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5 Economic Welfare and Physical Well-Being in France, 1750–1990

David R. Weir

Economic growth is desirable to the extent that it improves the human condition. Because of that intimate connection, economic history has always tempered studies of the process of economic growth with a concern for its consequences for human welfare. A familiar example is England, where the "standard of living" debate over the consequences of early industrialization has raged since the dawn of the industrial revolution (Engerman 1994). The controversy over English living standards has produced considerable empirical knowledge as well as a store of critical insights into the limits and problems of specific sources and methods of measurement.

In France there has been no comparable debate, not because of any well-established empirical consensus but rather because of a lack of comparable empirical attention. Quantitative economic history has not been as important in France as elsewhere, and that has been compounded by the well-known historiographical divide at the French Revolution, which has partitioned historians into two independent groups: one working on the eighteenth century and preoccupied with the origins of the French Revolution and another working on the nineteenth century. The economic history of the revolutionary era itself has drawn attention mainly to macro/financial issues and not to "real" issues like national output or living standards. As a result there are very few studies of the long-term evolution of the economy that span the Revolution.

This paper seeks to review the French experience of economic growth and its welfare consequences. The English standard of living debate serves as a standard of reference and a primer on how to use (and not to use) sources. The introduction outlines the theoretical basis for concerns that economic growth might have had negative consequences, sets out the main types of empirical

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evidence needed to address those concerns, and describes some crucial differences between France and other European countries that may have influenced the welfare consequences of economic growth.

5.1 Introduction: Economic Growth and Human Welfare

Two traditional theories link the historical realities of economic growth to possible deteriorations in the welfare of the general population. The first is based on the notion of "primitive accumulation." Economic growth is driven by increases in capital stock per worker and by improvements in technology; the latter are themselves generally introduced in the form of new capital investment. The accumulation of capital necessarily requires savings that must come at the expense of current consumption, hence the hypothesis that the initial stages of industrialization "squeeze" consumption. Consumption would be reduced even more if the primitive accumulation resulted from a concentration of wealth in the hands of a capitalist class at the expense of peasants or artisans who would have utilized nonlabor income for their own consumption, and further still if industrialization coincided with rapid population growth, either exogenously driven or due to a surge in marriage and household formation following the breakdown of traditional restraints under proletarianization. It then follows that income per capita is not necessarily a good indicator of the economic welfare of the general population when savings rates or income distribution change rapidly.

Gershenkron (1966) went to considerable lengths to show that primitive accumulation was not a necessary "prerequisite" of economic development. In the case of England, where the facts about consumption remain in dispute, the "optimists" offer three main arguments to explain how the consumption squeeze was avoided: (1) disembodied technical progress that raised productivity enough without new capital to provide enough income to maintain consumption levels and finance higher investment, (2) capital imports, notably from Holland, and (3) improvements in domestic capital markets that funneled existing savings into more productive investments.

The second traditional theme centers on "negative externalities." Economic development alters the spatial organization of production and consumption. Industrialization in the West created crowded urban-industrial areas. In addition to the (potentially) measurable effects on the cost of housing and food supply and distribution, high population densities contributed to the spread of epidemic and other contagious diseases. Therefore, even if we measure adequately the material economic well-being of the population, conventional measures will not take account of important systematic consequences of industrialization.

An examination of the standard of living issue requires four kinds of evidence, two direct and two indirect. First, we need general measures of output, savings, and structural change to identify the timing of economic growth and particularly the periods when a consumption squeeze was most likely to occur. Second, we should examine direct and comprehensive economic measures of living standards such as real wages. Because direct measures of material welfare are often limited to specific occupational groups and specific localities, there is also a place for the study of indirect or partial economic measures like the consumption of particular commodities that are likely to bear a stable relationship to the general level of well-being.

The final category is demographic or anthropometric evidence. Such data can be interpreted in several ways. To the extent that health or life expectancy contributes to individual utility independent of material consumption, it can in principle be considered a component, along with real wages, of a broader standard of living index. Assigning appropriate weights will be a difficult matter because we do not observe prices (Williamson 1981). The weighting problem is not so important when consumption of all the "goods" moves in the same direction, but it is crucial when the components move in opposite directions. Heights and mortality are also "produced" by material consumption, although the extent of that influence remains highly controversial. Some authors, chastened by the criticisms of real wage indexes, have proposed anthropometric measures as a more comprehensive and reliable indicator of the well-being of the population. When both sorts of indicators can be reliably measured, as I believe they can for France, it seems more informative to consider them separately as reflecting different aspects of living standards rather than as competing proxies for some single underlying truth. Material consumption was not the sole determinant of heights or mortality, so anthropometric data will also reflect conditions of public health and private hygiene that are not captured in economic measures or purchased with family income.

