4

Toward Order and Efficiency

The Recent Demography of Europe and the Developed World

4.1 From Waste to Economy

In 1769 James Watt built a steam engine with a separate condenser. Compared to the earlier Newcomen engine, which was used to pump water out of mines, Watt's design increased efficiency enormously: in order to produce the same power, Watt's engine consumed one-quarter the fuel of its predecessor, saving the energy wasted to reheat the cylinder after each piston stroke. This saving was decisive in determining the important role the steam engine would play in all sectors of the economy.[1]

During the nineteenth and twentieth centuries, western populations underwent a similar process. Previously, slow growth was accompanied by considerable demographic waste. Women had to bear half-a-dozen children simply in order to achieve replacement in the following generation. Between one-third and one-half of those born perished before reaching reproductive age and procreating. From a demographic point of view, old-regime societies were inefficient: in order to maintain a low level of growth, a great deal of fuel (births) was needed and a huge amount of energy was wasted (deaths). The old demographic regime was characterized not only by inefficiency but also by disorder. The probability that the natural chronological hierarchy would be inverted – that a child would die before its parent or grandparent – was considerable. High levels of mortality and frequent catastrophes rendered precarious any long-term plans based on individual survival.

The modern demographic cycle in the West passed through all phases of its trajectory during the nineteenth and twentieth centuries: European population multiplied fourfold; life expectancy increased from the range of 25–35 to over 80; the average number of children per woman declined from five to less than two; birth and death rates both declined from values generally between 30 and 40 per thousand to about 10.

A Concise History of World Population, Sixth Edition. Massimo Livi-Bacci.

This profound transformation, an integral part of the social transformation of the eighteenth century, is generally referred to as the "demographic transition," a term that has entered common usage much as has "Industrial Revolution." It is a complex process of passage from disorder to order and from waste to economy. In the developing countries, with which we shall deal in the next chapter, this transition is in process; in the more backward countries it has just begun, while in others it is near completion. Keeping in mind the necessary historical adjustments, the European experience – and that of the West in general – can serve as a useful guide to that which is occurring in the rest of the world. It is this experience that we will now consider in its general outline, attempting to identify common points rather than manifestations peculiar to specific societies and cultures. The latter limitation ignores a rich area of research, but one which it is impossible to include in a synthetic treatment of the type I have proposed.

The strategic space discussed above (see Chapter 1, Section 5, Figure 1.8) is traversed by "isogrowth" curves, each of which represents the locus of points that combine life expectancy (e_0) and number of children per woman (*TFR*) to give the same rate of growth. Historically, populations have occupied an area between the 0 and 1 percent curves, with low life expectancy and a large number of children. We have also seen that this space has expanded greatly in present-day developing countries as rapid mortality decline is often not accompanied by similar declines in fertility, with the result that many of these countries occupy the space between the 2 and 4 percent curves.

For European countries, instead, the transition since the 1800s has taken place without growth-rate "explosions," but rather by means of a gradual and in part parallel modification of mortality and fertility, so that the various populations have occupied a more limited area, generally bounded by the 0 and 1.5 percent curves. Figure 4.1 displays fairly well the area of strategic space occupied by 17 European countries at various times during the nineteenth and twentieth centuries. For each date an ellipse represents the area occupied by these countries. Within a fairly narrow strip, the ellipses move gradually from the upper left (high fertility and mortality) to the lower right (low fertility and mortality). The majority of the area of the 1870 and 1900 ellipses occupies an area between 1 and 2 percent, revealing that period of the demographic transition when the distance between fertility and mortality was greatest. By contrast, the majority of the area of the 1930 and 1980 ellipses is below the 0 percent curve, periods when fertility was below replacement.

As I have already mentioned, the demographic transition had several phases. In order to describe the movement simplified in Figure 4.1 better, it will be useful to consider several aspects: the beginning of both

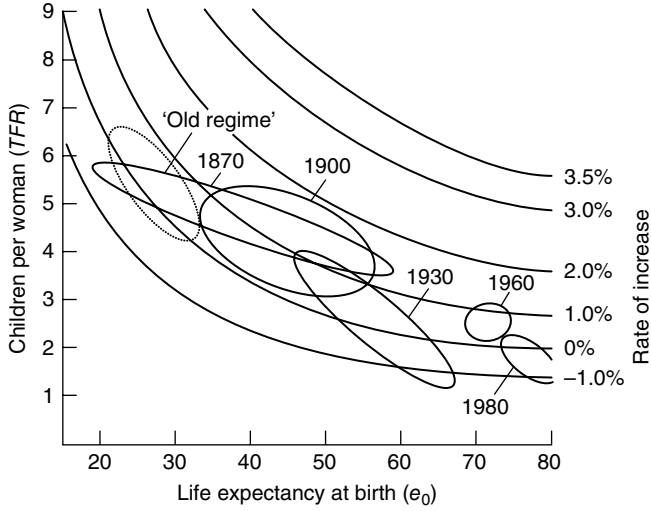

Figure 4.1 The strategic space of growth for 17 European countries (nineteenth to twentieth centuries). *Source*: A. J. Coale, "The Decline of Fertility in Europe since the Eighteenth Century," in A. J. Coale and S. C. Watkins, *Human Demographic History* (Princeton University Press, Princeton, 1986), p. 27. © 1986 Princeton University Press. Reprinted with permission of Princeton University Press.

mortality and fertility decline, the end and duration of the phase of decline, and the maximum and minimum distances between the two variables.

Figure 4.2 presents an abstract model of transition. The beginning of mortality decline generally precedes that of fertility, and during this phase the separation between the two components (the rate of natural increase) reaches a maximum; as fertility decline accelerates and that of mortality slows down, the two curves approach one another again and the natural rate of increase returns to a low level (similar to that at which it began the transition). Implicit in this model is the hypothesis that once fertility and mortality decline have begun the process will continue until low rates are reached, an hypothesis upheld for the most part by European experience.

The duration of the transition, the steepness of the two curves, and the distance between them varied considerably from country to country. Population increase during the transitional phase, a phase characterized by accelerated growth, is a function of these parameters. The ratio between population size at the beginning and the end of the transition may be called the transition "multiplier."[2] In France, for example, the transition began at the end of the eighteenth century and lasted more

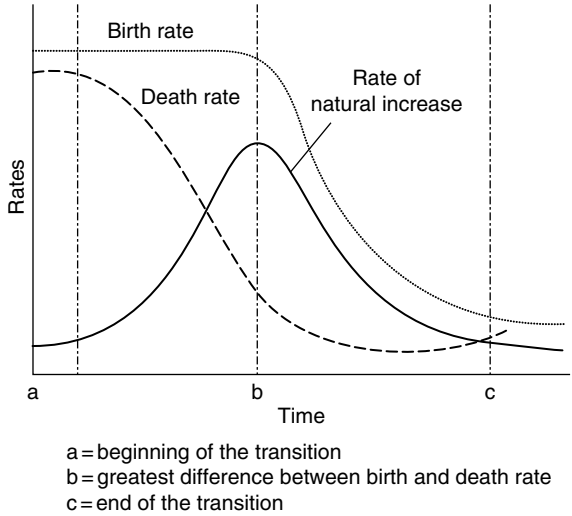

Figure 4.2 Demographic transition model.

than 150 years; mortality and fertility declined in similar, almost parallel, fashion, not diverging greatly from one another in time, and the multiplier was barely 1.6. In Sweden, on the other hand, mortality decline proceeded ahead of fertility decline and the transition was shorter; the multiplier was more than double that of France (3.8). If we want to compare the European experience to that of present-day developing countries, we might choose Mexico and imagine that the transition would have been complete by 2000, having lasted 80 years. Mortality decline came much before fertility decline; natural increase has reached very high levels; and the multiplier was about 7. Table 4.1, borrowed from Chesnais, lists the duration of transition and value of the multiplier for a number of European and, by extrapolation, developing countries. The multiplier tends to be considerably higher for developing countries than for the European ones, with the exception of China, whose population has been controlled by a Draconian demographic policy.

I have intentionally focused on the mechanical aspects of the transition, leaving discussion of the causes until now. The mortality decline that began in the second half of the eighteenth century is generally ascribed partly to exogenous factors, including the reduced frequency of epidemic cycles and the disappearance of the plague; partly to the reduction of famine due to better economic organization; and to sociocultural practices that helped to reduce the spread of infectious diseases and improve survival, especially of infants. Mortality decline spurred demographic growth and so increased pressure on available resources, which in turn

Table 4.1 Beginning and end, duration, and "multiplier" of the demographic transition for several countries.

Country	Beginning and end of the transition	Duration in years	Multiplier
Sweden	1810–1960	150	3.83
Germany	1876–1965	89	2.11
Italy	1876–1965	89	2.26
USSR	1896–1965	69	2.05
France	1785–1970	185	1.62
China	1930–2000	70	2.46
Taiwan	1920–1990	70	4.35
Mexico	1920–2000	80	7.02

Source: J.-C. Chesnais, *La transition démographique* (PUF, Paris, 1986), pp. 294, 301. Reprinted with permission of Presses Universitaires de France (PUF).

led to lower fertility owing to both reduced nuptiality and the spread of deliberate attempts to limit births. Equilibrium was only reestablished at the end of the process of fertility decline, the timing of which depended upon the level of progress of the various populations. The above is an adaptation of the Malthusian model that implies an adjustment of population to available resources by means of a check on reproduction – reproduction being less and less conditioned by biological factors and more and more dependent on individual fertility control, a possibility which Malthus did not foresee.

Widely varying opinion seems to agree that the social transformation associated with the Industrial Revolution induced a change in the fertility choices of couples. In particular, the growth of urban industrial society increased the "cost" of child rearing: children became autonomous wage earners and producers at a much later age than in agricultural societies and required greater "investments," both material and in terms of health-care and education, which deprived the mother, particularly, of employment opportunities. The increased cost of children appears to have been the spur behind fertility control; its progress was made easier by the gradual relaxation of societal control exercised by tradition, institutions, and religion, proceeding in tandem with the economic and social development of European society. Improved communication aided the spread of these practices from city to country, from the upper to the lower classes, and from the more central to the peripheral regions.

In the following sections we shall consider mortality and fertility decline in more detail. Here we can conclude that, as with Watt's steam engine, the energy wasted by the traditional European demographic regime had, by

the second half of the twentieth century, been enormously reduced. In the contemporary "economic" regime, a small number of births are sufficient to compensate for a small number of deaths; and yet, at the beginning of the third millennium, these societies seem no longer inclined to produce even those few births that would maintain demographic equilibrium.

4.2 From Disorder to Order: The Lengthening of Life

In the second half of the eighteenth century mortality began to show signs of decline: life lengthened and the hierarchical sequence of death, dictated by age, became firmly rooted. Out of the disorder of earlier times, owing to random and unpredictable mortality, the processes of life became orderly. Two connected factors essentially explain the earlier capricious nature of death. The first was the frequent and irregular occurrence of mortality crises which, stemming from a variety of causes, slashed away sectors of all ages and classes, seriously upsetting the life of a society. Leaving aside the catastrophes brought about by the plague (the 1630 plague wiped out almost half of the population of Milan; that of 1656 half that of Genoa and Naples[3]), a doubling of the already high number of annual deaths (a frequent enough occurrence) was a traumatic experience for the social body. The second factor was the risk that the natural age-linked and chronological succession of death would be overturned. Ignoring infant mortality – so frequent as to be considered almost normal – the probability that young or adolescent children would die before their parents was high. If we take, for example, French mortality in the mid-eighteenth century (expectation of life at birth was between 25 and 28 years in the period 1740–90), then we can estimate that the probability that a 40-year-old mother would outlive her 10-year-old son over the course of the following 20 years was one in four. With today's low mortality, this same probability is almost insignificant.[4]

If I have emphasized the importance of the introduction of order and regularity – I shall discuss the lengthening of life later – it is because these are essential prerequisites for development: "Perhaps only a society freed from the fear as well as from the material and spiritual consequences of sudden death was able to achieve that high rate of intellectual and technical progress without which population growth could not have been sustained."[5]

The decline in the intensity and frequency of mortality crises, of those sudden and short-term – from a few weeks to a couple of years in the case of a serious epidemic – increases of the normal death rate, constitutes the first aspect of the mortality transition. A wide range of events come under

the general heading of "crisis": the destruction of war, famine, and recurring bouts of epidemic diseases. Figure 4.3 provides an example of the attenuation of crises. The solid line traces the progress of the Swedish crude death rate for the period 1735–1920; the broken lines connect (somewhat arbitrarily) the maximum and minimum values. One can easily make out the progressive narrowing of the band of oscillation and also secular decline. Table 4.2 lists maximum and minimum values, and the

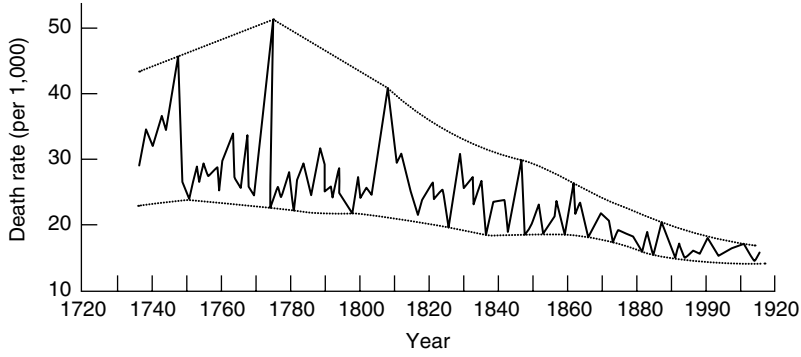

Figure 4.3 Attenuation of mortality swings in Sweden (1735–1920).

