Volume Title: Health and Welfare during Industrialization

Volume Author/Editor: Richard H. Steckel and Roderick Floud, Eds.

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-77156-3

Volume URL: http://www.nber.org/books/stec97-1

Publication Date: January 1997

Chapter Title: Conclusions

Chapter Author: Richard H. Steckel, Roderick Floud

Chapter URL: http://www.nber.org/chapters/c7437

Chapter pages in book: (p. 423 - 450)

11 Conclusions

Richard H. Steckel and Roderick Floud

The papers in this volume present and analyze evidence on health and welfare in diverse settings. The temporal trends, geographic patterns, and socioeconomic differences that they depict help to tell the story of living standards from the preindustrial era to the creation of modern, industrial societies. Their focus is primarily local, with emphasis on changing conditions within particular countries.

In contrast, this concluding chapter adopts a comparative perspective to investigate common patterns across countries. General tendencies appear in the evidence despite substantial differences across countries in dates of industrialization, geographic location, major wars, land availability, government policies, and cultural conditions. While mindful of conditions specific to individual countries, it is those general tendencies that this chapter seeks to elucidate.

11.1 Methodology

As an aid to understanding cross-country patterns, we arrange indicators of the standard of living by country and date (table 11.1) and by country and phase of industrialization (table 11.2). The dates chosen—1800, 1850, 1900, and 1950—encompass the process of industrialization for most countries in the study and provide benchmarks for assessing change.[1]

Though imprecise, the phases of industrialization are also useful concepts for understanding patterns of health and welfare. While economic historians abandoned rigid chronological structures (such as the stages of economic

Richard H. Steckel is professor of economics at Ohio State University and a research associate of the National Bureau of Economic Research. Roderick Floud is provost of London Guildhall University and a research associate of the National Bureau of Economic Research.

1. The exception is England, which started to industrialize before 1800. The date of 1800 is also problematic for Australia, which was colonized only a few years earlier.

Table 11.1 **Socioeconomic Indicators by Country and Date**

Country	Per Capita GNP (1985 $)	Growth Rate	Men's Height	Life Expectancy	Literacy Rate (%)	Percentage Urban
			Date: 1800			
United Kingdom	1,301	0.1	168.9	36.1	52.2	33.6
United States	828	0.5	172.9	46.8	72.4	6.1
France	700	0.3	163.7	34	40	19
Netherlands	876	0.0	167.8	34.1	75	37
Sweden	808	0.1	167.0	39.2	82.5	9.8
Germany				37	83.5	23.3
Australia						
Japan	575	0.1	157.1	36	20	14
			Date: 1850			
United Kingdom	1,943	1.6	165.3	39.5	61.3	53.4
United States	1,179	1.5	171.1	39.5	78.0	15.3
France	1,150	1.3	164.7	40	58	26
Netherlands	1,551	0.2	167.4	37.3	75	39
Sweden	871	0.9	168.2	43.9	90.0	10.1
Germany	835	0.0	162.6	37.1	95	32.3
Australia	2,517	1.8	172.7	46	45	34
Japan	606	0.1	155	38	25	34.5
			Date: 1900			
United Kingdom	3,792	1.3	169.3	48.0	97	77.7
United States	3,824	2.3	170.0	47.8	89.3	39.7
France	2,250	1.3	166.6	46.8	95	41
Netherlands	2,842	0.9	170.0	49.0	90	49
Sweden	1,895	2.4	172.5	52.9	100.0	21.5
Germany	1,743	1.5	169	44.4	99.9	53.8
Australia	4,100	0.9	170.9	55	80	52
Japan	947	1.0	157	44	75	54.5
			Date: 1950			
United Kingdom	5,628	0.9	174.1	69.0	100.0	80.7
United States	8,588	2.1	177.1	68.2	97.4	59.0
France	4,149	4.0	172.3	66.8	99	55
Netherlands	4,706	3.4	178.1	71.3	100	71
Sweden	5,834	2.4	177.9	71.4	100.0	46.6
Germany	2,554	6.4	176.3	66.5	100.0	71.1
Australia	5,931	2.4	173.8	69.5	98	70
Japan	1,563	1.5	162	58	100.0	75.2

Sources: See data appendix.

growth) many years ago, they agree that some order or sequence prevailed in the process. For example, England was clearly the first industrial country, and the process of industrialization tended to spread across Europe from west to east. Industrial activity began in the United States sometime in the early nineteenth century, and economic growth accelerated in Australia near the middle of the century. In Japan the transformation began in the 1880s.

Table 11.2 Socioeconomic Indicators by Country and Phase of Industrialization

Country	Approximate Dates	Per Capita GNP (1985 $)	Growth Rate	Men's Height	Life Expectancy	Literacy (%)	Percentage Urban
		Phase: Preindustrial					
United Kingdom	1720–60	1,172	0.4	165.1	33.7	48.9	22.6
United States	1800–1820	872	0.4	173	45.3	72.9	6.9
France	1800–20	952	0.1	164.1	36	41	19
Netherlands	1830–50	1,469	0.1	164.0	35	75	38
Sweden	1830–50	832	0.5	168.0	42.1	87.5	9.7
Germany	1830–50				36.9	91	30.5
Australia	1840–60	1,994	1.6	172.5	46	45	30
Japan	1868–80	775	0.2	155.3	36	25	34.5
		Phase: Early Industrial					
United Kingdom	1760–1800	1,263	0.2	168.2	36.0	50.2	29.4
United States	1820–50	1,025	0.9	172.4	41.7	75.6	10.5
France	1820–50	976	1.3	164.4	39.3	49	22
Netherlands	1850–70	1,807	0.5	165.9	40	80	44
Sweden	1850–70	980	1.2	169.1	43.9	92.5	11.2
Germany	1850–70	972	1.5	166.2	37.6	95	34.4
Australia	1860–90	3,425	1.8	172	48	55	42
Japan	1880–1900	875	1.0	157	38	70	50
		Phase: Middle Industrial					
United Kingdom	1800–1830	1,422	0.6	170.7	38.6	54	38.7
United States	1850–80	1,727	2.5	170.6	40.9	80.3	22.3
France	1850–80	1,400	1.3	165.4	41	67	31
Netherlands	1879–1900	2,453	1.1	168.6	45	85	46
Sweden	1870–1900	1,466	1.8	171.4	49.3	98.2	17.2
Germany	1870–90	1,371	1.6	167.5	38.9	98.5	43.6
Australia	1890–1920	4,263	0.8	172	59.2	80	53
Japan	1900–1920	1,100	2.0	158.8	44	75	60
		Phase: Late Industrial					
United Kingdom	1830–70	2,770	2.2	166.9	49.5	64.5	54.1
United States	1880–1910	3,539	2.2	170.2	45.6	87.8	37.2
France	1880–1910	2,050	1.3	166.7	45.5	90	39
Germany	1890–1913	1,885	1.3	169.7	46.8	100.0	56.1
Netherlands	1900–1925	3,718	0.5	172.0	55.2	98	56
Sweden	1900–1925	2,423	2.2	173.5	57.4	100.0	25.7
Australia	1920–40	5,170	0.7	173.2	65.4	90	60
Japan	1920–40	1,320	2.2	160	47	96	75.5

Sources: See data appendix.

The dates assigned here to the phases of industrialization are necessarily imprecise because the character of the process differed across countries. The United Kingdom, the United States, Germany, and Japan developed large manufacturing sectors and heavy industry, whereas the Netherlands (lacking coal and water power) cultivated banking, shipping, and services, and Australia emphasized agriculture and mining. Indeed, it might be more appropriate to call

the transformations in Australia and the Netherlands economic modernization rather than industrialization. The term "industrialization" is used here in a broad sense to encompass economic modernization within these countries.

As a result of this variation there is no single indicator of industrialization, such as the percentage of the labor force in manufacturing or the share of GNP originating outside agriculture, that adequately captures the diversity and complexity of the process. Instead, we consider numerous indicators to judge the experiences of various countries against the benchmark of the United States. The categories begin with a short preindustrial period that acts as a backdrop against which the industrial experience is compared. Three phases of industrialization are then identified, beginning with an early industrial period in which the transition to a modern industrial economy began. Industrialization and modernization spread geographically and diversified in the middle period and became widespread and dominant in the late industrial phase.

The phases of industrialization in individual countries are judged relative to developments in the United States. America's early industrial period unfolded in the years 1820 to 1850, a time when economic growth accelerated, a decline in the relative importance of agriculture occurred, and expansion of manufacturing and trade was evident, particularly in the Northeast. In the middle phase, 1850–80, industrialization spread to the Midwest, mechanization and factory methods of production penetrated numerous industries, and regional interdependence became significant. In the late phase, 1880–1910, agriculture was eclipsed by heavy industry, manufacturing, trade and services, and substantial self-sufficiency of the household, which declined throughout industrialization, disappeared as a way of life.[2] Inevitably, the choice of dates for the phases of industrialization in individual countries is imprecise, which is acknowledged by rounding or frequent use of years ending in zero as end points. Given this situation, it is important not to rely too greatly on the results.

