedules and the Z schedule and determine the equilibrium levels of subsistence real per capita income, y_0 (where the crude rate of natural increase is zero) and population size, P_0.

b) Find the impact of a mortality shock, e.g., a plague, that raises the CDR schedule to: CDR' = 60 - .04y, on population and per capita income. What would be the long run equilibrium after the mortality shock has passed? Explain.

c) Find the impact of technological progress, e.g., an increase in agricultural productivity, that raises the Z schedule to: P' = 210 - .2y, on per capita income. What would be the long run equilibrium with the technological progress? Explain.

A: a) The CBR and CDR curves intersect at $y_0 = 400$ where the $CBR_0 = CDR_0 = 34$. From the technology curve, the equilibrium population is $P_0 = 120$.

b) With the mortality shock, at $y_0 = 400$, the CDR' = 44, so the CRNI' = -10. The population declines to P' = 110, which raises per capita income to y' = 450. At this higher level of per capita income, the CBR rises to $CBR_1 = 37$ and the CDR, after the mortality shock passes, is $CDR_1 = 32$. With the positive CRNI, population grows back to $P_0 = 120$, and per capita income declines back to subsistence level, $y_0 = 400$, the long run equilibrium.

c) With technological progress, at $P_0 = 120$, per capita income rises from $y_0 = 400$ to y" = 450. With per capita income above subsistence level, the CBR increases to $CBR_1 = 37$, while the CDR decreases to $CDR_1 = 32$. The positive CRNI increases population to $P_2 = 130$, reducing per capita income back to the long run equilibrium of $y_0 = 400$.

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3) Discuss why in the demographic transition model it is intuitive that mortality rates would decline before fertility rates. Even so, in France during the early nineteenth century, it appears that mortality and fertility rates declined concurrently. Discuss possible explanations.

A: Given that in the traditional stage of the demographic transition high and volatile crude death rates are largely offset, on average, by high and somewhat less variable crude birth rates, yielding minimal population growth, if the crude birth rate significantly declined before the crude death rate, then the population would diminish in size. Such depopulation wouldn't last for very long. There would be little motivation for reducing fertility when mortality rates were equally high. Moreover, in traditional societies, improved mortality would likely precede lower fertility, if parents were seeking a desired number of surviving sons. If birth rates do fall and birth intervals increase, however, infant mortality rates would likely decline with improved health and care for those children born. Maternal mortality rates would likely also decline with fewer pregnancies and child births.

4) If the logistic curve mirrors the historical trend in population growth, what would happen if there were a fourth stage to the demographic transition, where crude birth rates fell below crude death rates? Do you think this is likely? Discuss.

If there were a fourth stage in the demographic transition with negative crude rates of natural increase, would there then have to be a fifth stage? Discuss.

A: If below level fertility rates were maintained for some time, there would be natural depopulation, and unless offset by net in-migration, populations would decline. Some European nations, particularly the former transition economies of Eastern Europe and the Soviet Republics, already are experiencing negative crude rates of natural increase. All the developed

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nations and an increasing number of developing nations are below replacement level fertility. If enough countries fall below replacement level fertility for long enough, then the population growth through positive population momentum in the rest of the developing nations could be offset and the world population would decline in size. The logistic curve would bend downwards, reflecting a fourth stage of the demographic transition. This may well happen in the latter part of the twenty-first century, but then it is likely that the world population would return to replacement level fertility, the long run equilibrium of zero population growth in a final fifth stage of the demographic transition, where the logistic curve of the world population would level off again.

5) If the contemporary developing nations had not experienced the significant declines in mortality largely due to imported medical technologies and disease control in the middle of the twentieth century, what might have been the consequences for the world population at the beginning of the twenty-first century?

A: The demographic transitions of the developing nations would have been delayed and the world population would be significantly smaller at the beginning of the twenty-first century. Moreover, with the advances in contraception and family planning programs that have occurred over the last half century, it is likely that the fertility transitions the developing nations then experienced might have been accelerated and sharper, so that the rapid population growth set off by the declines in mortality during the transition stage would have been less.

6) Do you think in the long run a zero rate of population growth for the world is inevitable? Explain why or why not. If so, would or should all the nations of the world have a zero crude rate of natural increase?

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A: If there is a carrying capacity for the earth, then in the long run a zero rate of population growth for the world seems inevitable. Nevertheless, this need not imply that all nations have replacement level fertility. Allowing for international migration could offset any national crude rates of natural increase that were not zero. The world's population is not, and need not be, evenly distributed across the nations of the world.

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Chapter 3

1) Given two countries, France and Italy, and two goods, cheese and wool, with the following unit labor costs:

	labor hours per unit of output	
	cheese (C)	wool (W)
France	4 hours	12 hours
Italy	3 hours	6 hours

Assume constant costs of production.

a) Determine the absolute and comparative advantages in the production of cheese and cloth.

b) If the international terms of trade were 1C = .4W (or 1W = 2.5C), determine the gains from trade (per unit of the export good traded) for France and Italy.

c) If France has 900 hours of labor and Italy has 600 hours of labor available each day, sketch the production possibilities boundaries for the two countries. What are the slopes of the production possibilities boundaries? Given the international terms of trade of 1C = .4W, sketch the consumption possibilities boundaries of the two countries. What are the slopes of the consumption possibilities boundaries?

d) If in autarky, France were producing (and consuming) 100 units of cheese, how much wool could it produce? If in autarky, Italy were producing (and consuming) 96 units of cheese, how much wool could it produce?

e) Given the autarkic or pre-trade productions and consumptions, and assuming complete specialization in production with trade, suppose France exports half of its comparative advantage good. Find the gains from trade for France and Italy.

f) How would the above analysis change if the international terms of trade were instead:

1W = 2.4C?

g) When would trade not take place between the two countries? Why not?

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