Table 4.2 Maximum and minimum death rates (per 1,000) in France and Sweden (eighteenth to twentieth century).

	Sweden			France		
Period	**Maximum**	**Minimum**	**Difference**	**Maximum**	**Minimum**	**Difference**
1736–49	43.7	25.3	18.4	48.8	32.3	16.5
1750–74	52.5	22.4	30.1	40.6	29.5	11.1
1775–99	33.1	21.7	11.4	45.2	27.1	18.1
1800–24	40.0	20.8	19.2	34.4	24.0	10.4
1825–49	29.0	18.6	10.4	27.7	21.1	6.6
1850–74	27.6	16.3	11.3	27.4	21.4	6.0
1875–99	19.6	15.1	4.5	23.0	19.4	3.6
1900–24	18.0	11.4	6.6	22.3	16.7	5.6
1925–49	12.7	9.8	2.9	18.0	15.0	3.0
1950–74	10.5	9.5	1.3	12.9	10.5	2.4
1975–2000	11.5	10.5	1.0	10.6	8.9	1.7

differences between the two, of French and Swedish crude death rates for 25-year periods between the mid-eighteenth century and 1975. The progressive contraction of the range of variation is clear: normally between 10 and 20 until the end of the last century, it shrinks by a factor of 10, to 1 or 2, in the final period. The declining incidence of mortality crises in western Europe during the eighteenth and early nineteenth centuries is well documented.[6] During the nineteenth century, improvements in social and economic organization were seconded by progress in the control of infectious diseases, including the smallpox vaccine (Jenner's discovery was made public in 1798 and spread rapidly in the first half of the nineteenth century) and the identification of the pathogens responsible for the most devastating epidemics.[7] Progress, however, was difficult. In the nineteenth century, epidemic disease (old ones like smallpox, but also diseases new to Europe, like cholera) still took a heavy toll, as would the influenza pandemic that followed World War I; not to mention the yet more serious destruction of life caused by two world wars, civil wars in the USSR and Spain, mass deportations, and the Holocaust.

Nonetheless, mortality declined, and not only because of the reduced frequency and severity of crises but also because of a decline in the probability of death at the various ages during normal periods. Table 4.3

Table 4.3 Life expectancy in several western countries (1750–2009).

	1750–59	1800–9	1850–59	1880	1900	1930	1950	1980	2012
England and Wales			41.2	44.8	46.8	61.4	69	73.9	81.1
France			39.7	43.4	45.8	56.9	66.4	74.4	82.01
Sweden	36	37.2	42	48.3	52.1	63.2	71.1	75.8	81.9
Germany								73	80.5
Italy				33.6	43	55.2	65.8	74.1	82.87
Netherlands			37	41.8	48.8	64.7	71.4	75.8	81.1
Russian Federation								67.7	68.89
United States							68.1	73.9	79.0
Australia						65	69	74.6	82.2
Japan							59.3	76.2	83.3

Source: Human Mortality Database, 2012 http://www.mortality.org/ [accessed February 3, 2016]: Russia (2010), Germany and Australia (2011), France, United Kingdom, United States and Sweden (2013).

reports the progress of life expectancy (e_0, males and females) for some of the major developed countries between the mid-eighteenth century and the present day. In many European countries, before the modern transition, life expectancy was frequently below 30, and increased to about 80at the beginning of the twenty-first century. Some countries show noticeable improvement from the mid-nineteenth century; almost all make considerable progress before the impact of medical discoveries is felt.[8]

For our purposes, two aspects of mortality decline are particularly significant: first, the effect that the reduced probability of death at various ages had on the increase of life expectancy; the greatest reductions came in the first years of life due to improved infant care and measures taken to block the spread of infectious diseases. The second, related, aspect was the decline in deaths due to various causes, primarily infectious diseases.

This picture of mortality decline has been confirmed by Caselli. Table 4.4 provides a breakdown by cause of the lengthening of life expectancy in England and Wales between 1871 and 1951 (from 40.8 to 68.4) and in Italy between 1881 and 1951 (from 33.7 to 66.5).[9] The results for

Table 4.4 Life expectancy gains in England (1871–1951) and Italy (1881–1951), broken down by contributing causes of death.

	England and Wales		Italy	
Causes of death	**Gains in e_0 (years)**	**(%)**	**Gains in e_0 (years)**	**(%)**
Infectious diseases	11.8	42.9	12.7	40.1
Bronchitis, pneumonia, influenza	3.6	13.1	4.7	14.8
Diseases of the circulatory system	0.6	2.2	0.8	2.5
Diarrhea, enteritis	2.0	7.3	3.4	10.5
Diseases of infancy	1.8	6.5	2.3	7.3
Accidents	0.7	2.5	0.5	1.6
Tumors	0.8	2.9	0.4	1.3
Other diseases	7.8	28.4	7.7	24.3
Total	27.5	100.0	31.7	100.0

Note: Life expectancy was 40.8 years in England and Wales in 1871 and 68.4 in 1951; in Italy it was 33.8 in 1881 and 65.5 in 1951.
Source: G. Caselli, "Health Transition and Cause-Specific Mortality," in R. Schofield, D. Reher, and A. Bideau, eds., *The Decline of Mortality in Europe* (Oxford University Press, Oxford, 1991).

these two countries, in spite of their different social histories, are similar. In both cases about two-thirds of the gains in life expectancy are due to the control of infectious diseases (especially among infants: measles, scarlet fever, diphtheria), respiratory diseases (bronchitis, pneumonia, influenza), and intestinal diseases (diarrhea, enteritis). From the point of view of age, about two-thirds of the lengthening of life expectancy (a bit less for England and Wales, a bit more for Italy) derive from mortality decline in the first 15 years of life. Improvements in the older ages, over 40, account for only a sixth or seventh of the total increase.

Mortality transition in the developed countries has been relatively slow. For example, the date at which female life expectancy reached 50 (at which level a cohort's losses due to mortality between birth and the onset of reproductive age is still considerable, between 20 and 25 percent, and the "waste" of reproductive potential is about 30 percent) varies between 1861 for Norway and the 1930s for Bulgaria, Portugal, and the Soviet Union. The median date for European countries is 1903.[10]

Gains in life expectancy accelerated until the middle of the twentieth century. Between 1750 and 1850 England, France, and Sweden gained less than a month of life expectancy for each calendar year. These three countries, together with the Netherlands and the United States, gained about 2 months per year between 1850–9 and 1880. In the following five periods the average annual gains for the countries listed in Table 4.3 were 4.6 months (1800–1900), 5.2 months (1900–30), 4.6 months (1930–50), 4.4 months (1950–1980), and 2.3 months (1980–2012).The transition is not yet over, though its pace slowed in the last few decades, after gaining 4 or 5 months per year in the century ending in 1980, during which even the disasters of World War II did not succeed in blocking the progress of survival due to the pharmacological successes (sulfa drugs and penicillin) of the 1930s and 1940s.

The mortality decline of the period since 1850 has proceeded in tandem with economic and social progress (a vague expression that includes the expansion of those material, technical, and cultural resources, which improve survival). It is the task of social and demographic historians to sort out the when and where of the dominant factors of this decline, which probably include social and cultural factors (methods of child rearing, personal hygiene, improved organization of markets, and so forth) in the first phase of the transition; economic factors (improvements in the material quality of life, improvements in infrastructure) in the second; and medical, scientific, and behavioral factors in the last and ongoing phase. Though, of course, in every period a combination of factors acted together.

Figure 4.4 offers a simplified picture of the relation between the increase in life expectancy in 16 western countries (see Table 4.5) and a

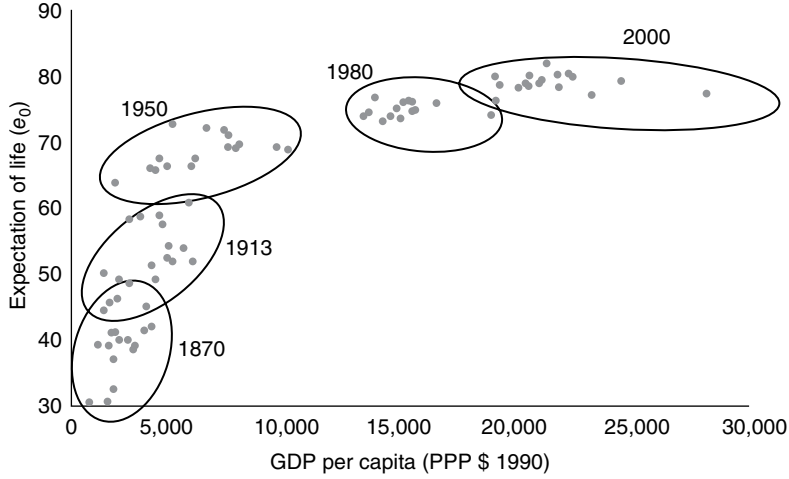

Figure 4.4 Relationship between real GDP per capita and life expectancy (e_0) for 16 industrialized countries (1870, 1913, 1950, 1980, 2000).

rough indicator of material well-being, namely estimates of the value of goods and services produced (real gross domestic product, or GDP) per capita, expressed in 1990 international dollars. These values have recently been recalculated retrospectively using a uniform method.[11] The figure compares the value of e_0 with that of the per capita GDP for 1870, 1913, 1950, 1980, and 2000 for each country and includes 64 points (four for each country) that describe the long-term relationship between life expectancy and material well-being. I shall pass over discussion of the apparent simplifications upon which the graph is based[12] and concentrate on the results. These are surprisingly clear: in the first phase of the transition increased production corresponds to considerable improvements in life expectancy, improvements that become progressively more modest until, in the final phase, even large increases in wealth are accompanied by small gains in e_0. The fact that in the final phase of the transition countries with differing levels of per capita production have nearly identical levels of e_0 reveals that, beyond a certain limit, the availability of goods has virtually no influence on survival. In 2000 the United States had a per capita GDP 50 percent higher than that of Italy, but US life expectancy (77.3) was below the Italian (80). This is not to say, of course, that greater well-being will not result in increased life expectancy, but these increases will probably be linked to "immaterial" progress – changes in individual behavior or scientific advances opening previously unimagined horizons. The simple increase of production as measured by GDP has ceased to play a role, at least in this historical phase. In the first phase

Table 4.5 Population, GDP, and productivity in 16 more-developed countries (1870 and 2000) (1990 international $).

	Population (thousands)			GDP ($ million)		
Country	**1870**	**2000**	**% change**	**1870**	**2000**	**% change**
Australia	1,770	19,071	1.8	6,452	410,789	3.2
Austria	4,520	8,096	0.4	8,419	162,705	2.3
Belgium	5,096	10,304	0.5	13,746	213,726	2.1
Canada	3,781	30,689	1.6	6,407	681,234	3.6
Denmark	1,888	5,340	0.8	3,782	122,873	2.7
Finland	1,754	5,177	0.8	1,999	104,757	3.0
France	38,440	59,278	0.3	72,100	1,233,457	2.2
Germany	39,231	82,344	0.6	71,429	1,531,351	2.4
Italy	27,888	57,715	0.6	41,814	1,081,579	2.5
Japan	34,437	127,034	1.0	25,393	2,676,479	3.6
Netherlands	3,615	15,898	1.1	9,952	343,238	2.7
Norway	1,735	4,502	0.7	2,485	109,687	2.9
Sweden	4,164	8,877	0.6	6,927	180,390	2.5
Switzerland	2,664	7,167	0.8	5,867	157,853	2.5
UK	31,393	58,670	0.5	100,179	1,162,663	1.9
USA	40,241	284,154	1.5	98,418	7,992,968	3.4
	GDP per Capita			**Productivity per hour**		
	1870	**2000**	**% change**	**1870**	**2000**	**% change**
Australia	3,645	21,540	1.4	3.48	28.4	1.6
Austria	1,863	20,097	1.8	1.38	28.8	2.3
Belgium	2,697	20,742	1.6	2.17	35.8	2.2
Canada	1,695	22,198	2.0	1.71	28.1	2.2
Denmark	2,003	23,010	1.9	1.57	27.2	2.2
Finland	1,140	20,235	2.2	0.86	28.4	2.7
France	1,876	20,808	1.9	1.38	35.9	2.5
Germany	1,821	18,597	1.8	1.55	27.8	2.2
Italy	1,499	18,740	1.9	1.05	29.4	2.6
Japan	737	21,069	2.6	0.46	23.3	3.0
Netherlands	2,753	21,590	1.6	2.43	32.7	2.0
Norway	1,434	24,364	2.2	1.2	33.7	2.6
Sweden	1,664	20,321	1.9	1.22	28.6	2.4
Switzerland	2,202	22,025	1.8	1.53	25.6	2.2
UK	3,191	19,817	1.4	2.55	29.1	1.9
USA	2,445	28,129	1.9	2.25	35.6	2.1

Source: Adapted from A. Maddison, *The World Economy: Historical Statistics* (OECD, Paris, 2003); A. Maddison, *The World Economy. A Millennial Perspective* (OECD, Paris, 2001).

of the transition increased production translated into greatly improved survival, for obvious reasons: more food, better clothing, better houses, and more medical care have a notable effect on those who are malnourished, badly clothed, poorly housed, and forced to trust fate in case of sickness. On the other hand, when increased production benefits already prosperous populations the effects are minimal or nonexistent, if not negative, as may be the case with overeating and environmental deterioration.