11.2 Patterns of Health and Welfare

Table 11.1 shows that the countries varied substantially by income, growth rates, urbanization, health, and literacy at the benchmark dates.[3] In 1800 the

2. These phases of industrialization are least clear in the cases of the United Kingdom and Australia. Numerous researchers emphasize the continuity rather than changes or transitions in the English experience. Moreover, the process of industrialization in the United Kingdom was elongated and drawn out relative to other countries, which poses difficulties in selecting dates. Australia, as noted earlier, had fewer of the hallmarks of industrialization than other countries in the volume. With the possible exception of the United Kingdom, the early phase of industrialization—the transition from agriculture to heavy industry, manufacturing, commerce, and services—is more clearly marked than the later phases.

3. We urge readers to consult the data appendix for sources and qualifications in these data. In general, the estimates for the early period are somewhat fragile relative to the later years, and the per capita GNP data are limited in comparability by reliance on exchange rates. Major conflicts (Napoleonic Wars and World War II) may be an important factor in the results for particular countries in 1800 and 1950.

United Kingdom was ahead of the pack in terms of incomes, but the United States was growing most rapidly. Even at a 0.5 percent annual rate, however, incomes in the United States were doubling every 139 years, an improvement barely noticeable within an individual's working life. Elsewhere, average changes in access to goods and services within a working life span were virtually nil. Americans were the tallest (172.9 cm for males) and the healthiest (life expectancy at birth of approximately 46.8 years) by a wide margin. A substantial majority of the population was literate in the United States, Germany, Sweden, and the Netherlands, but only a small minority could read and write in Japan, which serves as a reminder of the significant educational investments made in that country after the Restoration. The United States, Sweden, Australia, and Japan were thoroughly rural societies, but even the most urban countries (the United Kingdom and the Netherlands) had only one-third of their populations living in cities or towns with populations of 2,500 or more.

By 1850 several countries were growing at nearly 1.0 percent or more, and modest improvements in health had occurred in some countries since 1800. Australia, with its substantial endowment of mineral and grazing resources, led the pack in terms of income, growth rate, stature, and life expectancy. Sweden and Germany had achieved near universal literacy, and the vast majority of residents were literate in the United States, France, and the Netherlands. With over 50 percent of its population living in cities or towns, England was by far the most urbanized country, while Sweden and the United States remained predominantly rural.

All countries in the sample had begun the process of industrialization by the end of the nineteenth century. In 1900 growth rates of real per capita income were more than 2.0 percent in Sweden and the United States, and they were 1.0 percent or more in the United Kingdom, France, Germany, and Japan. Australia and the Netherlands were experiencing temporary economic reversals in which growth rates fell below 1.0 percent. Health had improved substantially since the middle of the nineteenth century, as evidenced by the number of countries in which men's stature was 170.0 cm or more (the United States, the Netherlands, Sweden, and Australia) and life expectancy at birth surpassed 50 years (Sweden and Australia). The Japanese were moderately healthy as measured by life expectancy at birth (44 years), but their stature (156 cm) was remarkably low even after allowing for genetic differences in growth.[4] The vast majority of the population was literate in all countries. In 1900 most residents in the United Kingdom and a majority (or near majority) of those in the Netherlands, Germany, and Australia lived in urban areas. Sweden was the only society in the group under study that remained substantially rural at the turn of the century.

By the middle of the twentieth century the modern industrial economy had

4. Today the Japanese have the highest life expectancy in the world, but well-nourished adults in that country fall about one standard deviation (6.5 cm) below modern NCHS height standards. For a discussion of growth in Japan see Tanner et al. (1982).

recently emerged or had existed for some time in all countries in the sample. Although the post–World War II era was generally prosperous, growth rates varied widely at midcentury. The United Kingdom and Japan temporarily languished, but the growth rate reached 3.4 percent in the Netherlands, 4.0 percent in France, and 6.4 percent in Germany. Health had improved substantially over the last half-century. Average adult male stature exceeded 170 cm for seven out of eight countries in the sample, and it equaled or surpassed 175 cm in the United States, France, the Netherlands, Germany, and Sweden. Life expectancy at birth, which was at most 55 years in 1900, exceeded 65 years in seven out of eight countries, and in the Netherlands and Sweden it topped 70 years. Literacy was nearly universal in every country including Japan, which made the remarkable leap from only 25 percent literacy in 1850. The majority of all populations, except residents of Sweden (46.6 percent), lived in urban areas, and the figure exceeded the remarkable level of 80 percent in the United Kingdom.

Table 11.1 highlights the diverse experiences of countries over the long term, but the arrangement of the evidence at particular dates obscures trends that accompanied industrialization. Table 11.2 presents evidence on socioeconomic indicators by country for the preindustrial period and the various phases of industrialization. Given the ambiguities surrounding dates for phases of industrialization that were noted earlier, it is important not to give too much credence to the results that use these categories. Nevertheless, several interesting patterns emerge.

With some notable exceptions, preindustrial life was characterized by poverty, slow growth, poor health, widespread illiteracy, and rural habitation. With its good health and a per capita income and growth rate significantly above those elsewhere, Australia was an outlier. Fueled by mineral and agricultural resources, its economy was well positioned to reap the advantages of a growing demand for fibers and metals that accompanied industrialization elsewhere, and by rising food prices brought on by population growth, wars, or harvest failures near the middle of the century. Good health in Australia was promoted by a sound nutritional base and low population density. With extensive access to land, the United States also had relatively good health in the preindustrial era, but income growth (0.4 percent) was modest by the standards of industrial countries. The vast majority of adults in Germany and Sweden, and to a lesser extent the United States, were literate in the preindustrial period, an investment that helped to catapult these countries along a path of rapid industrialization later in the century.[5]

The countries in table 11.2 are listed in the approximate order in which industrialization unfolded. The United Kingdom was first, followed by the United States and France, and then by a group of three—the Netherlands, Sweden, and Germany. Australia came next, followed by Japan. This configuration

5. On the importance of literacy for economic development, see Sandberg (1979).

shows that while income levels varied widely in the early phases of industrialization, growth rates were often higher for the late-comers. Alexander Gerschenkron (1962) noted such a pattern for Europe, but it holds when Japan and Australia are included in the picture. He cited the ability to borrow advanced technology as an important factor that gave late-comers a rapid industrial spurt.

Except in the United States and Australia, stature was substantially below modern height standards in the early industrial period. Life expectancy at birth approached 50 years in Australia, and was nearly 45 years in Sweden. Despite its early industrial success, Germany's life expectancy languished at 37.6 years. Literacy rates improved substantially over those for the preindustrial period in Japan, while France and Australia registered modest improvements. Despite its vast land area, Australia was the most urban country with 42 percent of its population living in cities or towns.

Some departures from the pattern of growth rates appeared in the middle phase of industrialization. In the United Kingdom and Australia, per capita income growth languished, albeit at a high income level in the latter country. Meanwhile, the United States, a relative newcomer, attained the highest growth rate of all countries in the sample.[6] However, stature declined from its level in the early phase, which suggests that the American population may have paid a biological price for aspects of this prosperity. Life expectancy at birth advanced substantially in Australia and Sweden, and large increases in literacy rates were achieved by France and Australia. Australia and Japan became the first countries to have a majority of their populations (53 percent and 60 percent, respectively) reside in urban areas within this phase of industrialization, while the United States and Sweden remained substantially rural.

In the late industrial phase, the United Kingdom, the United States, Sweden, and Japan had annual growth rates of 2.2 percent. Sluggish growth continued in Australia, and the growth rate plummeted to 0.5 percent in the Netherlands. Health measured by life expectancy improved everywhere in the sample, led by an 11-year gain in the United Kingdom, but stature declined from its level in the middle industrial phase in the United Kingdom and the United States. Literacy was virtually universal in Germany, Sweden, and Japan, was very widespread in Australia, France, and the United States, but reached only 64.5 percent in the first industrial country, the United Kingdom. A majority of the population lived in urban areas in Australia, Germany, the Netherlands, the United Kingdom, and Japan, but only one-quarter of the residents in Sweden, the least urban country in the group, lived in cities or towns.

The organization of data by phases of industrialization may disguise declines in health that were not centered on the time periods chosen. Table 11.3 considers whether any meaningful decline in stature occurred during industri-

6. This was a notable achievement in light of the economic penalties associated with destruction of capital during the Civil War of the 1860s and reorganization of the Southern economy thereafter. On the other side of the ledger, inflows from Europe promoted labor force growth and huge amounts of farm land and other resources were made available through westward expansion.