Two crucial characteristics set France apart from other European countries in the nineteenth century: slow population growth due to deliberately restrained marital fertility and a wider distribution of property ownership. These underlying factors contributed to make economic growth a slow and gradual transformation not marked by sudden discontinuous changes. That is of course a statement about national aggregates. Economic change was more rapid in some regions, disruptive to some villages or cities, and at times profoundly destructive to some families. The hypothesis we wish to explore here is that low demographic pressure and less concentration of income and wealth took the steam out of the forces that would otherwise have produced a consumption squeeze and negative externalities.

5.2 The Evidence

The data sources and methods underlying the following discussion and the accompanying figures are discussed in appendix A.

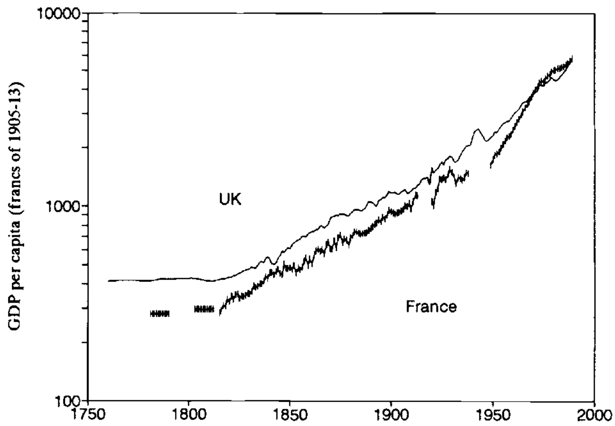

Fig. 5.1 Real GDP per capita in France and the United Kingdom, 1750–1990

5.2.1 Output per Capita

Figure 5.1 shows real output per person in France and the United Kingdom from 1750 to 1990. The period 1750–1913 is remarkable in that the two paths were largely parallel, with the United Kingdom's eighteenth-century advantage declining rather little in the long run. Both countries saw slow growth or stagnation from 1750 to 1820, followed by more rapid "modern" economic growth from 1820 to 1913. In France, growth rates of per capita income were on the order of 0.3 percent per year in the first phase and 1.3 percent per year in the second.

The twentieth-century experience is offered here for perspective. Growth rates in the United Kingdom seldom exceeded the rates established during earlier periods, but in France the post–World War II "miracle" saw growth rates of 4 percent per year. The comparability of levels between the two countries is more difficult in this period. Fixed exchange rates and stable international relative prices under the gold standard prior to 1913 make the conversion of U.K. figures into francs at par of exchange a relatively safe procedure compared with later years. The relative level of real output in the United Kingdom after 1920 was set by using Maddison's (1991) purchasing-power-parity exchange rate for 1985 to fix the relative levels in 1985. An extension based on the pre-1913 relative levels would show the United Kingdom at a much lower level. The use of Maddison's data to study convergence runs the risk of serious distortion if changes over time in purchasing power parity are not carefully considered.

We can be confident that sustained economic growth in France had begun by 1820 (Lévy-Leboyer's estimates of real per capita output begin in 1820 and are virtually identical in levels and trend to those shown here). We are hindered in identifying the starting point of rapid growth by the uncertainty of the evi-

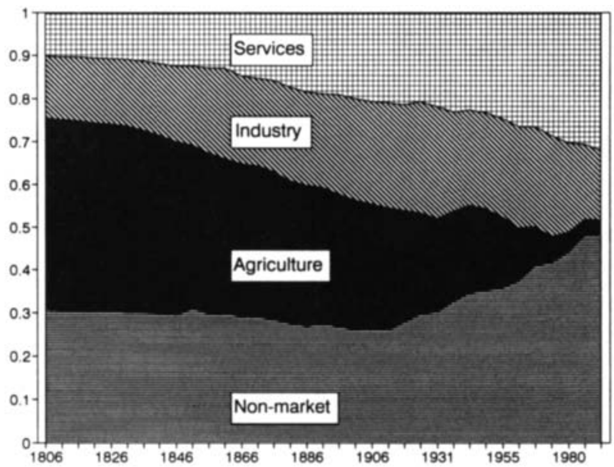

Fig. 5.2 Activity distribution of the potential adult labor force in France, 1806–1990