4.3 From High to Low Fertility

Fertility decline, like that of mortality, was a gradual and geographically varied process. I have already discussed the combination of factors, both biological (which determine birth intervals) and social (which determine the portion of the reproductive period devoted to childbearing: age at marriage, proportion marrying), which regulate the "production" of children (see Chapter 1, Section 4).[13] As we have seen, these factors were able to significantly influence fertility, so that prior to the transition European levels ranged from a low of about 30 per 1,000 to a high of above 45. Nonetheless, voluntary fertility control[14] was the decisive factor in fertility decline – certainly a more efficient method than extended breast-feeding, late marriage, or remaining single.

Figure 4.5 records the effectiveness of the marital check in Europe during the period leading up to the fertility decline. Low-nuptiality female populations occupy the upper left portion of the graph: they are characterized by a high age at first marriage (over 27 in Switzerland, Belgium, Sweden, and Norway) and a low proportion of women who have married before the end of the reproductive period (a little over 80 percent). In the lower right of the graph are high-nuptiality populations (Romania, Bulgaria), with low age at first marriage (around 20) and a high percentage married (over 95 percent). In the premodern age there existed a fairly strong (and inverse) relationship between the two components of nuptiality, as revealed by the graph.

Figure 4.5 gives an idea of the variability of pretransition nuptiality and, indirectly, the degree to which it controlled the production of births. And while the level of control was considerable, it was not sufficient to regulate fertility during the rapid social transformation of the previous century; more efficient control was provided by voluntary fertility limitation. Birth control, for a time virtually unknown except to select groups (nobility, the urban bourgeoisie),[15] appeared in France and a few restricted areas toward the end of the eighteenth century[16] and spread rapidly throughout Europe during the second half of the nineteenth – though

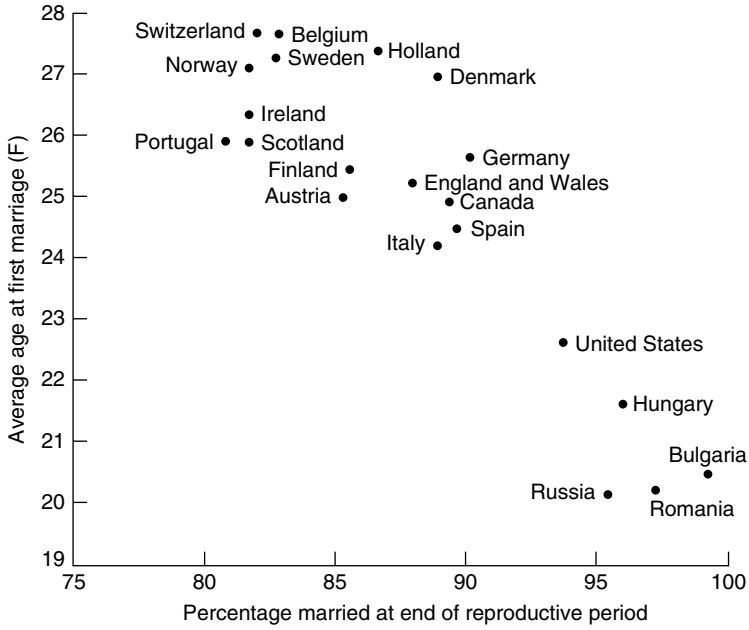

Figure 4.5 Relationship between average age at marriage and proportion of women who have married by the end of the reproductive period for several countries; generations born toward the end of the nineteenth century. *Source*: P. Festy, *La fécondité des pays occidentaux de 1870 à 1970 [The Fertility of Western Countries 1870 to 1970]* (PUF, Paris, 1979), p. 29. Reprinted with permission of Presses Universitaires de France (PUF).

some rural and peripheral areas seem only to have adopted these practices in the middle part of the twentieth century.

The European fertility transition from 1870 to 1960 is depicted in Figure 4.6, which is based upon an international study of European fertility decline.[17] We have used graphs of this type previously (Figures 1.8 and 4.1). Here, however, the axes have been changed, and the curves are of "isofertility": each curve represents the locus of those points that combine legitimate fertility (the x axis) and nuptiality (the y axis) to give the same "general fertility" (an index of the rate of production of children, strongly correlated with the average number of children per woman, *TFR*). The indices of legitimate fertility (I_g) and nuptiality (I_m), explained in a note,[18] tell us the following:

1) The index of legitimate fertility measures the intensity of childbearing within marriage as it relates to the maximum value ever encountered in a normally constituted population (value equal to one). Prior to the spread of voluntary fertility control, I_g values generally fall between

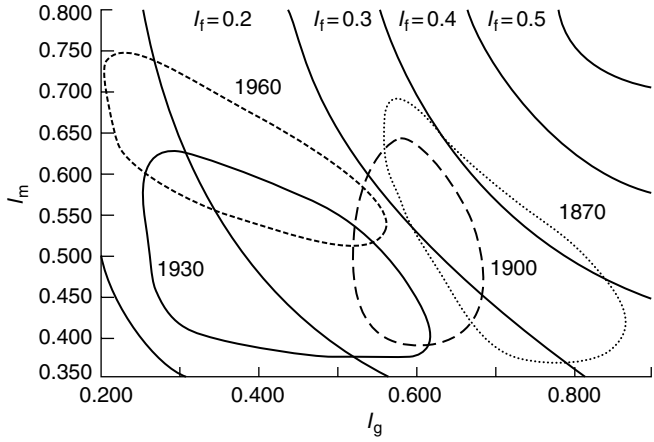

Figure 4.6 Relationship between general fertility (I_f), legitimate fertility (I_g), and proportion married (I_m) in 16 European countries (1870, 1900, 1930, 1960).

0.6 and 1 as a function of those factors (the length of breast-feeding and others discussed in Chapter 1, Section 5), which determine the birth interval. The spread of birth control usually reveals itself by a "continuous" decline of legitimate fertility. In the above study a 10 percent decline relative to an initial stable level is considered an unequivocal sign of control. Values of 0.5 and less are definitely those of countries practicing fertility limitation.

2) The nuptiality index is simply a measure of the proportion of women of childbearing age who are married (weighted for potential fertility at the various ages). It is then a synthesis of the effects of age at marriage and proportions marrying (as well as of widowhood, declining in the period considered due to reduced mortality) presented in Figure 4.5.

Figure 4.6 illustrates the progressive decline of general fertility in European countries as a function of the indices described above. In 1870, fertility levels varied considerably: from below 0.3 for France (where fertility control was already well established) to about 0.5 in eastern European countries (not shown in graph), characterized by high nuptiality and high legitimate fertility. Excepting France, the range of positions occupied by the different countries at this date is due more to nuptiality variation than to that of legitimate fertility; the area enclosing these points is stretched vertically. The decline of general fertility at successive dates, on the other hand, is due primarily to a drop in legitimate fertility as a result of the spread of birth control; the area acquires a progressively more horizontal orientation, and in 1960 general fertility levels are about 0.2. In more than one case the decline of legitimate fertility is

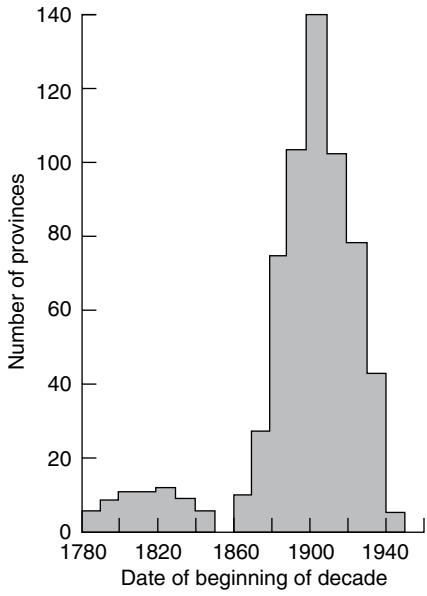

Figure 4.7 Distribution by decade of number of provinces of Europe experiencing 10 percent decline in legitimate fertility (I_g). *Source*: A. J. Coale and S. C. Watkins, eds., *The Decline of Fertility in Europe* (Princeton University Press, Princeton, 1986), p. 38. © 1986 Princeton University Press. Reprinted with permission of Princeton University Press.

accompanied by an increase in nuptiality. The latter phenomenon can be interpreted as a reaction to the availability of an efficient means of fertility control (contraception), which rendered the nuptial check superfluous and relaxed inhibitions to marriage.

The point at which marital fertility registered a 10 percent drop relative to a previous stable level (and without subsequent increases) is an empirical indicator that an irreversible decline has been initiated. This date is an important moment in the demographic transition and signals the substitution of the traditional system of fertility regulation (marriage) with a new one (contraception). It occurred first in France, in 1820s, and in European Russia and Ireland, in the 1920s – almost a century later. For Belgium, Denmark, England and Wales, Germany, the Netherlands, and Switzerland the date falls between 1880 and 1900; for Sweden, Norway, Austria, and Hungary between 1900 and 1910; and for Italy, Greece, Finland, Portugal, and Spain between 1910 and 1920.The date of 10 percent decline has also been calculated for approximately 700 European provinces or districts; their distribution by decade is reported in Figure 4.7. There are essentially two distributions: that on the left represents French departments, which clearly preceded the rest of Europe, beginning fertility decline in the period between 1780 and 1850; that on the right represents the rest of Europe. In 60 percent of all cases the date of decline falls between 1890 and 1920; the most crowded decade is 1900–10. The last areas only began decisive decline in the 1940s.

A complete geography of the transition of legitimate fertility, like that of the detailed Princeton study, reveals a process of decline that began in France and spread to the more-developed regions of Europe, including Catalonia, Piedmont, Liguria, and Tuscany in the south and England and Wales, Belgium, Germany, and Scandinavia in the center-north; subsequently it reached more generally the regions of southern and eastern Europe. The most peripheral regions (some areas of Mediterranean Europe, the Balkans, Ireland) and areas geographically central but culturally traditional (certain areas of the Alps) were the last strongholds of high fertility, gradually conquered in the middle of this century.[19]

We may now turn from this general, long-range view of the fertility transition to consideration of the indices of the production of births and their evolution in time. The most suitable index is the *TFR* (average number or children per woman), which for some countries has been calculated for generations of women born at 25-year intervals (Table 4.6). Levels range from a high near or above five children per woman for

Table 4.6 Average number of children per woman (*TFR*) for several generations in western countries (1750–1975)[a].

Country	1750	1775	1800	1825	1850	1875	1900	1925	1950	1975
Sweden	4.21	4.34	4.68	4.4	4.28	3.51	1.9	2.05	1.98	1.98
England and Wales	5.28	5.87	5.54	5.05	4.56	3.35	1.96	2.15	2.06	1.95
Germany[b]					5.17	3.98	2.08	2.06	1.72	1.58
France				3.42	3.27	2.6	2.14	2.59	2.11	2.04
Netherlands					4.98	3.98	2.86	2.76	1.85	1.80
Spain						4.64	3.38	2.51	2.15	1.45
Italy[c]					4.67	4.5	3.14	2.27	1.88	1.52
USA					4.48	3.53	2.48	2.94	1.96	2.20
Australia						3.22	2.44	2.98	2.30	2.05

Note: [a] Periods are centered on the indicated dates. For the Netherlands, 1841–50 for 1850; for Australia, 1876–85 for 1875.
[b] For Germany, 1925 and 1950 values refer only to West Germany.
[c] Italian values for 1850 and 1875 are based on a 1931 fertility survey.
Sources: P. Festy, *La fecondité des pays occidentaux de 1870 à 1970 [The Fertility of Western Countries 1870 to 1970]* (PUF, Paris, 1979). J.-P. Sardon, "Le remplacement des générations en Europe depuis le début du siècle [Generation Replacement in Europe since the Beginning of the Century]," *Population* 45 (1990). For England: E. A. Wrigley and R. Schofield, *The Population History of England, 1541–1871* (Edward Arnold, London, 1981). For 1950 see Conseil de l'Europe, *Evolution démographique recente en Europe [Recent Demographic Developments in Europe]* (Strasbourg, 2005). For 1975, Author's estimates.