Table 11.3 Stature during Industrialization

Country	Decline in Stature?	Birth Cohorts Approximate Dates	Amount
United Kingdom (men)[a]	Yes	1760–90	0.7 cm
		1820–50	5.4 cm
United Kingdom (women)[b]	Yes	1790–1815	2.5 cm
		1835–55	2.5 cm
United States	Yes	1830–90	4.0 cm
France	No		
Netherlands	No		
Sweden	No		
Germany[c]	Yes	1860–72	2.5 cm
		1879–85	2.0 cm
Australia	Yes	1867–93	3.0 cm
Japan	No		

Sources: See data appendix.

[a]The years 1760 to 1850 embraced two downturns and an upturn from 1790 to 1820 such that the net decline was 2.0 cm over the period. The upturn between 1790 and 1820 was 4.1 cm.

[b]The upturn between 1815 and 1835 was approximately 0.75 cm.

[c]The upturn between 1872 and 1879 was 3.3 cm.

alization.[7] The answer is clearly no in France, Sweden, the Netherlands, and Japan. The results are somewhat ambiguous in Germany; declines were small and short lived, and there was a modest improvement in stature of approximately 1 cm for birth cohorts of the early 1860s through the early 1890s. This leaves the United Kingdom, the United States, and Australia. The deepest decline (about 5.4 cm) occurred for men in the United Kingdom, 1820–50, while the longest—60 years—took place in the United States. Interestingly, the two countries with greatest stature during the nineteenth century—Australia and the United States—experienced declines in this measure of health. However, in neither case did stature at their nadirs approach the level typical of Europe.

11.3 Explanations

If we ask whether the perception of industrialization as seen by Marx, Engels, and Dickens in mid-nineteenth-century England—a world of misery, degradation, and declining quality of life for the working population—was the fate of all industrializing countries, the answer is clearly no. While it may be true that some indicators, such as stature, were deteriorating in England for a portion of the industrializing period, several countries (France, Sweden, the Netherlands, and Japan) witnessed virtually uninterrupted increases in a broad

7. In principle, the question of declines in health could be asked of data on life expectancy. However, the evidence on this measure of health is not so continuous or abundant as it is for stature.

spectrum of measures of the quality of life during industrialization.[8] The situation was more complex in Germany, where downturns in health were cyclical rather than secular, and the long term saw significant improvement in all indicators. Only the United Kingdom, the United States, and Australia experienced significant declines in health.

A comparative international perspective makes clear that no simple relationship existed between various measures of living standards and industrialization. The diversity of experiences—details in the type of indicators, the timing, and the amount of change during industrialization—suggests that some country-specific factors were important. The issue is one of common causal mechanisms, and we find three that were important in the experiences of all countries studied: (1) the timing of industrialization relative to the rise of the germ theory of disease and public health, (2) the extent of urbanization, and (3) diets. Beyond these, numerous characteristics helped to distinguish the experiences of particular countries, including the vigor of public health efforts; the relative abundance of land, or population density; income; inequality of wealth or income; food prices; the nature of industrialization; birthrates; migration and emigration; interregional trade; the rise of public schooling; wars; emancipations; and government policy.[9] The potency and mechanism of these variables for health and nutritional status have been discussed in the literature on stature, including the papers in this volume. Here we provide only a sketch of their relevance.

The germ theory of disease, which came to be widely accepted in the medical profession by the 1880s, and the consequent diffusion of public health measures in the late nineteenth and early twentieth centuries were ultimately effective in preventing infection.[10] The former provided a mechanism for understanding the transmission of pathogens, and its application in the form of public health and personal hygiene led to better health through policies such as waste disposal, clean water supplies, and antiseptic medical procedures. Because congested living in cities or towns provided an environment favorable to the spread of communicable diseases, the percentage of the population living in urban areas was relevant for health prior to the era when public health was effective.

Although urbanization and the germ theory of disease were important for their claims placed on nutritional intakes, as the major input to net nutrition, diets were clearly detrimental to growth and general health. Moreover, diets varied over time and across countries in ways significant for understanding the course of health during industrialization. Abundant land resources improved

8. Business cycles and short-term reversals in health were part of the picture.

9. Climate could be on the list, but with the exception of Australia, variations in this factor were modest across the countries in the sample.

10. Some public measures beneficial to health were undertaken before the germ theory was generally accepted by the medical profession (Szreter 1988). In England, for example, Edwin Chadwick's arguments for sanitary reform were based on a different theory of disease causation.

health in three ways: low population density, which reduced the spread of communicable diseases; availability of land to produce food; and the opportunity to choose the best plots for cultivation, which lowered work effort in food production.[11]

Income was important for health because it provided the means to purchase the essentials of life: food, clothing, housing, and medical care. At the level of the individual or household, height was a nonlinear function of income. Extreme poverty resulted in inadequate calories and a lack of vitamins and minerals for health and growth. As income increased from very low levels, a better diet as well as improved clothing and shelter could be purchased. Additional income may have increased the consumption of basic necessities, particularly medical care, but once a person's genetic potential was realized, additional expenditures no longer contributed to growth. The limits to the process are clear from the fact that children from wealthy families are not superhealthy, physical giants. If height is a nonlinear function of income, then the distribution of income or wealth affects average stature and overall health. Assuming that incomes were low enough in some households to constrain health and physical growth, then redistribution of some income from the rich to the poor increased average health and stature of the population because the basic necessities for health for the rich were met even with their lower income.

Exposure to pathogens made substantial claims on health and nutrition, particularly in the era before public health measures. The nature of industrialization affected health through the size of the workplace and associated environmental conditions. The transmission of communicable diseases was greater in large factories as opposed to small workshops, while surrounding conditions such as dust, dampness, ventilation, and lighting affected the prevalence of pathogens. In contrast with the self-paced work on farms or in artisan shops, arduous factory work geared to machines may have been a drain on health. The rise of mass schooling may have contributed to human capital, but at a cost of exposure to communicable diseases in the classroom. Migration, emigration, and interregional trade also increased the exposure of the population to pathogens, as made clear by the diffusion of epidemics along trade routes. Studies of child survival in the mid-nineteenth century indicate that death rates increased with the number of siblings, which indicates that child health and growth varied inversely with the birthrate (Steckel 1988).[12] As recently as the 1960s, among families of unskilled workers in the United Kingdom the stature of children declined by more than 2.5 cm as the number of siblings increased from zero to more than three (Eveleth and Tanner 1990, 202).

Wars and government policy affected the consumption of basic necessities and therefore health and physical growth. Concentrations and turnover of

11. Of course, a measure such as square miles per person is only a crude proxy for available farmland, and population may be far from evenly distributed.

12. The finding that wealth of the household had no systematic effect on survival suggests that the number of siblings was important for its impact on the disease pool.

troops in the American Civil War, for example, spread communicable diseases. This war also disrupted food production and distribution within the country and led to the distress of the cotton famine in Britain. The paper by Gail Honda on Japan shows how government support for the military before and during World War II diverted health resources and lowered nutritional status.

In summary, by reducing exposure to pathogens the germ theory of disease, public health measures, and personal hygiene were significant for the consequences of industrialization. Countries that industrialized and urbanized before these developments paid a biological penalty, as did those places with environments conducive to the spread of infections through high rates of migration, emigration, interregional trade, and early development of public schools. Depending on the country, the costs may have been aggravated by war and perverse government policies. On the other hand, higher incomes, widespread access to land, relatively equitable distribution of resources, and low birthrates could have reduced the penalty.

We also know that significant improvements in mortality and stature occurred before the public health movement of the 1880s, and that countries with relatively greater access to good agricultural land tended to have better diets, larger stature, and lower mortality rates. Stature trended upward from the second quarter of the nineteenth century in France, from the middle of the nineteenth century in the United Kingdom, Sweden, and the Netherlands, and from the 1870s in Germany. Although trends in mortality rates were clouded by subsistence crises near the middle of the century, which is additional testimony to the importance of diets for health, significant improvement was visible by the middle of the century in France and Sweden, by the 1860s in the Netherlands, and by the 1870s in the United Kingdom and Germany. Land-rich countries such as the United States and Australia experienced downturns in heights, but from a relatively high level. A deterioration in diets has been suggested as a contributing factor in the American height decline after 1830 (Komlos 1987).

Although most scholars agree that dietary improvements added to better health prior to the 1880s, they disagree on relative importance. McKeown (1983) has been perhaps the strongest advocate of the dietary position, while Razzell (1993) and Livi-Bacci (1983) have raised doubts or downplayed the contribution of nutritional inputs to health, citing factors such as the independence of many diseases from nutrition, human adaptability to food availability, smallpox inoculation, and changing virulence of diseases. Fogel (1985) estimated that roughly 40 percent of the decline in mortality in England between 1800 and 1980 can be explained by improvements in nutritional status (net nutrition).