dence prior to 1820. The 0.3 percent per year growth rate from 1750 to 1780 is merely an assumption based on a review of existing estimates (see Riley 1986, chap. 1). The Institut de Science Economiques Appliquées' estimates for 1781–90 and 1803–12 leave the impression that the Revolution held growth somewhat below even the low level of the eighteenth century. If growth rates were higher during the Revolution, that would also imply a lower level of real output in the eighteenth century.

5.2.2 Labor Force Reallocation

A perspective on the timing of industrialization comes from the structural changes in labor force activity and location (urbanization). Figure 5.2 gives a long perspective on the activities of French adults. It shows the allocation of the "potential" adult labor force, defined simply as men over age 15 plus 62 percent of women over age 15 (62 percent being the ratio of female to male wages). Those who pursue nonmarket activities, usually classified as out of the labor force, include housewives, students, and retirees. Their share declined very slowly in the nineteenth century and then rose rapidly in the twentieth, reflecting primarily the rise of advanced schooling and retirement. The "modern" sectors of industry and services gained at the expense of agriculture throughout the period.

Figure 5.3 shows a more narrow measure of the industrialization of the labor force—the share of industrial workers in the market labor force. Here again France and the United Kingdom moved roughly in parallel, with the United Kingdom always substantially more industrial. The most rapid growth apparently came before 1860, coinciding with a period of slightly more rapid output

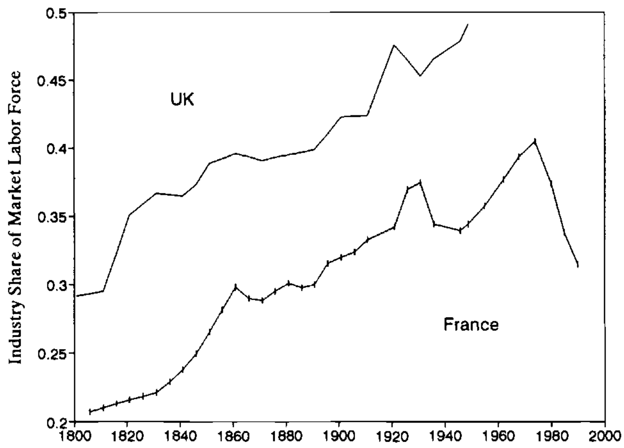

Fig. 5.3 Industrialization of the labor force in France and the United Kingdom, 1806–1990

growth in France. The slowdown after 1860 corresponds to the "deceleration" of the French economy that has been emphasized by Lévy-Leboyer.

Urbanization is not precisely coterminous with industrialization because of the wide extent of rural industry early and its decline later. Nevertheless, urbanization is the more relevant measure for some of the negative externality issues, and in the face of uncertainty over the labor force activities of the rural population it may be a useful proxy for other aspects of structural change. Table 5.1 shows the timing of urban growth in France.

Urban growth was never as rapid in France as it was elsewhere in Europe. This is entirely attributable to low fertility and low natural increase in France and not to any shortcomings of rural-urban migration. French cities grew fastest at midcentury, from 1831 to 1881. That is later than the peak rate of net investment or the peak rate of change of the industrial labor force. Paradoxically, it includes the period of deceleration identified by Lévy-Leboyer. The paradox is at least partially resolved by the fact that rural industry was declining rapidly after 1860.

5.2.3 Consumption

Can we find evidence of a "consumption squeeze" in the early years of industrialization? The most direct approach is to identify the personal consumption component of GDP using the familiar national income accounting identity:

$$Y = C + I + G + (X - M).$$

Given the nature of historical data, consumption is generally found as a residual after deducting gross domestic investment (I), net foreign investment

Table 5.1 **Urban Growth in France**

Years	Urban Growth Rate (%)	Percentage Urban (period average)
1756–81	.66	17
1781–1806	.28	19
1806–31	.54	20
1831–56	1.11	24
1856–81	1.06	31
1881–1906	.79	38

Source: See Weir (1994b).

Notes: Urban growth in percent per year is the growth rate of communes classified as urban at the beginning of the period; i.e., it excludes the additions to urban population due to the reclassification of communes from rural to urban during the period. By definition, urban communes are those with at least 2,000 population in an agglomerated area.