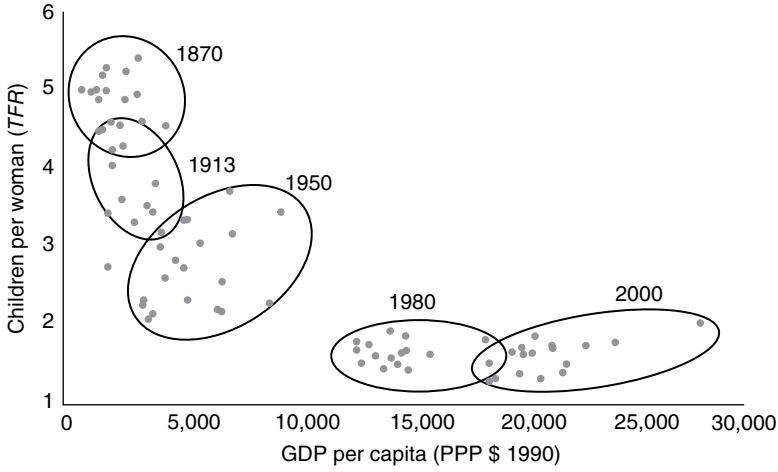

Figure 4.8 Relationship between real GDP per capita and children per woman (*TFR*) in 16 industrialized countries (1870, 1913, 1950, 1980, 2000).

generations born around 1850 or before in England and Wales, Germany, and the Netherlands, to a low of about two children for the generations born around 1950 (who have already completed their reproductive cycle). Women born in the 1970s have fallen way below replacement in countries like Germany, Italy, and Spain, and at the end of their reproductive period, those who are childless or mothers of an only child outnumber those with two or more children. Russia and many other ex-socialist countries and Japan have joined the league of those countries with dangerously low fertility, which has become a cause of concern. Have we entered into a prolonged period of very low fertility that might jeopardize the development of European society or have we reached the low point of a cycle, to be followed by an increase?[20]

It will be interesting to compare, as we did for life expectancy, *TFR*,[21] and per capita GDP for the 16 industrialized countries at the usual dates: 1870, 1913, 1950, 1980, and 2000 (Figure 4.8). The relationship is the reverse of that between per capita production and e_0: the growth of per capita GDP is initially accompanied by sustained fertility decline; subsequently, GDP increases combine with ever smaller reductions in fertility until the current state of economic maturity is reached and fertility is essentially unchanging. We should not accept as "law" a relationship observed during an historical period in which increased well-being seems to have favored the spread of voluntary fertility control. The present-day lack of correlation between fertility and income levels suggests that other complex motivations, only slightly connected with the availability of material goods, govern the fertility decisions of couples.

During the nineteenth and twentieth centuries social and economic transformation was an important factor in fertility decline, confirmed by its generally slower progress in peripheral and backward areas. There have, of course, been important exceptions which, as often happens in the social sciences, have frustrated those scholars looking for simple solutions to complex problems. The following are a few examples from the many which the literature offers: (1) In rural France, fertility decline began earlier than in England, a richer and more advanced country in the midst of the Industrial Revolution. (2) In many countries the rate of fertility decline is only minimally explained by social and economic indices, such as levels of education, rurality, industrialization, or urbanization. (3) It is often the case that cultural factors – membership of a linguistic or ethnic group, religious or political affiliation – seem to be more significant to fertility decline than economic factors.

But if we look at the entire process, we see that no population has maintained high levels of fertility for long in the face of increasing well-being and declining mortality. The demographic transition has clearly been an integral part of the transformation of European society.

4.4 European Emigration: A Unique Phenomenon

The synthesis of the transition I am presenting here would not be complete without reference to the great currents of migration that populated two continents while at the same time lowering European demographic pressure. I have already discussed the importance of the availability of space (and also of land) in shaping European demographic growth prior to the Industrial Revolution. At the end of the eighteenth century, more than 8 million people of European extraction, about equally divided, inhabited the two halves of the American continent. Over three centuries Europe had by means of Iberian and British imperialism established the political, economic, and demographic foundations for the coming mass migration. The causes of that migration were both economic and demographic: economic because the Industrial Revolution and technological progress increased productivity and so rendered masses of workers superfluous, especially in rural areas; and demographic because the transition entailed a large demographic "multiplier," which is to say it sped up population growth, and so worsened the problems created by economic changes. The availability of land and space in North and South America and to a lesser degree in Oceania, combined with the demand for labor in these new societies, created the conditions for massive migration.

During the latter part of the nineteenth century and the first decades of the twentieth century, the process of economic integration between countries accelerated and extended its geographic reach. This process of globalization was due to the increased mobility of the production factors – capital, labor, and goods – and exports grew faster than production. According to Maddison, more than half the savings of Great Britain flowed abroad; other major countries, like France and Germany, also expanded their investments abroad. A great proportion of foreign investment went into the expansion of the railway networks, whose length increased fivefold in North America between 1870 and 1913 (from 90,000 to 450,000 kilometers), attracting legions of migrant workers. In Latin America, the few thousand kilometers of railways of 1870 grew to 100,000 in 1913.[22] The growing economic integration is well measured by the increased ratio between the value of manufactured exports and GDP: this ratio increased from 3 percent in 1820 to 12 percent in 1870 and 18 percent in 1913 in the United Kingdom; and, between the same dates, from 1 percent to 5 percent and 8 percent in France; in Germany, from 9 percent in 1870 to 16 percent in 1913. According to O' Rourke and Williamson, the mass migration from Europe to America that accompanied this process of globalization determined, in the countries of origin, an increase of real wages, an improved standard of living, and a reduction of poverty. However, mass migration had a relevant impact on the American labor market, where wages were moderated, and, because of the competition of the new arrivals, the standard of living of previous immigrants and of native workers declined and new poverties emerged. Mass migration, therefore, determined an economic convergence between countries, and between the standard of living of the poor countries of origin and of the wealthier countries of destination.[23] Perhaps this conclusion can be reformulated by saying that, because of mass migration, the growing divergence between the standard of living of Europe and America – as measured by the income per capita (see Table 4.5) – was slowed and compressed. The following are estimates for European transoceanic migration between 1846 and 1932 from the major countries of departure: 18 million from Great Britain and Ireland, 11.1 million from Italy, 6.5 million from Spain and Portugal, 5.2 million from Austria-Hungary, 4.9 million from Germany, 2.9 million from Poland and Russia, and 2.1 million from Sweden and Norway. This flood of emigration, which was of course balanced to some degree by a countercurrent of return migration, went primarily to the United States (34.2 million), Argentina and Uruguay (7.1 million),Canada (5.2 million), Brazil (4.4 million), Australia and New Zealand (3.5 million), and Cuba (0.9 million). In the first 15 years of the twentieth century the annual rate of European emigration exceeded 3 per 1,000, equal to about one-third of natural increase.[24]

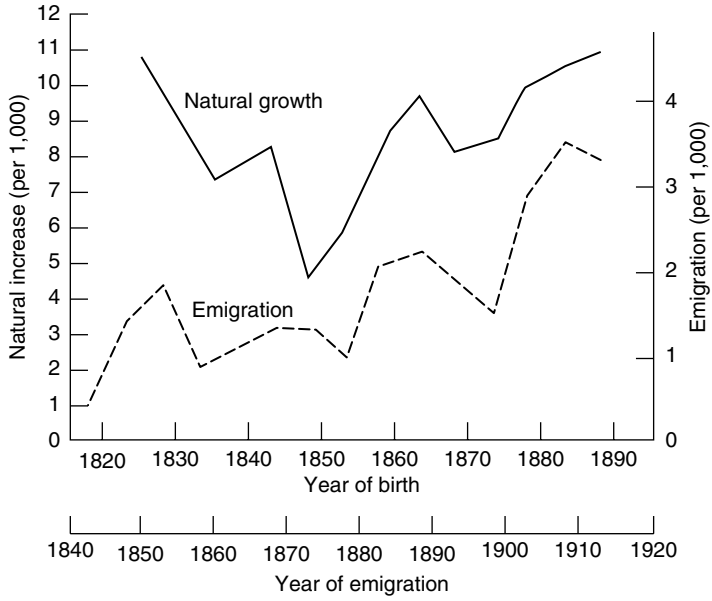

Figure 4.9 Emigration and natural growth for continental Europe.

Between 1861 and 1961, net Italian population loss due to emigration was 8 million. Imagining that emigrants had remained in Italy and, as a group, had grown at the same rate as that of the Italian population in Italy (a fairly restrictive hypothesis), they would in 1981 have numbered 14 million, about 25 percent of the national population at that time.[25]

These brief notes should give an idea of the importance of emigration for the European demographic system. All in all, from the viewpoint of aggregate economic growth, this emigration was certainly beneficial. It made possible rapid economic growth in the areas of emigration, utilization of labor where it could be most productive, and a general increase of resources both in Europe and overseas.

Figure 4.9, taken from Chesnais, compares demographic increase in continental Europe with the intensity of emigration about 25 years later, a period that corresponds more or less to the average age of the emigrants. There is a striking relationship between growth rate increases and decreases and emigration trends a quarter-century later. Emigration serves to lower demographic pressure caused by the influx of larger cohorts of workers into the labor market.[26] A strong overseas demand for workers is of course the complement to this process for the export of excess population. From the point of view of the demographic development of Europe, the implications are several, and not only quantitative.

These implications, however, relate primarily to the nature of the emigrant selection process and would take us beyond the scope of the present study.

A word on the causes of European migration is, however, in order. We have already referred to these in general terms: the creation of surplus population that the economic system could not absorb (Figure 4.9), the availability of land and capital combined with a strong demand for labor in America, income gaps between home and overseas destinations, and the "shrinking" of the world due to cheaper, easier, and more rapid transportation. But this analysis needs to be pursued further in order to understand better the reasons behind the gigantic transfer of population. In particular, three complex phenomena and their interrelationships need to be identified: first, rural population growth, the availability of land both in Europe and outside it, and agricultural productivity; second, the rural population dynamic; and third, the contemporary growth of nonagricultural activities.

With regard to the first point, in the latter half of the eighteenth century about three-quarters of the population of all European countries except England, which was rapidly industrializing, were employed in agriculture. This proportion dropped rapidly though not uniformly during the following century: in 1850 it was about half and by the beginning of the twentieth century about one-third. Nonetheless, the size of the agricultural population grew during the first part of the century due to rapid European demographic growth (a doubling during the course of the century) and stabilized in the latter part.[27] Demographic expansion increased demand for food, and this demand was for the most part due to the increase in cultivated land. New land was available in northern Europe and also east of the Elbe; elsewhere the usual fallow periods were gradually eliminated. Productivity, however, remained low: in the mid-nineteenth century the wheat yield for one hectare of land was about a ton; by the beginning of the twentieth century this figure had increased by a modest 20 percent.[28] The scarcity of land – which multiplied the number of peasants who had none – combined with its slowly increasing productivity would have imposed new "Malthusian" limits on population had it not been for the vast expansion of land cultivated outside Europe. Grigg has calculated that arable land in Europe grew from 140 million to 147 million hectares between 1860 and 1910; in that same period the land cultivated in Russia grew from 49 million to 114 million hectares, in the United States from 66 to 140 million, and in Canada and Argentina from insignificant levels to 33 million.[29] The low production costs in the new areas of European settlement and the lowering of shipping costs were in fact the basis of a fall in agricultural prices that plunged the European countryside into crisis from the 1870s. Finally, while the

productivity of land grew sluggishly, the injection of capital into the countryside and mechanization combined to increase the productivity of labor. Masses of peasants characterized by limited proprietorship and increased productivity of labor translated into a rapid increase in surplus labor, so workers frequently found themselves torn away from traditional activities and lifestyles and facing crisis situations. As a result, the pool of potential emigrants grew.[30]

The second point refers to the population dynamic of rural areas where birth control spread with a notable lag as compared to the cities, fostering higher rates of natural population increase during the period of the transition. In some cases – analogous to the situation in many developing countries – the first phases of the transition and the attendant improvements in sanitary conditions led to an increase rather than a decrease in fertility.[31]

The third point refers to the rapidity with which new nonagricultural activities sprang into existence in Europe and so provided an alternative outlet for rural population excess. This phenomenon is not of course independent of the stage of evolution of agriculture; indeed the two are intimately connected: tools, machines, and fertilizers that had previously been produced by agricultural concerns came gradually to be more efficiently created by the industrial system. But it was the growth of this latter system and of predominantly urban service activities that created new opportunities for surplus rural labor. In those areas where this process occurred relatively early, emigration was low or in any case short-lived; by contrast, in those areas where it took place relatively late, emigration tended to be massive. The ratio between those employed in manufacturing industries and those employed in agriculture serves as an index of the changing situation (Figure 4.10). When this ratio is greater than one (that is, when those employed in manufacturing exceed those in agriculture), then the pressure to emigrate becomes weaker and eventually disappears as the modern sector of the economy – which initially consisted of the manufacturing industries but then grew to include transportation, services, building, and so on – becomes sufficiently important to absorb the remaining agricultural surplus population. The United Kingdom, from which mass emigration had long ceased, well exceeded a 1:1 ratio during the late-nineteenth century. Prior to World War I, this ratio was surpassed by those countries undergoing a rapid process of industrialization: Belgium, where mass emigration had never taken hold, and Germany and Switzerland, where it had ceased. Mediterranean countries like Italy and Spain, where industrialization came late, only exceeded this ratio in the 1960s and 1970s, at which time large-scale emigration came to an end. In other countries where manufacturing industries came to dominate the national economy in the period between the