We need not resolve the debate over nutrition and the modern rise of population to make the point that health improved during the nineteenth century, and therefore later industrializers had lower biological costs associated with urbanization, congested working conditions, migration, and trade. However, we believe that better diets were important for improving health. Among the papers

in the volume, the clearest connection between trends in diet and stature can be seen in David Weir's paper on France. His figure 5.6 shows a rise in meat consumption during the nineteenth century that parallels the rise in stature and the downward trend in mortality. Dietary improvement in nineteenth-century Europe was made possible by technical improvements, such as light iron plows, steam threshers, mechanical harvesters, and commercial fertilizers, as well as by agrarian reforms such as enclosures or emancipation of serfs (Jones 1968; Trow-Smith 1967; Tracy 1964).[13] In the second half of the nineteenth century, diets also received a boost from the free trade movement. This and greater speed and lower transportation costs on long ocean voyages made it feasible to import foodstuffs from Australia and from the land-rich countries in the Western Hemisphere, principally the United States, Canada, and Argentina.

In light of these factors, the questions suggested by cross-country comparisons are: (1) Why did Australia and the United States have relatively tall stature throughout industrialization? (2) Why did some countries (the United Kingdom, the United States, and Australia) experience significant declines or cycles, and another (Germany) only mild fluctuations in stature during industrialization? (3) Why did other countries (France, Sweden, the Netherlands, and Japan) show continuous improvements in health during industrialization? (4) Why did stature and life expectancy remain so low in Japan as late as 1950?

Although the two continental countries had some negative attributes for health, such as early industrialization (the United States) or a relatively large percentage urban (Australia), it is clear that these adverse characteristics were more than outweighed by the enormous benefits of abundant land. Ample land for farming or grazing and excellent waters for fishing provided a strong nutritional base. Moreover, the nutritional costs of disease were less than elsewhere. Epidemics were rare or had minimal consequence for nonindigenous populations before the 1830s in the United States and before the 1860s in Australia. Relative isolation from other parts of the world, at least prior to the middle of the nineteenth century, also helped to reduce disease. Though the share of the Australian population living in urban areas was large, until the late nineteenth century the urban population was widely dispersed in five moderate-sized cities, which were weakly connected by trade and migration.

The height declines during industrialization add new perspective on the standard of living that was once seen primarily through the lenses of per capita income and real wages. The issue is how to reconcile the patterns in these diverse sources of evidence. The outcome depends in part on the definition of the problem. Paul Johnson and Stephen Nicholas demonstrate that women's stature in the United Kingdom declined between 1790 (the date of the earliest evidence) and the mid-nineteenth century, while Roderick Floud and Bernard Harris show that men's stature fell between the 1760s and the 1850s. This sim-

13. However, for most of the nineteenth century agrarian reforms were more important as a new, dynamic force in Central or Eastern Europe as opposed to Western Europe.

plified picture might be explained by the United Kingdom's early industrialization and its large and growing share of population living in urban areas that were well connected by migration and trade with other parts of the country and the world. However, this view of the evidence ignores a substantial increase in the stature of military recruits that occurred in the early nineteenth century, which indicates that some beneficial environmental change must have occurred along the way. Likely explanations are income growth, which at 1.0 percent per year was the largest in the sample, and increasing nutritional equality as indicated by a narrowing of occupational differences in stature. These advantages led to a temporary increase in stature, at least for men, which was later offset by the substantial leap in urban population that occurred from 1830 to 1860.

The Americans and the Australians declined in height from the highest levels attained in the early and mid-nineteenth century. Dora Costa and Richard Steckel show that even though the United States was an early industrializer, the share living in urban areas was relatively small and grew slowly. Rising incomes associated with industrialization were beneficial for health, but other costs related to the process outweighed the advantages of income per se. The rise of factories in the era before public health contributed to the height decline, which is consistent with smaller stature in the Northeast where textile mills and other manufacturing plants were located. However, most of the half-century decline after 1830 was rural in nature. The transportation revolution, which began with steamboats on western rivers in 1816 and continued with canals after 1825 and with railroads in the late 1830s, promoted interregional migration and trade that spread communicable diseases among a population whose prior isolation afforded them little immunity to pathogens. The emergence and growth of public schools in the 1840s also contributed to the spread of disease. Over half a century of heavy immigration from Europe, beginning with the Irish potato famine in the late 1840s, churned the disease pool in the United States. Growing inequality of wealth combined with rising food prices, and the falling birthweights of babies of poor women suggest that the quality of life may have decayed for the lower classes. The hardships of the Civil War in the 1860s contributed to the decline in health of those born near the middle of the century, and the struggles of the Southern economy thereafter affected health in that region. In sum, numerous factors contributed to America's deterioration in health, a process that was eventually reversed in the 1880s by growing incomes and by the public health movement acting on the germ theory of disease.

The Australian case parallels that of the United States: residents of both countries were tall and their recovery from the downturn coincided with the rise of the germ theory of disease and public health in the late nineteenth century. Because evidence has yet to be compiled for birth cohorts prior to the 1860s, the timing of the downturn is uncertain. A decline of approximately 3 cm occurred from 1867 to 1893, with most of the drop occurring after 1880.

Why would health decline in a rich country with abundant land and widespread access to resources? Greg Whitwell, Christine de Souza, and Stephen Nicholas observe that the explanation cannot be pinned on the rise of factories and congested working conditions. Instead, the major culprit seems to have been the negative externalities of a large and rapidly growing urban population. As cities grew rapidly in the 1880s, crowd diseases such as typhoid became more prevalent. Those born in the 1880s also experienced, as adolescents, the economic hardships of the depression of the 1890s.

Sophia Twarog argues that the fluctuations in German (Württemberg) stature were not attributable to urbanization. Those born in urban areas were taller during the industrial period, probably due to a vigorous public health movement and government encouragement of breast-feeding in the cities. Instead, the first decline in stature (cohorts born in the 1860s and early 1870s) was related to widening occupational differentials in stature, which were themselves associated with growing inequality and income decline reinforced by the crash of 1873. Economic hardship also lay behind the second dip in stature during the 1880s. The distress in this period led to emigration and to social legislation creating health and accident insurance.

Among the four countries that had sustained increases in health during industrialization—France, the Netherlands, Sweden, and Japan—the first two are particularly intriguing. How did these two countries avoid a decline in health during industrialization, given that France industrialized early and had a moderate-sized urban sector while the Netherlands industrialized later but had a larger share living in urban areas? David Weir's study emphasizes two unusual aspects of French urbanization during industrialization. The first is the slow growth and low overall levels of urbanization, which eased health externalities associated with congestion. The second is the relatively high meat consumption in cities, which apparently improved the diet sufficiently to reduce the negative health consequences of urban living. In addition, he has argued elsewhere that the early decline in fertility in France helped to advance parental investments in child health (Weir 1993). Social, legal, and economic changes of the French Revolution also reallocated resources and reduced inequality compared with other countries. The low French birthrates also improved the health and physical growth of young children by restricting the spread of communicable diseases. J. W. Drukker and Vincent Tassenaar note that in the Netherlands the sustained increase in stature beginning near the middle of the century was matched by a sustained decline in mortality rates. In the early phase of industrialization the modernizing urban sector remained relatively small while much industrial activity occurred in the healthier rural areas, a phenomenon also found in Sweden.

It is easier to explain why industrialization was compatible with improving health in Sweden and Japan. The paper by Lars Sandberg and Richard Steckel notes that Sweden was largely a rural society well into the early twentieth

century. Moreover, Sweden had a very high literacy rate that complemented a particularly vigorous public health movement. Japan industrialized rather late, with most of the action occurring after the rise of public health.

Although life expectancy at birth in Japan today is approximately 80 years, health and welfare lagged during industrialization. Between the early phase of industrialization and 1950, average stature grew only 5 cm in Japan compared with 7.4 cm in other countries of the sample.[14] Consistent with this observation, life expectancy at birth grew only 20 years in Japan compared with an average of 28 years elsewhere over these dates. Table 11.2 shows that in 1950 Japan had the lowest life expectancy and the smallest stature (even after allowing 6.5 cm for genetic considerations). Therefore, much of the distance toward exceptional health was achieved along with the phenomenal economic growth of the past few decades. As Honda notes in her paper, stature was higher in the more urban, industrializing areas of the country, which makes it implausible to argue that industrialization per se retarded health. Instead, the answer can be found in government policies that diverted resources from health and nutritional uses to military expansion.

11.4 Epilogue

The papers in this volume expand the range of indicators and apply new methodologies for assessing welfare during industrialization. Once seen primarily through the lenses of per capita income or real wages, here the standard of living is also measured by stature, life expectancy, body mass index, inequality, and education. Among these, stature is the most abundant new source of information on health aspects of the quality of life.

All papers apply the multiple indicators approach to evaluating these measures—an intuitive method for appraising their importance. Several papers also utilize more explicit, but debatable, methods such as the United Nations' Human Development Index or Usher's adjustment for calculating growth rates, and some apply Borda rankings of indicators or Thaler-Rosen estimates of the value of life for adjusting GNP.