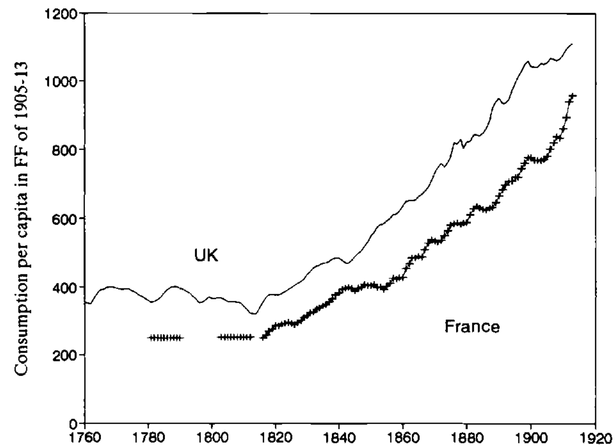

Fig. 5.4 Real consumption per capita in France and the United Kingdom, 1750–1913

($X - M$), and government spending on goods and services (G). The work of Feinstein for the United Kingdom and Lévy-Leboyer for France provides the crucial estimates of investment, yielding the real consumption per capita estimates shown in figure 5.4.

Personal consumption declined slightly in the United Kingdom during its early industrialization phase from 1750 to 1815. A detailed look at the expenditure components reveals that the crucial variable was government (military) spending (which increased) rather than investment (which remained fairly steady). There is an ongoing debate about whether government spending crowded out private investment in Britain during the Napoleonic Wars, but it appears clear that personal consumption was "crowded out" by the two in combination. French expenditure data are lacking for this period, so the consumption figures are built on a crude guess about the shares of each.

With the return of peace in 1815 personal consumption rose in both countries. The 1840s saw a short, sharp setback in Britain (even before the Irish Famine) and ushered in a longer phase of no growth in France. From the mid-1850s personal consumption increased fairly steadily in both countries.

The evidence for a consumption squeeze in the United Kingdom is ambiguous: there was a very slight decline in consumption during early industrialization, but it appears to have been caused by the burden of war and not by "primitive accumulation." We have less evidence about the effects of the same wars on France. It is clear, however, that there was no consumption squeeze during its early industrialization in the first half of the nineteenth century.

5.2.4 Real Wages

Real wages are the traditional measure of living standards and have remained at the center of the English standard of living debate. Index numbers of real wages are typically constructed by dividing indexes of nominal wages for some specified group by indexes of the prices of the commodities they consume. Unlike some other measures of living standards, there is a specific microeconomic foundation for real wage indexes that is worth setting out.

We assume that income equals expenditure, so that the index of nominal wages in year t relative to nominal wages in the base year 0 is also equal to the ratio of expenditures:

$$\frac{W_t}{W_0} = \frac{\sum_i p_{it} \times q_{it}}{\sum_i p_{i0} \times q_{i0}}.$$

A Laspeyres cost-of-living index relates the cost of purchasing a fixed bundle of commodities in year t to the cost of purchasing the same fixed bundle in the base year:

$$\frac{P_t}{P_0} = \frac{\sum_i p_{it} \times q_{i0}}{\sum_i p_{i0} \times q_{i0}}.$$

A real wage index formed by dividing the nominal wage index by the cost-of-living index therefore compares expenditures in year t to the cost in year t of purchasing the same bundle of consumption as was attainable in the base year:

$$\frac{RW_t}{RW_0} = \frac{W_t/W_0}{P_t/P_0} = \frac{\sum_i p_{it} \times q_{it}}{\sum_i p_{it} \times q_{i0}}.$$

When the real wage index for year t is greater than 1 (or greater than 100 if set to 100 in the base year), we can infer that the worker-consumer could purchase the exact base year consumption bundle plus some more, that is, that he is better off in year *t*.

The most common practice, and the one followed here, is to use the wages of unskilled labor. Part of the improvement in economic welfare during development is due to the shift in labor force composition toward higher skilled and higher paid occupations. By holding constant the labor force composition, wage indexes will trace a more pessimistic path than would indexes of average earnings that included the compositional change.