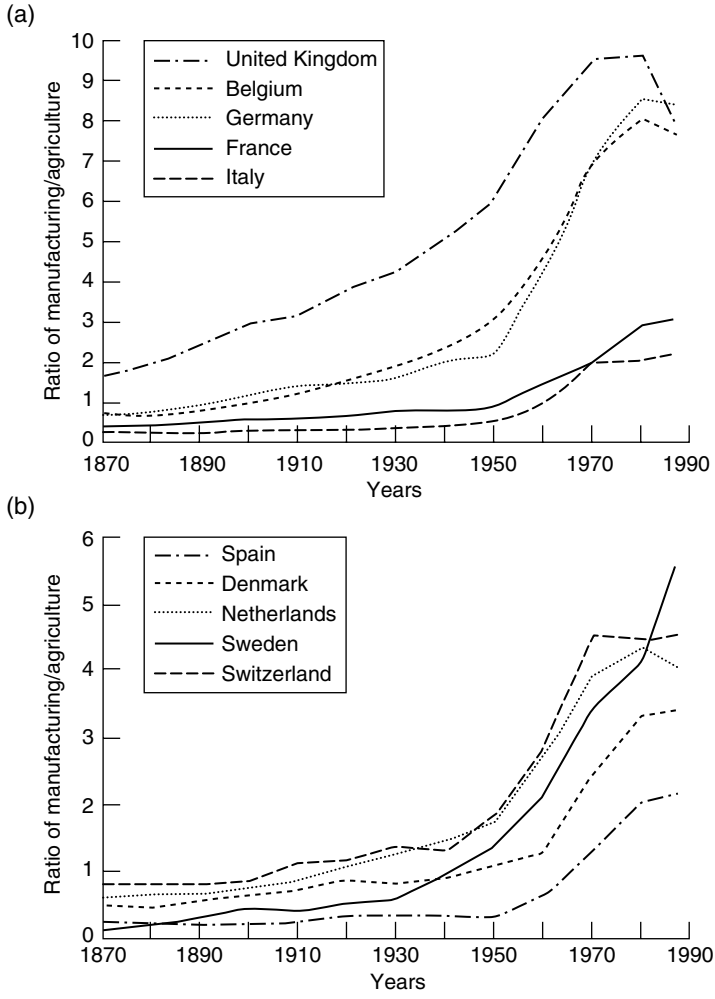

Figure 4.10 Ratio of those employed in manufacturing industries to those engaged in agriculture (1870–1987): (a) United Kingdom, Belgium, Germany, France, Italy; (b) Spain, Denmark, Netherlands, Sweden, Switzerland.

wars (Denmark, Sweden, the Netherlands), emigration had been halted first by receiving country restrictions and then by the economic crisis.

The experience of Europe – throughout the nineteenth century and for much of the twentieth century, which was the main source of population for the "neo-Europes" overseas – cannot simply be applied to the present day. The current situation of demographic pressure that fuels migration from the poorer to the richer countries differs fundamentally in that

"empty" areas open to immigration no longer exist and national policies severely limit the possibilities for human movement. On the other hand, economic globalization tends to increase inequalities between countries, creating widening income gaps between rich and poor areas and thus increasing incentives to migrate. However, globalization may also foster growth, pushing an increasing portion of developing countries' populations to modest levels of well-being. When these are reached, the cost of emigration – particularly its social and cultural components – tends to increase more rapidly, thus reducing the propensity to leave one's country.

4.5 A Summing Up: The Results of the Transition

The demographic transition and associated migration left the European population profoundly changed, both dynamically and structurally. The changes associated with the achievement of a high level of demographic efficiency can be expressed by several indices. Table 4.7 lists these for Italy in 1881 and 1981, approximately the beginning and ending dates for the demographic transition in that country. With certain adaptations the Italian case is typical of Europe as a whole. The "position" of Italy in the context of the demographic transition of the 15 western countries plus Japan (see the list in Table 4.5) can be appreciated in Figure 4.11. In 1870 and in 1913 Italy is clearly a "laggard," with higher mortality and fertility than the other countries; in 2000, on the other hand, it is in the vanguard, with lower than average fertility and higher than average expectation of life.

But let us return to Table 4.7, which requires a brief commentary. The birth and death rates repeat what we have already discussed in the previous pages, namely the reduced intensity, by about two-thirds, of both phenomena; at the same time, life expectancy more than doubled as survivorship increased immensely. In 1981, 98 percent of each generation arrived at reproductive age (15 years) and 42 percent achieved the respectable age of 80. At 1881 these figures were 58 and 6 percent. Clearly these dramatic improvements make important changes to a society.[32]

The measures of nuptiality and family structure provide a less clear picture, revealing both stability and change at the same time. Age at marriage and the proportion of women remaining single at the end of the reproductive period were stable, confirmation that in the West the nuptial check played a minimal role in the dramatic changes that took place. While fertility declined, utilization of the reproductive space decreased considerably, as revealed by the decrease in average ages at

Table 4.7 The results of the transition: Demographic indices for Italy (1881 and 1981).

Demographic index	c.1881	c.1981
Births (per 1,000 population)	36.5	11.0
Deaths (per 1,000)	28.7	9.6
Natural increase (per 1,000)	7.8	0.4
Life expectancy (e_0, M and F)	35.4	74.4
Survivorship at age 15 (per 1,000)	584	982
Survivorship at age 50 (per 1,000)	414	936
Survivorship at age 80 (per 1,000)	65.0	422
Age at first marriage (F)	24.1	24.0
Average age at childbirth	(30.0)	27.6
Average age at birth of last child	(39.0)	30.0
Unmarried (F) at age 50 (%)	12.1	10.2
Children per woman (*TFR*)	4.98	1.58
Net reproduction rate	1.26	0.76
Intrinsic rate of natural increase (%)	0.77	0.99
Population 0–14 (%)	32.2	21.4
Population 15–64 (%)	62.7	65.3
Population 65 and over (%)	5.1	13.3
Children per married woman	5.6	1.7
Average family size	4.5	3.0

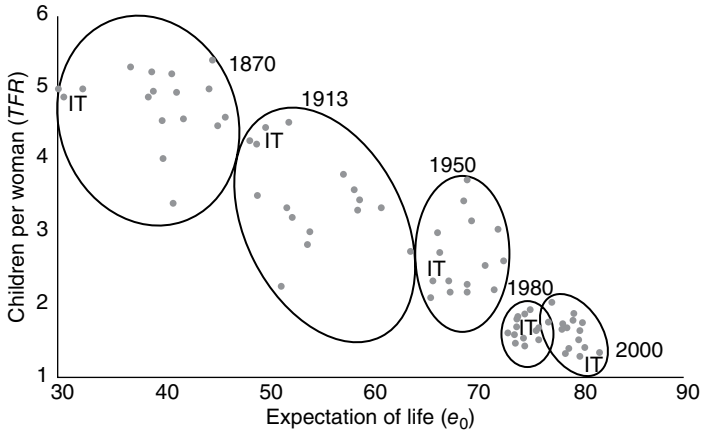

Figure 4.11 Relation between life expectancy (e_0) and children per woman (*TFR*) in 16 European countries (1870, 1913, 1950, 1980, 2000).

birth and at last birth – the latter lower by almost 10 years. As a result, in the modern demographic regime the last child reaches maturity when the mother (or father) is relatively young (about 50) and still has a large portion of her (or his) life to live. By contrast, in the old regime maturity for the last-born occurred when the parents were about 60 and so fairly old, given the lower life expectancy of the period. Finally, fertility decline is largely responsible for reduced family size (three persons per family in 1981 as opposed to four-and-a-half a century before).[33]

The last group of indices, relating to age structure, is especially revealing. Fertility decline has reduced the relative size of the younger age groups (the percentage of the population under 15 has declined from 32.2 to 21.4 percent) and increased that of the older (from 5.1 to 13.3 percent over 60), advancing the process of "demographic aging." Still more intriguing is the "projection" in time of the mortality and fertility behavior of 1881 and 1981 so that they remain constant until the population achieves "stability."[34] In 1881 the difference between the stable state and the real state of the population was minimal. In 1981, however, the implications were disconcerting: should fertility (0.76 daughters per woman) and mortality remain at 1981 levels, the growth rate will become about -1 percent per year, implying a halving time of 71 years; population rates and proportions will suffer further with an aging population. In 2016, 35 years later, fertility is even lower than in 1981, but the Italian population has continued to increase because of the unexpected contribution of migration that has more than compensated the negative balance between births and deaths.

These comments round out the picture of the demographic transition in the developed world, a transition that followed a basic plan common to many countries. It entailed general demographic expansion which, by means of emigration, extended to other continents. This largely positive development, however, did not come without a price: while populations today are far more "economical" and efficient than they were 100 or 200 years ago, they have acquired new weaknesses. In the case of mortality, increased demographic order has not entirely eliminated the risks of disorder (the loss of an only child or of parents at an early age), and these, precisely because of their rarity, are more devastating to their victims. Family structures are reduced and so are more fragile in the face of risk. And population aging, beyond certain limits, constitutes a heavy burden on the social system. Finally, extremely low fertility, way below replacement, engenders costly diseconomies that in the long run are unsustainable.

Evaluating the present and predicting the future evolution of contemporary "liquid" demography is a hard task. The economic crisis, the deepest and longest since the end of World War II, may add a further

discontinuity from the past. In 2016, most European countries approach an expectation of life of 85 years; fertility, with minor fluctuations, hovers around 1.6 children per woman; the population in adult and active ages is shrinking; women reaching their 70th birthday are as numerous as girls reaching puberty; the inflow of refugees has dwarfed the traditional forms of migration.

4.6 Theoretical Considerations on the Relationship between Demographic and Economic Growth

The advent of the Industrial Revolution, the introduction of machinery, the exploitation of new sources of energy, and increased trade all combined to rapidly alter the terms of the population/land/labor equation. Population growth no longer led, by means of increased demand, to a rise in prices and a decline in wages. Beginning in the nineteenth century, European population, in spite of considerable growing pains, nonetheless grew in a climate of declining prices and increasing wages. The difficult balance between population and land was broken as economic and demographic growth became not competing but complementary forces. This, however, is only a general picture; clearly the attempt to describe more specifically the nature of the relationship between population and economy is a difficult undertaking. One is inclined to adopt Schumpeter's point of view, according to which population plays a secondary or background role in economic development: "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates."[35] My task, however, will not be to discuss whether or not demographic variation determines economic development, but rather to consider how and to what degree the one conditions the other.

Once again we may consider the problem in terms of the returns from the factors of production, labor included, and whether these tend to increase or decrease. It is certainly the case that dependence on the availability of land decreases as an economy expands beyond agriculture, but the dependence on other resources, like coal, iron, or other minerals derived from the earth, increases. Due to market integration, the opening of new continents, the substitution of raw materials, and unceasing human innovation and technological progress, the limits of these resources have not yet been reached. The secular decline of the relative prices of raw materials, food, and industrial products attests to this fact.[36]

Land scarcity and diminishing returns have not been avoided simply because of the opening of the North American continent to European agriculture, but above all because of the dramatic increase in agricultural productivity, especially since the mid-1950s, during which the cultivation of new lands has ceased.[37] A century-and-a-half ago, the economist Jevons feared that coal supplies would be used up,[38] and in the 1970s the Club of Rome made similar predictions regarding other raw materials,[39] while the specter of declining petroleum reserves haunted the 1970s. None of these fears has been realized, though it is reasonable to believe that resource scarcity might in the future present an obstacle to development (see also Chapter 6, Section 6). Those resources used to produce energy (petroleum, coal, wood) clearly have become neither rarer nor more costly, as demonstrated by their reduced incidence over time in relation to a constant product. In the United States, the energy required in 1850 to produce $1,000 of goods or services (GDP, expressed in constant prices) amounted to 4.6 tonnes of petroleum equivalent; by 1900 this figure had dropped to 2.4, by 1950 to 1.8, and by 1978, at the peak of the oil crisis, to 1.5. In other words, a unit of energy (whatever source used) in 1978 produced triple the value (in constant prices) that it did in 1850. In the past 30 years, the energy content of every unit of production has been further reduced by half.[40]

In 1910, Alfred Marshall wrote:

> There have been stages in social history in which the special features of the income yielded by the ownership of land have dominated human relations … But in the present age, the opening out of new countries, aided by low transport charges on land and sea, has almost suspended the tendency to diminishing return, in that sense in which the term was used by Malthus and Ricardo, when the English laborer's weekly wages were often less than the price of half a bushel of good wheat.[41]

Returning to consideration of the long-term relationship between demographic growth and economic development, between 1820 and 2000 the population of the four leading western nations (Great Britain, France, Germany, and the United States) grew by a factor of 5.6 while their combined GDP (in constant prices) multiplied by about 107. Per capita production, then, increased 19-fold (107/5.6 = 19.1). Given that per capita production (a rough indicator of individual well-being) has doubled every four decades or so during the past two centuries, it would appear that demographic growth, by whatever means it may have acted, was at best a modest check to economic development; in fact, at first glance it might seem more reasonable to adopt the opposite opinion, namely that population increase reinforced economic growth.