Ample research opportunities remain. Several additional countries could be added to the database—Norway, Austria-Hungary, Spain, and Italy come readily to mind in Europe, while in the Western Hemisphere, Canada and several Latin American countries have considerable potential for developing databases on living standards. Study of several Asian countries, which developed in the twentieth century, would provide perspective on events of the eighteenth and nineteenth centuries. In all countries, including those studied in this vol-

14. This point does not hinge on a deterioration in Japanese health that occurred during World War II. The results would be essentially unchanged if health conditions in 1940 were substituted for those in 1950.

ume, it may be possible to gather additional information, such as body mass index, stature, inequality, or life expectancy, which will enhance our knowledge of welfare during industrialization.

There may be substantial payoffs to further study of the functional implications of anthropometric measures. Stature and the body mass index are not easily understood in isolation by social scientists who are unfamiliar with biomedical studies or who lack firsthand experience observing malnourished children in poor, developing countries. Therefore, it is important to explain the meaning of these measures in terms of familiar concepts such as income, real wages, educational achievement, productivity, life expectancy, labor force participation, and causes of death. Knowledge of these functional implications will also assist efforts to attach monetary values to nonmonetary indicators of the standard of living, which is important for assessing the net effect of diverse measures on welfare. Several possibilities are explored by the papers in this volume, and we hope that the results will encourage interest in this valuable area of research.

Data Appendix

Australia

(a) Per capita GNP: Interpolated, where necessary, from Maddison (1991, table 1.1).

(b) Stature: Prior to 1950, the source is figure 10.3 of the paper in this volume by Whitwell, de Souza, and Nicholas. The figure cited for 1850 is based on cohorts of the late 1860s and early 1870s. For 1950, the source is Eveleth and Tanner (1976, appendix table 25), which pertains to men aged 18 in Sydney.

(c) Life expectancy at birth: Estimates are based on Vamplew (1987, tables MFM 195–20, MFM 209–220, and MFM 221–232). The figure of 46 years in 1850 is based on Vamplew (MFM 195–201) for males and females in New South Wales for the period 1856–65. Male life expectancy (MFM 209–22), Australia-wide, was 51.06 for the period 1891–1900 and 55.20 for 1901–10, which in turn suggests a figure of about 53 for 1900. For females (table MFM 221–232), the figures are 54.76, 58.84, and 57.0. Averaging the male and female figures (53 and 57) gives a national average of 55. Male life expectancy was 66.07 for the period 1946–48 and 67.14 for the period 1953–55, which suggests a figure of about 66.5 for 1950. The corresponding figures for females are 70.63, 72.75, and 71.7. Averaging the male and female figures for the two periods gives a value of 69.5.

(d) Literacy: Interpolated from Vamplew (1987, 339).

(e) Urbanization: The figures, which include cities or towns with a popula-

tion of 2,500 or more, are interpolated, where necessary, from Vamplew (1987) and Frost (1990, table 1). The figures in 1850 and 1900 apply to New South Wales, Queensland, South Australia, and Victoria (Western Australia, which was lightly settled, is omitted).

France

Table 11.1 benchmark date estimates are trend values. The data points in table 11.2 are generally averages of annual data.

(a) GDP and growth rates: Estimates in 1985 U.S. dollars were formed by using the real GDP per capita described in the appendix to David Weir's paper in this volume (in 1905–13 francs) and then reflating to 1985 dollars by the ratio of Maddison's (1991) 1985 estimate for French per capita GDP in 1985 dollars to Weir's estimate in 1905–13 francs (ratio = 2.377).

(b) Stature: The average heights are for cohorts born in the years indicated in the tables. Prior to 1922 (cohorts born up to 1902), they are as described in appendix B of Weir's paper. The 1950 cohort is from Olivier et al. (1977, 200).

(c) Life expectancy at birth: The data, which cover both sexes and include civilian mortality only, are based on period life tables from Blayo (1975) for 1740–1829, Vallin (1973) for 1900–60, and unpublished annual life tables constructed by David Weir for 1806–1911.

(d) Literacy: This series is based on signatures for both sexes from new marriages in the years indicated. Data for 1740–1829 are reported by Houdaille (1977), while subsequent periods are taken from annual volumes of the *Annuaire Statistique.*

(e) Percentage urban: The official French census definition of urban is used (communes of at least 2,000 persons in agglomerated areas), following Tugault (1975).

Germany

(a) Per capita GNP: The data on per capita Net National Product (in constant 1913 prices) and average population between 1850 and 1955 were derived from Hoffmann (1965). For 1850–1950, these figures are presented in table 8.3 of Twarog (chap. 8 in this volume). The consumer price indices from Maddison (1991) were used to convert the income data into 1985 marks. The 1985 marks were converted into 1985 dollars using the International Comparison Project benchmark estimates for purchasing power parity (PPP) units in 1985 (DM 2.37162 per dollar), as employed by Maddison (1991). The growth rate for 1950 is the average annual rate between 1950 and 1955. The growth rate for 1900 is the average annual rate between 1895 and 1905.

(b) Stature: The height data for 1850 to 1937 are based on the RSMLE estimates in Twarog (1993), six-year and two-year phases for Württemberg recruits born between 1852 and 1893, and on Harbeck's (1960) finding that the average stature of German 20-year-old recruits born in 1937 was 173.2 cm. Estimates for birth years 1894–1914 were derived via interpolation using the trend be-

tween 1892–93 and 1937. The height estimate for 1950 is from Jürgens (1971) and is based on a geographically balanced sample of 7,093 draftable twenty-year-olds born in 1948 and 1949. Since growth generally continues past age 20 in populations subject to adverse environmental conditions, upward adjustments were made to the recruits' average stature as follows: 2 cm for the birth cohort of 1850; 1.5 cm for 1850–71 and 1871–96; 1 cm for 1896–1914 and 1900.

(c) Life expectancy at birth: The figures for life expectancy (average of males and females) after 1871 are derived from Wiegand and Zapf (1982) and given in table 8.12 of Twarog (chap. 8 in this volume). For the periods before 1871, the average mortality rates (from Mitchell 1980) were compared with the mortality rates in those periods for which the life expectancy is known. Based on a comparison of the average life expectancies and mortality rates in 1871–80, 1881–90, and 1891–1900, the assumption used was that a one-point drop in the mortality rate corresponds approximately to a one-year rise in life expectancy in the relevant range. For 1800, the average mortality rate of 1817–19 was used, because earlier data were not available. For 1850, the average mortality rate for 1845–55 was used.

(d) Literacy: Literacy rates are those of army recruits in Prussia (1841–74, available years) and the German Empire (1875–1912). The figures are drawn from table 8.18 in Twarog (chap. 8 in this volume) and Cipolla (1969). For the German army, literacy was defined as being able to write one's name and read sufficiently, a concept that is ambiguous. Moreover, these estimates certainly overestimate the adult population's literacy because women were generally less literate than men. The estimate for 1800 is based on the assumption that the change in the literacy rate between 1800 and 1841 was equal to that between 1841 and 1882 (7.5 percentage points).

(e) Urbanization: Urban refers to communities with over 2,000 residents. These estimates are based on Hoffmann's data as displayed in table 8.2 in Twarog (chap. 8 in this volume). Interpolation and extrapolation were used where necessary. For example, the estimates for 1800–1850 were derived by using the 1852–71 annual rate of change. The percentage urban for each period is the average of the beginning and end year estimated value.

The Netherlands

(a) Per capita GNP: The general source is Maddison (1991), using linear interpolation where necessary: Table A.5, Movement in GDP, 1700–1869 (1913 = 100.0), gives 15.71 for 1820 and 24.5 for 1850; table A.2, Gross Domestic Product in 1985 U.S.-Relative-Prices (million dollars) gives 19.588 for 1913; table B.1, Mid-Year Population, 1500–1860 (thousands), gives 2.355 for 1820 and 3.095 for 1850. So real Dutch GDP per capita in 1820 can be calculated as (15.71 / 100 * 19.588 * 1000) / 2.355 = 1307, and in 1850 as (24.5 / 100 * 19.588 * 1000) / 3.095 = 1551. Drukker and Tassenaar (chap. 9 in this volume, table 9A.7) give 104.08 for 1807 and 184.28 for 1851.

It is assumed that real income growth was negligible during the years of the French occupation of the Netherlands (1795–1813). If correct, real GNP per capita in 1800 equaled real GNP per capita in 1807. Then (104.08 / 184.28) * 100 = 56.48, so that 56.48 / 100 = real GNP per capita in 1800 / 1551, which implies real GNP per capita in 1800 was 876 in 1985 dollars.

The annual growth rate was assumed to be zero under the French occupation around 1800. Various estimates of the rate are available for the period around 1850, including 1.1 percent as calculated from the per capita GNP data given in table 11.1. However, this estimate is likely to be too high. For the period from 1820 to 1851, Maddison's figures show that the rate was 0.6 percent. Based on Drukker and Tassenaar (chap. 9 in this volume, table 9A.7), the rate was 0.15 percent (col. [2]) to 0.26 percent (col. [3]). Emphasizing the latter figures, a reasonable guess of the growth rate around 1850 is 0.2 percent.