Despite, or perhaps because of, heated controversies over technical issues in the construction of real wages for England, there is a general consensus emerging, at least within the narrow confines of the New Economic History between such participants as Crafts and Lindert and Williamson (Lindert and Williamson 1983, 1985; Crafts 1985; Williamson 1985; Crafts and Mills 1994). That consensus comprises both methodological issues and substantive findings. On substance, there is wide agreement that English real wages were largely stagnant from 1750 to sometime around 1815, after which time they began to rise slowly. On methods, all sides now recognize that the major source of divergent findings is in the cost-of-living indexes rather than in nominal wages. By that I mean that cost-of-living indexes are sensitive to the component price series chosen and the budget weights applied. The question of whether nominal prices "cause" real wages is a separate matter not considered here.

At the present time, Paris is the only city for which we have long runs of consistent nominal wages and prices from which real wage indexes can be constructed in a careful manner from the early eighteenth century. The wage index is based on unskilled construction workers. Its overall movement from 1820 to 1914 is not much different from the more sketchy data on similar workers in the rest of France. Agricultural wages, on the other hand, rose much less after 1870 than urban or Parisian wages. The cost-of-living index is taken from Singer-Kérel after 1840, but the index constructed for the earlier years shows very similar movement from 1840 to 1913. The earlier index combines price indexes for bread and related products, meat, dairy products, drink, house rent, textiles, and fuel and is of the usual Laspeyres form, using a single fixed set of weights for the entire period (Weir 1991). One rationale for a fixed-weight Laspeyres index is that it reflects the cost of "subsistence." Certainly, the weights given by budget studies for nineteenth-century France give dominance to essential foods. The close similarity of this index to Singer-Kérel's index of 213 articles using twentieth-century weights suggests that the precise weightings are not critical in the post-1840 period.

Figure 5.5 shows real wages in France and Britain, with the relative levels fixed by a direct comparison in 1905 (Williamson 1995). Parisian real wages fluctuated around a stable level in the eighteenth century while the higher British real wages declined very slowly. Influenced to some extent by war-induced labor shortages, French real wages under Napoleon were generally above their previous levels. Fighting Napoleon was hard on British consumers, and the

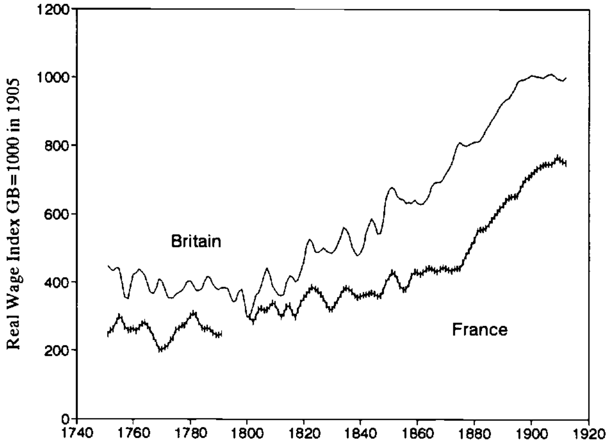

Fig. 5.5 Real wages in France and the United Kingdom, 1750–1913

"hot" war years around 1801 and 1812–15 marked the nadir of British real wages during industrialization.

From 1820 to 1860 real wages advanced sharply in Britain and more slowly in France, creating a wider gap than had existed before 1790. Recall from figure 5.3 that it was in this period that France reached the levels of industrialization that Britain had achieved in the late eighteenth century. Despite the later start, France industrialized at lower levels of real wages and per capita incomes. Perhaps because of greater opportunities for technological imitation France was able to grow more rapidly and sustain better real wage growth than Britain at a comparable phase of development. Population growth was also modest, which makes the discrepancy between real wages and per capita income or consumption all the more striking. Apparently, the distribution of income was shifting away from manual labor in this period.

The rapid fall in international food prices after 1870 led to rapid gains in both countries. Britain's stronger commitment to free trade in this period did not have a noticeable impact on real wages as compared with France, where the protection of agriculture was increased.