Abandoning any attempt to determine a causal relationship between population and economy, we may nonetheless discuss several factors linked to demographic growth that may have sped up, rather than slowed down, development or, in other words, brought increasing returns for each additional individual. These factors may be grouped into three categories: (1) purely demographic factors; (2) factors of scale and dimensional factors in general; and (3) the stock of knowledge and technological progress.

4.6.1 Purely Demographic Factors

Purely demographic factors are changes associated with the demographic transition discussed earlier in this chapter. Their influence is considered positive for a number of reasons. First, mortality decline and the reduced frequency of disease increased not only longevity but also the efficiency of the population. Second, the fact that mortality began to follow a more hierarchical and chronological order largely eliminated the risk of premature death and allowed for longer-term planning – certainly an aid to development. Third, the decline of fertility – previously accompanied by high infant mortality – reduced the amount of energy and resources devoted to the raising of children and so allowed these resources (particularly in the form of female employment) to be devoted to more directly productive activities. And finally, up until at least the middle of the twentieth century, age structure was shifting to favor the more productive ages, improving the ratio between the productive and dependent sectors of the population.[42]

These factors probably acted to increase the average efficiency of the population over the time period considered. As we shall see below, however, it will not be possible to repeat this sort of progress in the future. From the point of view of purely demographic variables, the low fertility of the past decades, the aging of the population, and the fact that the beneficial aspects of mortality gain have mostly been realized lead to the conclusion that a turning point has been reached and western populations are entering a phase of decreasing efficiency.

4.6.2 Factors of Scale and Dimensional Factors in General

We have already discussed factors of scale and dimensional factors in general at some length (Chapter 3, Section 5). It is likely that economies of scale were realized in the West during the past two centuries as a result of the fivefold demographic increase, which greatly expanded markets. Many studies have confirmed the existence of net gains in efficiency and productivity for individual industrial sectors as a result of market expansion.[43] More generally, Denison has estimated that factors of scale contributed

about 10 percent to the post-World War II growth of Europe and the United States.[44] Clearly, economies of scale do not derive merely from demographic growth, but also from the expansion of the economy and market integration. However, even given these limitations, the demographic component of economies of scale must be considerable.

The example of the manufacturing industries can probably be extended to other sectors of the economy, but not all – perhaps to service industries, much less to public administration. While economies of scale derived from demographic expansion are fairly evident for small populations, they are less so for large ones. Moreover, the elimination of international barriers to trade and the increasing integration of economies (globalization) can be a strong substitute for demographic growth with regard to market expansion. We may, in this regard, cite the opinion of E. A. G. Robinson: "There are no penalties for being bigger than the minimum size … there are no possibilities of diseconomies of scale arising from the excessive size of the market."[45]

Finally, demographic growth appears to have a positive effect not only by virtue of the economies of scale it makes possible but also because of the possibility of market expansion. When population grows entrepreneurs are encouraged to embark upon new undertakings and strengthen those already begun, a process that generates investment and growth. The opposite, of course, occurs in periods of demographic decline or stagnation. Keynes used an argument of this sort to explain the economic stagnation of Europe in the period between the two world wars.[46]

4.6.3 The Stock of Knowledge and Technological Progress

The stock of knowledge and technological progress are factors that we have also considered above (Chapter 3, Section 5). Gains in "tested knowledge" rely on the existence of ingenious individuals who "invent" new knowledge. The number of these inventors may be proportionate to population size. In any case, the invention of new knowledge is favored by economies of scale (for example, the number of research or scientific institutes, the frequency of contacts between scholars) and so, all things being equal, should enjoy increasing returns as a population grows. As Kuznets, a convinced proponent of this theory, admits,[47] this point of view suggests that we cannot fully compensate for potentially smaller numbers of inventors or institutions by greater investment in education and research: a large community will always have an advantage relative to a small one. It is certainly the case that technical progress – the true motor of development – must be ascribed to new "knowledge," applied with sufficient capital. If, then, the production of knowledge is favored by economies of scale resulting from demographic growth, we can conclude

that the latter contributes to economic growth. While this position is theoretically plausible, it is more difficult to establish historically, especially when we consider the technical progress of demographically small countries like England or the Netherlands, which for long periods significantly exceeded that of much more populous nations.

It is possible, then, that during the past two centuries demographic growth acted more as an incentive than a check to economic development (though more for the reasons given above in discussing purely demographic factors than those of scale and dimensional factors in general, and even less for those pertaining to the stock of knowledge and technological progress). For the opposite reasons we can expect that in the coming decades demographic decline and aging may have the reverse effect. However, the measure of past positive effects and future negative ones is a difficult quantity to assess.

4.7 More on the Relationship between Demographic and Economic Growth: Empirical Observations

Uncertainty about the nature and causal direction of the relationship between economy and population does not prevent us from observing the progress of these forces during the past two centuries, centuries characterized by vigorous expansion of both total and per capita production. Total production, as expressed by GDP (gross domestic product), measures the value of all goods and services produced, excluding foreign trade, and is expressed in constant prices. The series used here, constructed according to a standardized method, are taken from a comparative study of 16 developed countries over several centuries.[48] The accuracy of this reconstruction can only partially compensate for the problems of inadequate statistics (especially for the period prior to World War I) and of conversion to constant prices and a single currency. Consequently, the results should be considered with caution.

The case of the United Kingdom is the most well known. Table 4.8 covers a time span of just over two centuries, and from it we can derive the principal aggregate characteristics of modern demo-economic evolution: an increase in population and employment by a factor of five; a halving during the last century of the average number of hours worked per worker; a 13-fold increase in per capita production and still greater leap (22 times) in productivity per hour worked. Demographic evolution has fueled population and employment increase; social evolution has freed up a large chunk of what was once work time; and economic evolution has multiplied the returns from labor.

Table 4.8 Population, number of employed, production, and productivity in the UK (1785–2000).

Year	GDP (1990 $ million)	Population (thousands)	Employed (thousands)	Hours worked per year and per person employed	GDP per hour worked (1990 $)	Per capita GDP (1990 $)
1785	19,080	12,681	4,915	3,000	1.29	1,505
1820	34,829	19,832	6,884	3,000	1.69	1,756
1870	96,651	29,312	12,285	2,984	2.64	3,297
1913	214,464	42,622	18,566	2,624	4.40	5,032
1950	344,859	50,363	22,400	1,958	7.86	6,847
2000	1,162,663	58,670	26,861	1,489	29.10	19,817
% annual change, 1785–2000	1.9	0.7	0.8	–0.3	1.4	1.2
Ratio, 2000/1785	60.9:1	4.6:1	5.5:1	0.5:1	22.5:1	13.2:1
Doubling time (years)	37.0	94.5	88.0	–207.0	48.7	58.4

Source: Adapted from A. Maddison, *The World Economy. A Millennial Perspective* (OECD, Paris, 2001); and *The World Economy. Historical Statistics* (OECD, Paris, 2003). 1785 data based on A. Maddison, *Phases of Capitalist Development* (Oxford University Press, Oxford, 1982).

Table 4.8 lists a number of indices for the 16 countries in 1870 and 2000, together with annual rates of change for each. In spite of a degree of fundamental similarity, the performance of these countries varied considerably during the period considered. Annual population growth averaged between 1.5 and 1.8 percent for the transoceanic countries of immigration, while for European countries that normally ranged between 0.5 and 0.8 percent, with a few notable exceptions (France at 0.3 percent, Austria at 0.4, and the Netherlands at 1.1), which led to far from uniform demographic evolution within the European continent. Also significant were the different rates of increase in per capita GDP and productivity – per capita GDP ranged from 1.4 percent in Australia to 2.6 in Japan. We should keep in mind that seemingly small differences in growth rates result over time in enormous differences in absolute levels: Canadian per capita GDP, for example, grew at a rate of 2 percent per year during the period 1870–2000 and so multiplied by a factor of 13, while that of the United Kingdom, growing at a rate "barely" a half point less, multiplied by six.

The question arises whether the rate of population increase had an effect on economic development as measured by the growth of per capita production or productivity (admittedly approximate measures). Approaching the problem in this way, we assume that demographic growth itself is not influenced by economic factors, and yet we have already seen that the phases of the demographic transition were profoundly affected by economic developments. Figure 4.12 charts the relationship between population increase and annual per capita GDP increase for the period 1870–2000. The 16 countries are listed in roughly ascending order according to population growth rates. Clearly the economic performance of the countries considered bears no apparent relation to the intensity of demographic growth. The long-term experience of wealthy nations, whose populations grew at different rates, does not allow us to attribute a particular economic role to demographic growth.[49]

One should not conclude, based on the above analysis, that there is no connection between demographic growth and economic development. Instead, this relationship is complicated by the interfering effects of other phenomena. Referring to the same period as that covered by Maddison and arriving at the same conclusion, Kuznets, founder of this school of aggregate analysis, observes:

> Other factors – relative availability of natural resources, timing of the inception of the modern growth process, or institutional conditions – complicate the effects of population growth and prevent a simple association between it and growth in per capita

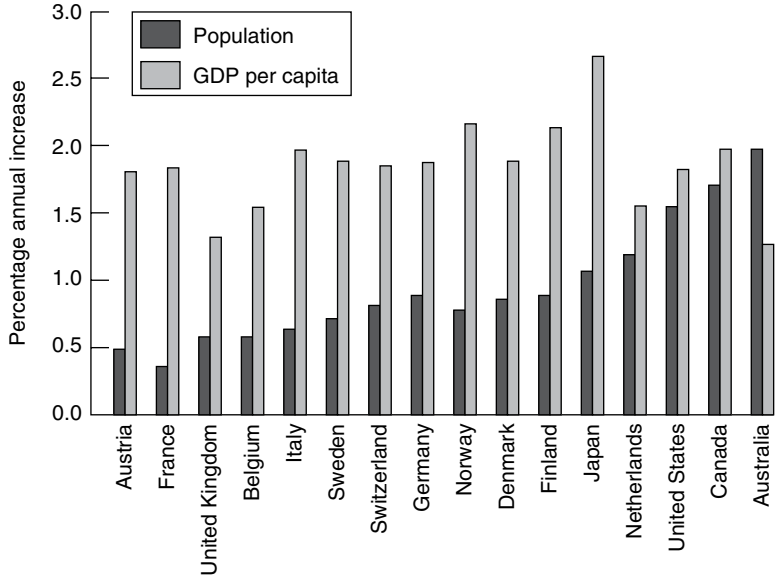

Figure 4.12 Annual rate of increase in population and per capita GDP for 16 industrialized countries (1870–2000).

> product: and population growth itself may have both expansive and depressive effects on the increase in per capita product that differ in their weight in conjunction with other factors.[50]

Beyond these considerations there is a more general one that can only further complicate the relationship: population and economy are at the same time dependent and independent variables. Economic development, as we have seen, exercised a strong influence on the progress of mortality and fertility during the demographic transition, but, as described in the previous section, the reverse is also true. In an open and integrated system, characterized by significant currents of migration (which served as an important force for maintaining equilibrium in much of the period considered), the long-term effects of economic and demographic stimuli tend to mitigate and compensate for one another.

Remaining on an aggregate level, the large economic cycles of the modern era can provide us with a few more insights into the population–economy relationship. Keynes, for example, discussing the rate of capital formation in Great Britain between 1860 and 1913, stated: "Thus the increased demand for capital was primarily attributable to the increasing population and to the rising standard of life and only in a minor degree to technical changes of a kind which called for an increasing capitalization

per unit of consumption"; the demographic deceleration of the interwar period presumably influenced the level of demand, creating overproduction and unemployment.[51] Hansen was of a similar opinion and attributed 40 percent of capital formation in western Europe and 60 percent in the United States during the second half of the nineteenth century to demographic growth; conversely, he traced the economic crisis of the 1930s to the demographic deceleration of the early part of the century and the consequent slowing of investment.[52] It was again Kuznets who attempted to detect a link between demographic and economic cycles in the United States. An increasing standard of living attracted immigration and encouraged nuptiality, accelerating demographic increase. Demographic increase in turn stimulated those investments particularly sensitive to population growth (housing, railroads), but at the expense of other investments in capital goods (machinery and industrial structures). The latter situation negatively affected production and consumption, and so demographic growth, and led to the beginning of another cycle.[53]

Figure 4.13 records changes (in relation to the previous decade) in population increase (in millions), in GDP increase (in billions of dollars), and in per capita income (in dollars) in the United States for each decade from 1875 to 1955. The trends of these three variables are surprisingly similar.