Three sets calculations were considered in estimating the growth rate around 1900. Interpolations from Maddison's figures for the period 1895 to 1905 indicate a rate of 0.7 percent, whereas Drukker and Tassenaar (chap. 9 in this volume, table 9A.7) give rates of 0.9 percent (col. [2]) to 1.11 percent (col. [3]). This collection of estimates suggests a rate of approximately 0.9 percent.

It is somewhat difficult to suggest a growth rate that typifies the period around 1950 since many European economies, including the Netherlands, were recovering from World War II. The annual data on population and GNP in Maddison for the years immediately around 1950 indicate a rate of 3.4 percent.

(b) Stature: (1) The figure for 1800 was estimated from Oppers (1963) using 392 observations in tables 12, 14, 15, 16, 18, and 19. He sampled men's heights from seven geographically spread cities in the Netherlands, ranging in age groups from 19 years up to 34 years, in total more than 14,000 observations, over the period (year of birth) 1794 up to 1877. A number of 382 observations could be used for the estimate of Dutch men's height for 1800. The estimate was calculated as a weighted average of subgroups of applicable observations by Oppers with the number of observations in each subgroup as weights. There is probably a slight underestimation in the figure, due to the facts that his observations were only for city dwellers, who may have been a little bit shorter than country dwellers, and men under 25 years of age may not have reached their final stature. (2) The figure for 1850 was estimated from the same source as for 1800, according to the same procedure, now based on 663 observations of city dwellers. (3) The figure for 1900 was derived from Drukker and Tassenaar (chap. 9 in this volume, table 9A.1) under the assumptions that average height equals median height around 1900, and that adult height was reached by age 19.75. The figure in 1920 was taken as an estimate for average height of the birth cohort in 1900, as the data are for 19.75-year-old year conscripts in the year of measurement. (4) The height of men born in 1950 is from Centraal Bureau voor de Statistiek (1994, 260, table 16, col. [6]). The figure for 1969 (conscription year) was taken, as conscripts were measured in that year at 19 years of age.

(c) Life expectancy at birth: (1) The figure for 1800 was estimated by regressing the crude death rate on average life expectancies for the consecutive periods from 1840–51 to 1900–1909. The life expectancies were obtained from Centraal Bureau voor de Statistiek (1942, 57, table 14) and the average death rates were calculated from Drukker and Tassenaar (chap. 4 in this volume, table 9A.4). The death rate for 1800 was calculated as an average of the yearly death rates between 1795 and 1805, as published by Horlings (1993, appendix 2, 18). The resulting estimate of life expectancy is 34.1 years. (2) Life expectancy in 1850 was estimated as an average for men and women over the years 1840–51 and 1850–59 as published in Centraal Bureau voor de Statistiek (1942, 57, table 14). The value for 1900 was calculated from the same source in a similar manner, while that for 1950 was tabulated in the same way from Centraal Bureau voor de Statistiek (1967, 57, table 14).

(d) Literacy: (1) The figure for 1800 is from van Zanden (1991, 41, table 10), which shows that the percentage of grooms not signing the wedding certificate was 24.6 percent between 1813 and 1819. Supposing that this percentage was more or less constant at least since 1800 gives a figure of approximately 25 percent. From the same table, it can be derived that 25.1 percent of all conscripts in the Netherlands could not read or write between 1846 and 1852, which forms the basis for the figure of 25 percent in 1850. (2) Data in Centraal Bureau voor de Statistiek (1994, 242, table 15, col. [2]; 16, table 1, col. [4]) show that approximately 93 percent of children between ages 6 and 16 attended school in 1900. Since a small percentage of these children were unlikely to master reading and writing skills, a reasonable estimate of the literacy rate is 90 percent around 1900. Of course, older generations alive at the time may have had somewhat lower literacy rates. From the same sources it can be calculated in the same way that the literacy rate around 1950 was very close to 100 percent.

(e) Urbanization: Percentage urban is defined here as the percentage of the population living in municipalities of more than 2,500 inhabitants. (1) 1800: According to De Vries and Van der Woude (1995, 82–83), in 1795 about 40 percent of the total population of the Netherlands lived in cities and 7.1 percent of total city population lived in cities that had fewer than 2,500 inhabitants. Taking conditions in 1795 as a proxy for those in 1800, the percentage urban was approximately $40 - (0.071 \times 40) = 37.2$. (2) 1850: According to the official census of December 1849, 36 percent of the total population of the Netherlands lived in cities. The same source indicates that 0.9 percent of the total population lived in cities that had fewer than 2,500 inhabitants, but not every urban center had the official status of a city. In these places lived 3.4 percent of the total population. So the urbanization rate (percent) was approximately $36.0 - 0.9 + 3.4 = 38.5$. (3) 1900: According to Kooij (1985, 97), 45.2 percent of the population lived in cities and 3.3 percent lived in urban centers without the official title of city. So the percentage living in urban areas was approximately $45.2 + 3.3 = 48.5$. (4) 1950: Kooij (1985, 97) indicates

that 54.4 percent of the population lived in cities and 16.2 percent lived in urban centers without the official title of city. So the percentage urban was approximately 54.4 + 16.2 = 70.6.

Japan

(a) Per capita GNP: Interpolated, where necessary, from Maddison (1991, table 1.1).

(b) Growth rates: 1800 and 1850, estimated from growth in per capita grain output, 1750–1850 (Hayami and Miyamoto 1988); 1900 and 1950, Ohkawa and Rosovsky (1973, 25, 28); preindustrial period, estimated from growth in per capita grain output, 1850–72 (Hayami and Miyamoto 1988); early, middle, and late industrial periods, Ohkawa and Rosovsky (1973, 28).

(c) Stature: 1800, based on length of right femur (Hiramoto 1972); 1850, Mosk and Johansson (1986, 429); 1900, Shay (1986, appendix); 1950, Shay (1986, appendix) by extrapolation; preindustrial period, based on length of right femur (Hiramoto 1972); early, middle, and late industrial periods, Shay (1986, appendix).

(d) Life expectancy: 1800, Saitō (1992); 1850 and 1900, Mosk and Johansson (1984); 1950, Taeuber (1958, 294); pre- and early industrial periods, Mosk and Johansson (1986, 429); middle industrial period, Mosk and Johansson (1984); late industrial period, Taeuber (1958, 288).

(e) Percentage urban: Defined in all years as the percentage of the population living in cities or towns of 5,000 or more inhabitants. 1800, Wilkinson (1965, 24); 1850 and 1900, interpolated from Taeuber (1958, 72) and Wilkinson (1965, 24); 1950, Taeuber (1958, 72). The figures for all phases of industrialization were interpolated from Wilkinson (1965, 24) and Taeuber (1958, 72).

(f) Literacy: 1800, Taira (1971, 375); 1850, Nakamura (1983, 48); 1900, Taira (1971, 376); 1950, Taeuber (1958, 66–68); preindustrial, Nakamura (1983, 48); early and middle industrial, Taira (1971, 374–75); late industrial, Taeuber (1958, 66–68).

Sweden

See the data appendix of chapter 4 in this volume, by Lars Sandberg and Richard Steckel, for additional discussion of sources.

(a) Per capita GNP: Maddison (1991) for the period 1820–60 and Krantz and Nilsson (1980) for the period thereafter to 1965. These original numbers were converted from Swedish kronor to U.S. dollars at an exchange rate of 5.18 Skr per dollar.

(b) Stature: Cohorts born before 1820: soldiers of various ages who served in the so-called settled (*indelta*) army (see Sandberg and Steckel 1988). Cohorts born 1820 and thereafter: conscripted militia. These nationwide average data cover the great majority of young men measured in the year they turned age 21 (born 1820–97), age 20 (born 1898–1929), age 19 (born 1930–35), and

finally age 18 (born 1936–). Because the age reductions occurred in line with the decline in the age of maturation, the changes had very little effect on the trend in final adult heights. More worrisome was the fact that the military imposed nontrivial height standards on cohorts born between 1819 and 1839. We corrected for the resulting shortfall using the Quantile Bend Estimator (Wachter and Trussell 1982). The fact that data are missing for a few scattered years forced us to interpolate for those years.

(c) Life expectancy at birth: Keyfitz and Fleiger (1968).

(d) Literacy: The numbers we provide are based on the conclusion reported by, although by no means unique to, Cipolla (1969) that Swedish literacy had reached 90 percent by 1850 and that virtually all Swedish youths were then literate. The compulsory education act of 1842 was unquestionably having an effect, although schools were certainly commonplace even before that year. Given a flow of virtually 100 percent literate cohorts reaching adulthood after 1850, a 0.25 annual rate of increase in literacy up to 100 percent in 1890 seems highly reasonable. Similarly, a 0.25 percent rate before 1850 also yields a reasonable result of 82.5 percent in 1820.

(e) Percentage urban: Defined here as cities or towns with populations of 2,500 or more, the source is Statistiska Centralbyrån (1969, 46).