5.2.5 Meat Consumption: Indirect Evidence of Living Standards

In a famous article, Eric Hobsbawm, a leading pessimist in the English standard of living debate, proposed to use indirect evidence to assess living standards (Hobsbawm 1957). There are many reasons to question the direct evidence of real wages: doubts about the underlying evidence on prices and budgets, limited scope, failure to account for unemployment, narrow focus on male workers to the exclusion of other family members, and so on. If one could trace the per capita consumption of some commodity that bore a stable

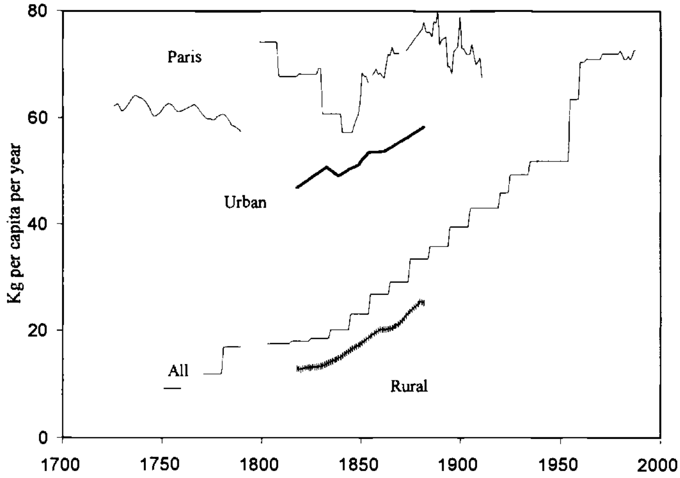

Fig. 5.6 Meat consumption by place of residence in France, 1750–1980

relationship to full family income, then its trends would mirror overall living standards. Hobsbawm reasoned that meat was such a commodity and presented evidence from the Smithfield meat markets outside London that indicated a decline in per capita consumption. His conclusions have largely been rejected because he failed to take account of a rising slaughter weight of animals brought to market, because he neglected pork (the consumption of which was rising), and because secondary sources of supply increased around the Smithfield markets (Hartwell 1961). The reasoning, however, still stands. Joel Mokyr recently applied it to the consumption of "luxuries" like tea and sugar and found weak support for the pessimist case (Mokyr 1988). English data problems may favor the use of tea and sugar, but common sense would suggest that the consumption of such items could more easily be influenced by taste, fashion, and the development of retail delivery systems than would be the case for meat, which is a central element of family budgets. For France the problems faced by Hobsbawm's study of London are resolved, and we can learn something from the data on meat consumption.

Figure 5.6 shows per capita meat consumption in Paris and in France as a whole, with shorter series for urban areas other than Paris and for rural areas. The most striking aspect is the enormous urban-rural differential. Urban-rural wage gaps were relatively small in France, so there were clearly other factors at work driving relative demand. The most important factor must have been nonwage income spent in cities. In addition to the obvious urban advantage in human capital and industrial wealth, a sizable proportion of the returns to agricultural land must have been spent in cities by absentee landowners or their family members. Given the rapid rate of spoilage of meat, there may have been economies of scale in urban consumption where entire animals could be consumed quickly as compared with dispersed rural areas where it might have been difficult to ensure a continuous supply at low levels of consumption without waste.

Paris consumed more than other cities and had already attained by the mid-eighteenth century a level of per capita meat consumption not reached by the national average until after World War II. Parisian consumption apparently increased under Napoleon and then fell until the 1850s, returning to its eighteenth-century levels. The second half of the nineteenth century saw renewed growth, pushed mainly by sources of supply that bypassed the main Paris slaughter markets. The declining Parisian meat consumption of the early nineteenth century is the first evidence we have seen of declining living standards, and it conflicts with the evidence of real wages, at least after 1820. Given the obvious influence of nonlabor income in urban consumption, the most likely explanation is that Parisian meat consumption was influenced by the social composition of the capital. The labor market served to constrain the differentials in workers' living standards between Paris and the rest of the country, but no such force determined where the wealthy would live or consume their meat. A rapid influx of working-class population could well have driven down the average consumption of meat without any deterioration in occupation or class-specific living standards.