Returning to Europe, it is difficult to explain the phases of economic growth – expansion preceding World War I, stagnation between the wars, and strong recovery since the 1960s (notably interrupted by the oil crisis of the 1970s) – in terms of demographic factors, which tend to act slowly. Nonetheless, this analysis would be incomplete if it did not take into account several significant demographic factors:

1) The first factor is the geodemographic structure of the European continent (excluding the USSR) and its consequences for spatial politico-economic organization, indirectly connected with advantages or disadvantages of scale. Prior to World War I, five large nations (Great Britain, France, Germany, Austria-Hungary, and Italy) dominated the European scene and contained more than three-quarters of the total European population. The rest of the population was scattered among a dozen small countries each one with a population of only a few million, plus Spain. After World War I and the Versailles Treaty, Europe was divided into 22 nations, and the large states, with the dismemberment of Austria-Hungary, were reduced from five to four. The level of continental fragmentation increased, a situation that aggravated the effects of political barriers to the mobility of population and goods.[54] After World War II and the "separation" of eastern Europe, compartmentalization (which declined within

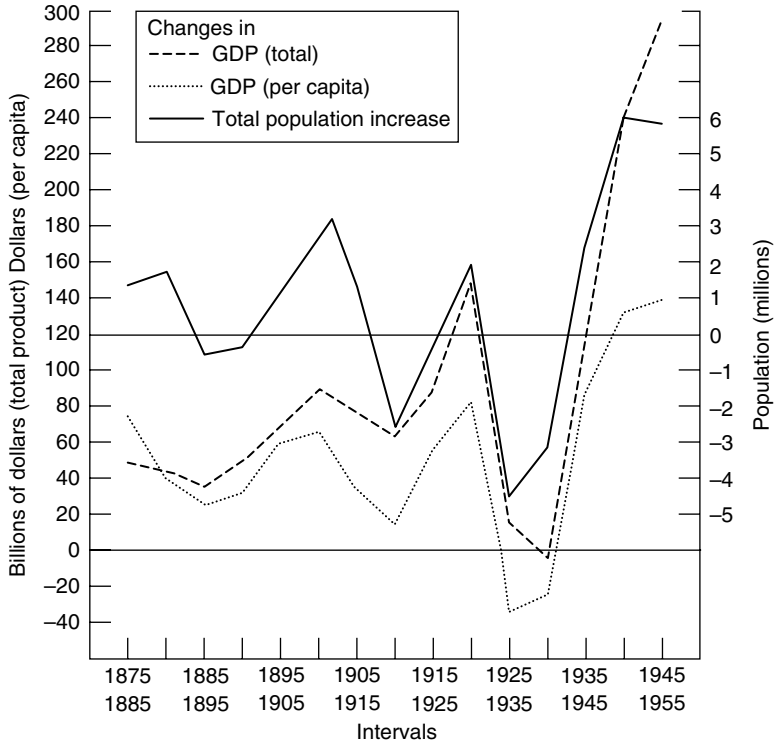

Figure 4.13 Changes in the increase in population compared with changes in GDP, total and per capita, 1929 prices, overlapping decades, United States (1870–1955). *Source*: S. Kuznets, "Long Swings in Population Growth and Related Economic Variables" Proceedings of the American Philosophical Society, Volume 102, Number 1, pp. 25–52. Reprinted with kind permission of American Philosophical Society.

western Europe due to economic unification) became regional. This division collapsed as a result of the events of 1989–90 in the Soviet Union and the Soviet bloc nations and the reunification of Germany, which now demographically (not to mention economically) dominates the center of Europe and – in 2013 – the enlargement of the European Union to 28 states. Both the demographic and political aspects of these recent changes should be taken into account when evaluating subsequent European development, as they bear significantly on the obstacles to population mobility and therefore on the better utilization of human resources. These same factors have also changed economies of scale linked to the absolute and relative size of markets and economic space in general.

2) Another important aspect in determining the role of demographic growth in the expansion of demand is the growth of urban areas and above all of large cities, so often the catalysts of development. Urban growth requires large investment in construction and also frequently in high-tech infrastructure. The 25 European cities that had populations above 500,000 in 1910 had grown in the period 1870–1910 at an annual rate of 1.9 percent; between 1910 and 1940 growth slowed to 0.9 percent and then to 0.3 percent between 1940 and 1970.[55] One could make similar observations regarding the non-European developed countries: while strong in the pre-World War I period, the driving role of urban growth rapidly declined afterward.
3) Mobility and migration measure the ability of a demo-economic system to efficiently distribute human resources. From this point of view, recent European history can be divided into three periods. The first ended with the imposition of immigration restrictions by overseas receiving countries in the early 1920s. It was characterized by strong redistribution processes that sent masses of primarily rural population to overseas destinations. At the same time migration between and within European states was also intense. Legislative barriers to migration were few, and the international labor market was relatively fluid and flexible, despite the difficulty and high cost of transportation. The second period, that between the two world wars, was characterized by the closure of extra-European outlets and the progressive internal compartmentalization of the continent.[56] The labor market shrank and became fragmented. The third, post-World War II phase has been characterized by the "natural" end of emigration outside Europe, by considerable population redistribution within western Europe (sharply divided from the nonmarket-economy Europe), and by the increasing availability of non-European labor. Intra-European migration closes progressively in the 1970s and 1980s as the population reservoir of Mediterranean Europe gradually dries up. But immigration from extra-European countries becomes a dominant factor, notwithstanding the restrictive policies of most countries. The importance of a mobile and plentiful labor force was underlined by economists like Kindleberger, who attributed to it the rapid economic recovery of western Europe in the immediate postwar period.[57]

The conclusions to be drawn from this analysis, kept intentionally general, are fairly weak. If nothing else, we can assert that during the nineteenth and twentieth centuries demographic growth did not hinder economic development. In fact, there are indications that the reverse was true. And while maintaining a position of neutrality on the question of the relationship between economic and demographic growth, it is

nonetheless the case that those nations that experienced the greatest demographic growth are those that have assumed a leading economic role. A final example may help to clarify this relationship. Between 1870 and 2000 the annual growth rate of per capita GDP in the United States and France was identical (1.9 percent), while the population growth rates were very different (1.5 percent in the United States, 0.3 percent in France). As a result, comparison of the economic dimensions of the two countries, as measured by GDP, has changed from a 1.4:1 ratio (in favor of the United States) in 1870 to 5:1 today. Many will hold that per capita income is what matters and that, under this profile, France has done as well as the United States. But under the geopolitical profile, it is the size of the economy that matters the most. With an economy five times larger, and with the same fraction of GDP, the United States can now send to the poor countries five times more aid than France, in the form of credit, food, medicines, tools, or computers. Or can have five times the number of planes, missiles, and ships to wage a war. One cannot but ask the entirely rhetorical question: Would the United States be the leader of the western world if it had experienced more modest demographic growth?

Notes

1 D. S. Landes, "Technological Change and Development in Western Europe 1750–1914," in H. J. Habakkuk and M. Postan, eds., *Cambridge Economic History* (Cambridge University Press, Cambridge, 2nd edn 1965), vol. 6, pt. 1, pp. 274–661.

2 The data in Table 4.1, the concept of multiplier, and the above description of the transition model are Taken from J.-C. Chesnais, *La Transition Démographique [The Demographic Transition]* (PUF, Paris, 1986), p. 33; J.-C. Chesnais, "Demographic Transition Patterns and Their Impact on Age Structure," *Population and Development Review* 16:2 (1990).

3 L. Del Panta, *Le Epidemie nella Storia Demografica Italiana (Secoli XIV–XIX) [Epidemics in Demographic History (XIV–XIX centuries)]* (Loescher, Turin, 1980), pp. 160, 168. C. Ó Gráda, *Famine. A Short History* (Princeton University Press, Princeton, NJ, 2009).

4 According to the model life tables of Coale and Demeny (A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations*, Princeton University Press, Princeton, NJ, 1966), for example, taking life expectancies of 27.5 years for women and 25.3 for men (model West), we obtain the following results. The probability that a 40-year-old woman lives to 60 is 0.536 and the probability that a 10-year-old boy lives to 30 is 0.764. During a 20-year period, a mother and son aged 40 and 10 present four possibilities: (1) that both survive, the probability for which is

0.536 × 0.764 = 0.410; (2) that the mother outlives the son, with a probability of 0.536 × (1 – 0.764) = 0.126; (3) that the son outlives the mother, with a probability of 0.764 × (1 – 0.536) = 0.354; (4) that both die, with a probability of (1 – 0.536) × (1 – 0.764) = 0.110. The sum of the four probabilities of course equals 1. Should the mother survive (probability 0.536), she outlives her son in one case out of four (0.126: 0.536 = 0.235). Given present-day mortality, the probability of this happening is about 1 in 60.

5 K. F. Helleiner, "The Population of Europe from the Black Death to the Eve of the Vital Revolution," in *The Cambridge Economic History of Europe* (Cambridge University Press, Cambridge, 1967), vol. 4: *The Economy of Expanding Europe in the Sixteenth and Seventeenth Centuries*, ed. E. E. Rich and C. Wilson.

6 The literature on this subject is vast. I shall limit myself to the following citations: for Italy, Del Panta, *Le Epidemie*; for England, E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541–1871* (Edward Arnold, London, 1981); for Spain, V. Pérez Moreda, *Las Crisis de Mortalidad en la España Interior, Siglos XVI–XIX [The Mortality Crisis in the Spanish Interior, XV–XIX Centuries]* (Siglo Veintiuno, Madrid, 1980); for France, G. Cabourdin, J.-N. Biraben, and A. Blum, "Les Crises Démographiques, [Demographic Crises]" in J. Dupâquier, ed., *Histoire de la Population Française [History of the French Population]* (PUF, Paris, 1988), vol. 2: *De la Renaissance à 1789 [From the Renaissance to 1789]*.

7 On the great microbiological discoveries of the nineteenth century, see G. Penso, *La Conquista del Mondo Invisibile* (Feltrinelli, Milan, 1973).

8 T. McKeown, *The Modern Rise of Population* (Edward Arnold, London, 1976).

9 G. Caselli, "Health Transition and Cause-Specific Mortality," in R. Schofield, D. Reher, and A. Bideau, eds., *The Decline of Mortality in Europe* (Oxford University Press, Oxford, 1991).

10 Values of e_0 equal to 50 are obtained by linear interpolation (and in some cases extrapolation) of series for the various countries found in L. I. Dublin, A. J. Lotka, and M. Spiegelman, *Length of Life* (Ronald Press, New York, 1949). For Sweden, Denmark, Belgium, the Netherlands, Switzerland, Australia, and the United States the date at which female life expectancy reached 50 falls between 1880 and 1900; for England, France, and Germany it is between 1900 and 1910; for Finland, Austria, and Italy between 1910 and 1920; for Greece, Hungary, and the USSR after 1920.

11 A. Maddison, *Monitoring the World Economy 1820–1992* (OECD, Paris, 1995). GDP (Gross Domestic Product) and GDP per capita used in this and in the next chapter are in "1990 international dollars" (or 1990

Geary–Khamis dollars, from the names of the scholars who developed the methodology). These are known also as PPP (Purchasing Power Parity) dollars. A PPP dollar is an abstract measure that, taking into consideration the fact that prices change across time and space, "buys" the same fraction of well-being and therefore is historically and geographically comparable. In practice, the "international dollar" has many limitations either intrinsic to the quantitative material available (quite scarce and often unreliable, particularly for remote times) or because the range of goods and services produced and available for consumption is in continuous change. See pp. 162–9 of Maddison's book. For the list of the 16 countries, see Table 4.5.

12 The most significant of these is that the two variables are not independent from one another: while it is true that mortality depends in part on well-being, it is also the case that there would not have been material progress without mortality decline.

13 There exists, of course, fertility outside of marriage, generally (and improperly) called illegitimate. Historically, levels of illegitimate fertility in the West have been insignificant as (at least until the last few decades) the vast majority of reproduction has taken place within the context of marriage.

14 It is a conceptually subtle distinction that separates voluntary from nonvoluntary fertility control. Demographers call fertility that is not voluntarily controlled "natural fertility." Its level can vary considerably as a function of the behavior of couples or mothers (sexual taboos, frequency of intercourse, length of breast-feeding, and so on – see Chapter 1, Section 4). Nonetheless, these types of behavior are presumably "structural" and do not reflect the desire of couples to achieve a particular family size; procreational behavior does not vary as a function of the number of children already born. Voluntary fertility control by means of contraception or coitus interruptus, on the other hand, has as its aim the production of a certain number of children. Control is practiced above all by couples who have reached the desired number, so that reproductive behavior tends to change as a function of children born. A decline in the average age of the mother at last birth or in fertility at the youngest ages is a sign of fertility control in a population; both situations lead to a change in the "shape" of the fertility curve by age.

15 M. Livi-Bacci, "Social-Group Forerunners of Fertility Control in Europe," in A. J. Coale and S. C. Watkins, eds., *The Decline of Fertility in Europe* (Princeton University Press, Princeton, NJ, 1986).