United Kingdom

(a) Per capita GNP: Mitchell's (1988, 837–41) estimates for 1830–1980 were extrapolated backward using the growth rates computed by Crafts (1985, 45). Mitchell's figures in 1900, 1938, 1958, and 1980 were converted to 1980 prices, and the results translated in 1985 sterling prices using the price index for GDP at market prices in Central Statistical Office (1995b, 20–21). The corresponding population figures were obtained from Mitchell (1988, 11–14) for 1801 onward. Backward extrapolation, where necessary, was based on the English population estimates in Wrigley and Schofield (1981, table A3.3). The results were converted from sterling prices into 1985 U.S. relative prices using conversion factors given by Maddison (1991, 197). Average annual growth rates were calculated for the previous five years; e.g., the figure for 1800 is the rate for 1795–1800.

(b) Stature: The basic sources are Floud, Wachter, and Gregory (1990, 142–48) for the eighteenth and nineteenth centuries and Rosenbaum (1988, tables 1, 13, and 19) for 1900 onward. Specifically, the methods are as follows: 1800, average heights of army recruits who were born in 1797.5 and 1802.5, and who were measured between ages 20 and 23; 1850, average height of army recruits who were born in 1847.5 and 1852.5, and who were measured between ages 20 and 23; 1900, the average of the averages of the height of army recruits who were born between 1886 and 1893, and who were measured between ages 20 and 24, and the height of industrial workers who were born between 1905 and 1912, and who were measured between ages 21 and 24; 1950, the average height of army recruits who were born between 1946 and 1954, and who were

measured between ages 20 and 24. The figure for 1720–60 is the average for men aged 20–23 who were born in 1742.5, 1747.5, 1752.5, and 1757.5, and for the remaining periods in table 11.2 the figures are based on the averages for the cohorts of 1762.5–1797.5, 1802.5–1827.5, and 1832.5–1867.5. The figures in table 11.3 were calculated as follows: 1760, average of cohorts of 1757.5 and 1762.5; 1790, average of cohorts of 1787.5 and 1792.5; 1820, average of cohorts of 1817.5 and 1822.5; 1850, average of cohorts of 1847.5 and 1852.5.

(c) Life expectancy at birth: Prior to 1871, Wrigley and Schofield (1981, table A3.1); 1871 and after, Office of Population Censuses and Surveys (1987, table 22).

(d) Literacy: Based on Schofield (1973) for 1754–1838, the registrar-general for England and Wales for 1839–1914 (Parliamentary Papers 1840, 1841, 1884, 1916).

(e) Percentage urban: It is defined from the total population of England and Wales inhabiting towns with more than 2,500 residents. Prior to 1800, the figures are based on Thompson (1990, 8); from 1800 to 1900 on Dodghson and Butlin (1978, 370); and that for 1950 on General Register Office (1956, table 5).

United States

Details on most methods and data sources are available from the paper in this volume by Dora Costa and Richard Steckel.

(a) Stature: Compiled from Steckel (1992), Steckel and Haurin (1982), 1959–62 NHES, 1971 NHANES, and from several data sets listed in the appendix to Costa and Steckel (chap. 2 in this volume): Union Army Recruits in White Regiments in the United States, 1861–1865; French and Indian War Army Recruits; American Revolution Army Recruits; United States Army Recruits, 1815–1820; and United States Army Recruits, 1850–1855.

(b) Per capita income: Weiss (1992, table 1.3, variant C) up to 1860, and thereafter U.S. Bureau of the Census (1975, Series F 1–5).

(c) Life expectancy at birth: 1800, based on Pope's (1992, table 9.4) estimate of life expectancy at age 20 (46.8 years, an average for males and females over the years 1780–99 and 1800–1809) and the results by Haines (1994, U.S. model for both sexes of the white population in 1850) that the ratio of life expectancy at birth to life expectancy at age 20 was approximately 1.0. The result hinges on the generality of life expectancy calculated from genealogies by Pope and on the stability over time of the ratio of life expectancy at birth to life expectancy at age 20 (this ratio is slightly greater than one in the Model West tables that Haines estimates for 1850). Given these assumptions, the estimate should be viewed with caution; 1850, Haines (1994, U.S. model of both sexes of the white population in 1850); 1900, Haines (1994, U.S. model for the total population of both sexes); 1950, U.S. Bureau of the Census (1975, Series B 107–115). Values for the preindustrial period and the early industrial

period were obtained through linear interpolation of the estimates for 1800 and 1850. Estimates for the middle and late industrial periods are averages of estimates for the relevant years in Haines (1994, U.S. model) and U.S. Bureau of the Census (1975, Series B 107–115).

(d) Literacy: Rates from 1850 onward were taken from the federal censuses as reported in U.S. Bureau of the Census (1975). Literacy rates for the free population to 1800 to 1840 were estimated using reports of literacy by age contained in the 1850 Public Use Micro Sample (PUMS). This procedure may contain biases to the extent that survival rates varied with literacy. The procedure also neglects cohort trends in literacy that may have existed among older generations alive in the early 1800s who did not survive to 1850.

(e) Urbanization: U.S. Bureau of the Census (1975, Series A 57–72). An urban place is defined as a city or town that has a population of 2,500 or more.

References

Blayo, Yves. 1975. La mortalité en France de 1740 à 1829. *Population* 30:123–42.

Centraal Bureau voor de Statistiek. 1942. *Sterftetafels voor Nederland, Afgeleid uit de Waarnemingen over de Periode 1931–1940* (Mortality tables for the Netherlands, derived from observations over the period 1931–1940). The Hague: Rijksuitgeverij.

———. 1967. *Sterftetafels voor Nederland, Afgeleid uit de Waarnemingen over de Periode 1931–1940* (Mortality tables for the Netherlands, derived from observations over the period 1946–1965). The Hague: Rijksuitgeverij.

———. 1994. *Vijfennegentig Jaren Statistiek in Tijdreeksen, 1899–1994* (95 years of statistics in time series, 1899–1994). The Hague: SDU-Uitgeverij.

Central Statistical Office. 1995a. *Economic trends.* London: HMSO.

———. 1995b. *United Kingdom national accounts 1995.* London: HMSO.

Cipolla, Carlo M. *Literacy and development in the West.* Baltimore: Penguin.

Crafts, N. 1985. *British economic growth during the Industrial Revolution.* Oxford: Oxford University Press.

de Vries, J., and A. M. van der Woude. 1995. *Nederland 1500–1815: De Eerste Ronde van Moderne Economische Groei* (The Netherlands 1500–1815: the first phase of modern economic growth). Amsterdam: Balans.

Dodghson, R., and R. Butlin. 1978. *An historical geography of England and Wales.* London: Academic Press.

Eveleth, Phyllis B., and J. M. Tanner. 1976. *Worldwide variation in human growth.* Cambridge: Cambridge University Press.

———. 1990. *Worldwide variation in human growth,* 2d ed. Cambridge: Cambridge University Press.

Floud, Roderick, Kenneth W. Wachter, and Annabel S. Gregory. 1990. *Height, health, and history: Nutritional status in the United Kingdom, 1750–1980.* Cambridge: Cambridge University Press.

Fogel, Robert William. 1985. Nutrition and the decline in mortality since 1700: Some preliminary findings. In *Long-term factors in American economic growth,* ed. Stanley L. Engerman and Robert E. Gallman, 439–555. Chicago: University of Chicago Press.

Frost, Lionel. 1990. *Australian cities in comparative view.* Melbourne: McPhee Gribble.

General Register Office. 1956. *Census 1951: General tables comprising population, ages and marital condition, non-private households, birthplace and nationality, education.* London: HMSO.

Gerschenkron, Alexander. 1962. *Economic backwardness in historical perspective.* Cambridge, Mass.: Harvard University Press.

Haines, Michael R. 1994. Estimated life tables for the United States, 1850–1900. NBER Working Paper Series on Historical Factors in Long Run Growth, no. 59. Cambridge, Mass.: National Bureau of Economic Research.

Harbeck, Rudolf. 1960. Die Körpergrössen 20 jähriger Männer. *Wehrdienst und Gesundheit: Abhandlungen aus Wehrmedizin, Wehrpharmazie und Wehrveterinärwesen,* vol. 1. Darmstadt: Wehr un Wissen Verlagsgesellschaft Mbh.

Hayami, Akira, and Matao Miyamoto. 1988. Gaisetsu 17–18 seiki (An outline of the 17th and 18th centuries). In *Keizai shakai no seiritsu 17–18 seiki* (The development of 17th and 18th century economy and society), ed. Akira Hayami and Matao Miyamoto, 2–84. Tokyo: Iwanami Shoten.

Hiramoto, Yoshisuke. 1972. Jōmon jidai kara kindai ni itaru Kantō chihōjin shinchō no jidaiteki henka (Periodic changes in the heights of Kantō region inhabitants from the Jōmon through the modern period). *Jinrui zasshi* (Journal of the Anthropological Society of Nippon) 80:221–36.

Hoffmann, Walter G. 1965. *Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts.* Berlin: Springer.

Horlings, E. 1993. De Ontwikkeling van de Nederlandse Bevolking in de Negentiende Eeuw, 1795–1913 (The development of the Dutch population in the nineteenth century, 1795–1913). Free University of Amsterdam. Unpublished manuscript.

Houdaille, Jacques. 1977. Les signatures au mariage de 1740 à 1829. *Population* 32:65–89.

Jackson, R. V. 1977. *Australian economic development in the nineteenth century.* Canberra: ANU Press.

Jones, E. L. 1968. *The development of English agriculture, 1815–1873.* London: Macmillan.

Jürgens, Hans W. 1971. Gruppenunterschiede des menschlichen Wachstums in zeitlicher und örtlicher Hinsicht. *Zeitschrift für Morphologie und Anthropologie* 63(1).

Keyfitz, N., and W. Fleiger. 1968. *World population: An analysis of vital data.* Chicago: University of Chicago Press.

Komlos, John. 1987. The height and weight of West Point cadets: Dietary change in antebellum America. *Journal of Economic History* 47:897–927.

Kooij, P. 1985. Stad en Platteland (City and countryside). In *De Nederlandse Samenleving sinds 1815, Wording en Samenhang* (Dutch society since 1815, origin and cohesion), ed. F. L. v. Holthoon, 93–118. Assen: Van Gorcum.

Krantz, O., and C. -A. Nilsson. 1980. *Swedish national product, 1861–1970: New aspects on methods and measurement.* Copenhagen: Gleerup.

Livi-Bacci, Massimo. 1983. The nutrition-mortality link in past times: A comment. *Journal of Interdisciplinary History* 14:293–98.

Maddison, Angus. 1991. *Dynamic forces in capitalist development: A long-run comparative view.* New York: Oxford University Press.

McKeown, Thomas. 1983. Food, infection, and population. *Journal of Interdisciplinary History* 14:227–47.

Mitchell, B. R. 1980. *European historical statistics, 1750–1975.* London: Macmillan.

———. 1988. *British historical statistics.* Cambridge: Cambridge University Press.

Mosk, Carl, and S. Ryan Johansson. 1984. Death and development: Mortality decline in Japan 1980–1960. Report to the National Science Foundation.

———. 1986. Income and mortality: Evidence from modern Japan. *Population and Development Review* 12:415–40.

Nakamura, Takafusa. 1983. *Economic growth in prewar Japan,* trans. Robert A. Feldman. New Haven, Conn.: Yale University Press.

Office of Population Censuses and Surveys. 1987. *Mortality statistics: Review of the registrar-general on deaths in England and Wales, 1985.* London: HMSO.

Ohkawa, Kazushi, and Henry Rosovsky. 1973. *Japanese economic growth.* Stanford, Calif.: Stanford University Press.

Olivier, G., Marie-Claude Chamla, G. Devigne, and A. Jacquard. 1977. L'accroissement de la Stature in France. *Bulletins et Mémoires de la Société d'Anthropologie de Paris,* 4 13th ser., 4(2): 197–214.

Oppers, V. M. 1963. *Analyse van de Acceleratie van de Menselijke Lengtegroei door Bepaling van het Tijdstip van de Groeifasen* (Analysis of the acceleration of human growth of height by determination of the timing of growth phases). Doctoral dissertation, University of Amsterdam.

Parliamentary Papers. 1840. (263) xvii, 1. *Second annual report of the registrar-general on births, deaths and marriages in England.*

———. 1841. (II) (345) vi, 1. *Third annual report of the registrar-general on births, deaths and marriages in England.*

———. 1884. C. 4009 xx, 1. *Forty-fifth annual report of the registrar-general on births, deaths and marriages in England (abstracts of 1882).*

———. 1916, Cd. 8206 v, 53. *Seventy-fifth annual report of the registrar-general on births, deaths and marriages in England (1914).*

Pope, Clayne L. 1992. Adult mortality in America before 1900: A view from family histories. In *Strategic factories in nineteenth century American economic history,* ed. Claudia Goldin and Hugh Rockoff, 267–96. Chicago: University of Chicago Press.

Razzell, Peter. 1993. The growth of population in eighteenth-century England: A critical reappraisal. *Journal of Economic History* 53:743–71.

Rosenbaum, S. 1988. 100 Years of heights and weights. *Journal of the Royal Statistical Society A* 151:276–309.

Saitō, Osamu. 1992. Jinkō tenkan izen no Nihon ni okeru mortality (Mortality in Japan before the demographic transition). *Keizai kenkyū* 43:248–67.

Sandberg, Lars G. 1979. The case of the impoverished sophisticate: Human capital and Swedish economic growth before World War I. *Journal of Economic History* 39:225–41.

Sandberg, Lars G., and Richard H. Steckel. 1988. Overpopulation and malnutrition rediscovered: Hard times in nineteenth-century Sweden. *Explorations in Economic History* 25:1–19.

Schofield, R. S. 1973. Dimensions of illiteracy. *Explorations in Economic History* 10:437–54.

Shay, Ted. 1986. The level of living in Japan, 1885–1938: New evidence. Paper presented at the Social Science History Association meetings, St. Louis.

Statistiska Centralbyrån. 1969. *Historisk statistik för Sverige,* del. 1. Befolkning. Stockholm.

Steckel, Richard H. 1988. The health and mortality of women and children, 1850–1860. *Journal of Economic History* 48:333–45.

———. 1992. Stature and living standards in the United States. In *American economic growth and standards of living before the Civil War,* ed. R. E. Gallman and J. J. Wallis. Chicago: University of Chicago Press.

Steckel, Richard H., and Donald R. Haurin. 1982. Height, nutrition, and mortality in Ohio, 1870–1900. Columbus, Ohio. Mimeograph.

Szreter, Simon. 1988. The importance of social intervention in Britain's mortality decline c. 1850–1914: A reinterpretation of the role of public health. *Social History of Medicine* 1:1–37.

Taeuber, Irene B. 1958. *The population of Japan.* Princeton, N.J.: Princeton University Press.
Taira, Koji. 1971. Education and literacy in Meiji Japan: An interpretation. *Explorations in Economic History* 8:371–94.
Tanner, J. M., T. Hayashi, M. A. Preece, and N. Cameron. 1982. Increase in length of leg relative to trunk in Japanese children and adults from 1957 to 1977: Comparisons with British and with Japanese Americans. *Annals of Human Biology* 9:411–23.
Thompson, F. M. L. 1990. Town and city. In *The Cambridge social history of Britain, 1750–1950,* ed. F. M. L. Thompson, 1–86. Cambridge: Cambridge University Press.
Tracy, Michael. 1964. *Agriculture in Western Europe.* New York: Praeger.
Trow-Smith, Robert. 1967. *Life from the land: The Growth of farming in Western Europe.* London: Longmans.
Tugault, Yves. 1975. *Fécondité et Urbanisation.* INED Travaux et Documents Cahier no. 74. Paris: Presses Universitaires de France.
Twarog, Sophia. 1993. *Heights and living standard in industrializing Germany: The case of Württemberg.* Unpublished Ph.D diss., Ohio State University, Columbus.
U.S. Bureau of the Census. 1975. *Historical statistics of the United States, colonial times to 1970.* Washington, D.C.: Government Printing Office.
Vallin, Jacques. 1973. *La Mortalité par Génération en France depuis 1899.* INED Travaux et Documents Cahier no. 63. Paris: Presses Universitaires de France.
Vamplew, Wray, ed. 1987. *Australians: Historical statistics.* Broadway: Fairfax, Syme and Weldon.
van Zanden, J. L., ed. 1991. *"Den Zedelijken en Materiëlen Toestand der Arbeidende Bevolking ten Platten Lande": Een Reeks Rapporten uit 1851 (Fotografische Heruitgave)* ("The moral and material situation of of the working population in the countryside": A series of reports from 1851 [photographic reprint]). Groningen: Nederlands Agronomisch-Historisch Instituut.
Wachter, K. W., and J. Trussell. 1982. Estimating historical heights. *Journal of the American Statistical Association* 77:279–93.
Weir, David R. 1993. Parental consumption decisions and child health during the early French fertility decline, 1790–1914. *Journal of Economic History* 53:259–74.
Weiss, Thomas J. 1992. U.S. labor force estimates, 1800 to 1860. In *American economic growth and the standard of living before the Civil War,* ed. Robert E. Gallman and John Joseph Wallis. Chicago: University of Chicago Press.
Wiegand, Erich, and Wolfgang Zapf. 1982. *Wandel der Lebensbedingungen in Deutschland: Wohlfahrtsentwicklung seit der Industrialisierung.* Frankfurt: Campus.
Wilkinson, Thomas O. 1965. *The urbanization of Japanese labor.* Amherst: University of Massachusetts Press.
Wrigley, E. A., and R. S. Schofield. 1981. *The population history of England, 1541–1871: A reconstruction.* Cambridge: Cambridge University Press.

This Page Intentionally Left Blank