16 Urban fertility was generally lower than rural, though this was due in part to the particular makeup of the urban population and its high mobility. However, contrary to the model of slower rural decline, fertility began to drop in some areas of Hungary from the late-eighteenth century. See R. Andorka,

"La prévention des Naissances en Hongrie dans la Région Ormansag Depuis la Fin du XVIII[e] Siècle [Birth Control in Hungary in the Ormansag Region since the End of the Eighteenth Century]," *Population* 26 (1971).

17 The general aims, characteristics, and results of this study, directed by Ansley Coale and coordinated by the Office of Population Research at Princeton, are summarized in Coale and Watkins, *Decline of Fertility*. The graphs in Figure 4.6 (a–e) include points for the following countries: Belgium, Denmark, England and Wales, Finland, France, Germany, Hungary, Ireland, Italy, the Netherlands, Norway, Portugal, Scotland, Spain, Sweden, and Switzerland.

18 The indices I_m, I_f, I_g (indices of the proportion of women of childbearing age who are married, general fertility, and legitimate fertility), and I_h (a similar index of illegitimate fertility not discussed here) are calculated in the following manner; f_i, g_i, and h_i represent, respectively, total births, legitimate births, and illegitimate births per woman of age interval i. Similarly, w_i, m_i, and u_i represent total women, married women, and unmarried women in the same age interval. F_i is the fertility coefficient for the model population, namely Hutterite women married in the period 1921–30, a group notable for having the highest fertility ever recorded in a regularly constituted population. Given the above information, the following indices can be calculated:

$$\textit{General fertility } I_f = \sum f_i w_i / \sum F_i w_i \quad [1]$$

$$\textit{Legitimate fertility } I_g = \sum g_i m_i / \sum F_i m_i \quad [2]$$

$$\textit{Illegitimate fertility } I_h = \sum h_i u_i / \sum F_i u_i \quad [3]$$

$$\textit{Proportion of women married } I_m = \sum F_i m_i / \sum F_i w_i \quad [4]$$

The numerators of equations 1, 2, and 3 are, respectively, the total births, legitimate births, and illegitimate births of the population studied. The values of F_i are: ages 15–19 = 0.300, 20–24 = 0.550, 25–29 = 0.502, 30–34 = 0.447, 35–39 = 0.406, 40–44 = 0.222, 45–49 = 0.061. The four indices are related by the following equation: $I_f = I_g \times I_m + I_h \times (1 - I_m)$. When I_h is very low, say below 0.05 (or 5 percent), as has traditionally been the case for all western populations, then the index of general fertility closely approximates $I_g \times I_m$. All the indices have values below 1. In the case of I_g the value of the index represents the ratio between the legitimate fertility of the population studied and the theoretical maximum of the Hutterites. Values below 0.6 generally indicate a degree of voluntary fertility control.

19 Among the results of the Princeton study are maps of fertility and nuptiality trends from the second half of the nineteenth century to 1960. See Coale and Watkins, *Decline of Fertility*. For more detailed

"geography," see the national monographs, all published by the Princeton University Press, for the following countries: France (E. van de Walle), Great Britain (M. Teitelbaum), Germany (M. Knodel), the former USSR (B. Anderson, A. J. Coale, and E. Harm), Italy (M. Livi-Bacci), Belgium (R. Lesthaeghe), and Portugal (M. Livi-Bacci).

20 Several authors believe that in the long term that fertility will hover around two, in keeping with the mean number of children that women and couples declare to want, or expect to have or consider as ideal – as shown repeatedly by surveys. Substantial deviations from this pattern would be mainly the consequence of changes in the "tempo" of fertility, due to transitory factors. On this position is J. Bongaarts, "Fertility and Reproductive Preferences in Post-Transitional Societies," *Population and Development Review* 27:Suppl. (2001). Others – among them this author – are of a different opinion and argue that societies may adjust, for long periods, to patterns of fertility that are structurally very low, as the cases of Germany and Italy demonstrate. Some more has to be said about the concept of "replacement fertility." Fertility is at "replacement level" when each generation of women exactly replaces the previous one, implying that a newborn girl gives birth to one daughter on average during her lifetime. Replacement fertility exceeds two because more boys are born than girls (the sex ratio at birth is 1.05/1.06 boys:1 girl) and also because children who die before reaching reproductive age must be replaced with additional births. The higher mortality, the higher replacement fertility. This now is fractionally lower than 2.1 in developed countries and stands at 2.4 in developing ones. See also note 16, Chapter 1. For the view that the era of very low fertility is at the end and that a turning point is in the making, see J. R. Goldstein, T. Sobotka, and A. Jasilioniene, "The end of 'lowest-low' fertility," *Population and Development Review* 35:4 (December 2009).

21 The values of *TFR* used here are "period" rates as opposed to the "cohort" rates used in Table 4.7. Period rates are calculated by combining fertility levels for women of different ages at the same date (and so born on different dates and having different fertility histories) and so emphasize the temporary influence of economic factors.

22 A. Maddison, *Monitoring the World Economy, 1820–1922* (OECD, Paris, 1995), pp. 61–4.

23 K. O'Rourke and J. G. Williamson, *Globalization and History, the Evolution of a Nineteenth Century Atlantic Economy* (MIT Press, Cambridge, MA., 1999).

24 Chesnais, *La Transition Démographique*, p. 164.

25 By combining US immigration statistics with census results (which asked for the nationality of those surveyed), I have been able to calculate that between 1880 and 1950, 50.2 percent of Italian immigrants returned to Italy after stays of varying lengths. M. Livi-Bacci,

L'Immigrazione e l'assimilazione degli Italiani negli Stati Uniti [Immigration and Assimilation of Italians in the United States] (Giuffrè, Milan, 1961), pp. 34 – 5. In order to calculate the present-day population descended from net Italian migration in the period 1861–1961, I applied the Italian growth rate for each decade to the net migration for the same period, assuming that it was maintained (by both the first migrants and their descendants) up until 1981.

26 Chesnais, *La Transition Démographique*, pp. 169–72.

27 P. Bairoch, *International Historical Statistics*, vol. 1: *The Working Population and its Structure* (New York, 1969).

28 D. Grigg, *The Transformation of Agriculture in the West* (Blackwell, Oxford, 1992), Table 4.2, p. 35.

29 Grigg, *Transformation of Agriculture in the West*, Table 2.2, p. 19.

30 See D. S. Massey, J. Arango, G. Hugo, A. Kouaouci, A. Pellegrino, and J. E. Taylor, *Worlds in Motion: Understanding International Migration at the End of the Millennium* (Oxford University Press, Oxford, 1998). D. J. Hatton and J. G. Williamson, *The Age of Mass Migration: Causes and Economic Impact* (Oxford University Press, Oxford, 1998).

31 A typical case is that of Venetia, which, in the 1920s, was the last region of north-central Italy to initiate fertility control. Legitimate fertility (I_g) increased considerably in the period just prior to the onset of decline (almost 20 percent between 1881 and 1911). Factors influencing the increase included improved living conditions and the elimination of pellagra, a vitamin-deficiency-related disease resulting from excessive dependence on corn (maize). See M. Livi-Bacci, "Fertility, Nutrition and Pellagra: Italy during the Vital Revolution," *Journal of Interdisciplinary History* 16 (Winter, 1986).

32 It is, however, generally considered obvious that the increased survivorship of the twentieth century is responsible for the demographic aging of the population – that is, the increased proportion of old people. This aging has, in fact, been due exclusively to the progressive decline of fertility as a result of which the younger levels of the age structure have not been sufficiently replenished. Moreover, one can show that improved survivorship was proportionately more significant for younger age groups than for older and so created a greater increase, all things being equal, among the young than the old; the age structure actually became younger. The situation today and in the near future, however, is different. Improvements in survivorship will almost exclusively benefit the old (there being virtually no room left for improvement at the younger ages). As a result further mortality decline will contribute to population aging. Historically, however, this has not been the case.

33 Obviously fertility alone does not determine the change in family size. Survivorship, age at which the children leave home, widowhood and

second marriages, the frequency of extended families (composed of more than one biological nucleus), and cohabitation of nonrelated persons are also factors determining family size.

34 A population with fixed fertility and mortality behavior ultimately achieves a fixed-age structure (determined by this behavior) as well as fixed crude birth, death, and growth rates. A theoretical population of this sort is called a "stable" population. In Table 4.6, the parameters reported refer to the stable populations, which would be produced by Italian mortality and fertility behavior in 1881 and 1981.

35 J. A. Schumpeter, *Capitalism, Socialism, and Democracy* (Harper & Brothers, New York, 2nd edn 1947), p. 83.

36 J. Simon, *The Economics of Population Growth* (Princeton University Press, Princeton, NJ, 1976); J. Simon, *Theory of Population Economics* (Blackwell, Oxford, 1986).

37 Y. Hayami and V. W. Ruttan, *Population Growth and Agricultural Productivity* (Johns Hopkins University Press, Baltimore, MD, 1985).

38 W. S. Jevons, *The Coal Question* (Macmillan, London, 1865).

39 Club of Rome, *The Limits to Growth* (Universe Books, New York, 1972).

40 Maddison, *Phases*, p. 48. A similar trend has taken place in Great Britain, where the ratio declines from 2.55 TPE per $1,000 of production in 1855 to 0.99 in 1979. For recent trends in the United States and in other major countries, see http://data. worldbank.org/indicator/ EG.GDP. PUSE.KO.PP.KD/countries?page = 5 [accessed July 21, 2016].

41 A. Marshall, *Principles of Economics* (Macmillan, London, 1920), pp. xv–xvi. A bushel is equivalent to 35.2 liters.

42 These arguments are developed in S. Kuznets, *Modern Economic Growth* (Yale University Press, New Haven, CT, 1966), p. 57.

43 J. J. Spengler, *Facing Zero Population Growth* (Duke University Press, Durham, NC, 1978), pp. 136–9.

44 E. F. Denison, *Accounting for the United States' Economic Growth* (Brookings Institution, Washington, DC, 1974), pp. 71–5; and by the same author: *Why Growth Rates Differ* (Brookings Institution, Washington, DC, 1967), pp. 232–3.

45 E. A. G. Robinson, ed., *Economic Consequences of the Size of Nations* (Macmillan, London, 1960), p. xxii of Robinson's Introduction. A. Alesina and A. Spolaore, *The Size of Nations* (MIT Press, Cambridge, MA, 2003).

46 J. M. Keynes, "Some Economic Consequences of a Declining Population," *Eugenics Review* 4:3 (April 1937). These same ideas were stated much more explicitly in J. R. Hicks's review of Keynes, "Mr. Keynes' Theory of Employment," cited in Spengler, *Facing Zero Population Growth*, p. 62: "Expectation of a continually expanding market, made possible by increasing population, is a fine thing for keeping up the spirit of entrepreneurs. With increasing population

investment can go roaring ahead, even if invention is rather stupid; increasing population is therefore actually favorable to employment."

47 S. Kuznets, "Population Change and Aggregate Output" (NBER report), in *Demographic and Economic Change in Developed Countries* (Princeton University Press, Princeton, NJ, 1960), pp. 329–30.

48 These series, in 1990 international dollars, are found in Maddison, *Monitoring the World Economy*. See also note 11 of this chapter.

49 The lack of a clear relationship is evident even when examining separately the three subperiods. The correlation coefficients between the rates of variation for population and GDP are: 1870–1913, + 0.003; 1913–50, +0.180; 1950–87, –0.220; 1970–87, –0.119.

50 Kuznets, *Modern Economic Growth*, p. 68.

51 Keynes, "Some Economic Consequences," p. 15.

52 Cited in Spengler, *Facing Zero Population Growth*, p. 64.

53 S. Kuznets, *Economic Growth and Structure* (Norton, New York, 1965), pp. 345–9. For refinement and discussion of the Kuznets model see R. A. Easterlin, "Economic– Demographic Interactions and Long Swings in Economic Growth," *American Economic Review* 56 (1966).

54 I. Svennilson, *Growth and Stagnation in the European Economy* (United Nations Economic Commission for Europe, Geneva, 1954), pp. 67–8.

55 The population of these 25 cities was 13.1 million in 1870, 28.4 million in 1910, 37.7 million in 1940, and 41.4 million in 1970. Data taken from B. R. Mitchell, *European Historical Statistics* (Macmillan, London, 1980).

56 D. Kirk, *Europe's Population in the Interwar Years* (League of Nations, Princeton University Press, Princeton, NJ, 1946), pp. 97–125.

57 C. P. Kindleberger, *Europe's Postwar Growth* (Harvard University Press, Cambridge, MA, 1967). See also M. Livi-Bacci and G. Tapinos, "Economie et Population," in J.-P. Bardet and J. Dupâquier, eds., *Histoire de la Population de l'Europe [The History of the Population of Europe],* vol. 3: *Les Temps Incertains, 1914–98 [Uncertain Times: 1904–98]* (Fayard, Paris, 1998).

Further Reading

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