Clearly, indirect inferences about living standards based on consumption statistics in a particular locality are subject to more spurious influences than are direct real wage measures, so we will focus instead on national patterns. Inferring the course of general material welfare from meat consumption entails knowledge of three things: the income elasticity of meat demand, the course of relative meat prices, and the price elasticity of demand. Several sorts of evidence suggest an income elasticity of demand for meat in the range of 0.7. That is what we get from a crude time-series regression of aggregate national meat consumption on per capita output. Postel-Vinay and Robin (1992) estimated a demand system on a cross section of districts in 1852 and found that the elasticity of meat consumption with respect to total food expenditure was about 1.5. They do not report the elasticity of food expenditure with respect to total income, but it was on the order of 0.5 in the aggregate data, which yields an income elasticity for meat demand around 0.75. Holding quality constant, we would expect income elasticities to decline as the absolute level of meat consumption increased toward some satiation point. Price elasticities are less easily pinned down. Postel-Vinay and Robin estimated (and worried over) a very small price elasticity found also in regressions on time-series aggregates. Department cross sections tend to find a positive price elasticity, that is, that quantity and price move together. That suggests that we are identifying a supply curve rather than a demand curve because we have not fully accounted for the determinants of demand. In the end, these econometric difficulties are not terribly worrisome for basic inferences because the trend of meat prices relative to other prices was very simple: no trend prior to 1840 or so, and a rising

Table 5.2 Determinants of Meat Consumption by Department, 1840–1911

Independent Variable	(1)	(2)	(3)
Constant	1.565***	−6.13***	−5.44***
	(.057)	(1.22)	(1.08)
Log real wage	.756***	.519***	.420***
	(.025)	(.045)	(.041)
Year		.0044***	.0040***
		(0.0007)	(.0006)
Urbanization			.910***
			(.065)
R^2	.55	.57	.66

Notes: The dependent variable is the log of per capita meat consumption in a department in a year. The total sample size is 81 departments in nine cohorts, or 729 observations. Regressions were ordinary least squares; standard errors are in parentheses. Asterisks following coefficients indicate statistical significance of a t-test of the null hypothesis that the true coefficient is zero.

*$p < .05$.

**$p < .01$.

***$p < .001$.

trend after about 1860 (as international relative price movements dictated). Thus, whatever the true price elasticity of demand, relative prices would not have much affected meat consumption prior to the middle of the nineteenth century and should only have held it back after that time.

Returning to figure 5.6, we see that the available estimates suggest that national meat consumption grew very little from 1780 to 1840, despite the estimated increase in per capita income and real wages. From 1840 to 1913 meat consumption grew at just about exactly seven-tenths the rate of real per capita output, as the elasticity estimates would predict. The rapid gains in meat consumption after World War II were nevertheless at a rate slower than 0.7 times real output growth, indicating that the income elasticity was declining as the whole population approached high average levels of consumption.

Table 5.2 shows the results of a pooled cross-section time-series regression of meat consumption per capita by department over time. When real wages are used alone, they indicate an elasticity of 0.75, consistent with other estimates of income elasticities. When time trends and urbanization are included as predictors, the estimated effect of real wage declines and urbanization emerges as an important predictor of meat consumption independent of the level of real wages. The large urban-rural differential in meat consumption is therefore not entirely explicable by urban-rural differences in real wages. It seems reasonable to suppose that unmeasured nonwage income sources (including human capital) were greater in cities and that they account for the greater meat consumption.

Meat consumption is of interest not only as a good indicator of average income but also because it was the primary source of protein, an important

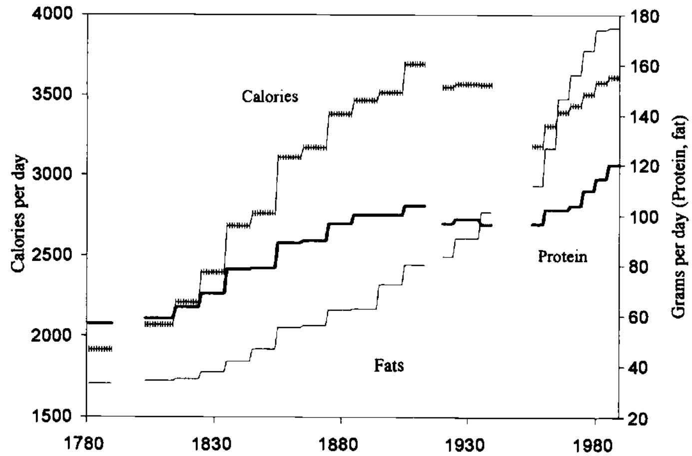

Fig. 5.7 Nutrient consumption per capita in France, 1780–1980

nutrient. Figure 5.7 shows the course of average availability for human consumption of total calories, protein, and fats. In the nineteenth century total calories rose faster than proteins as the population augmented previously inadequate diets with cheap grain-based calories. Over the twentieth century protein consumption rose faster than total calories as the generally adequately nourished population shifted into more expensive and protein-rich sources of calories. The decline of energy-consuming manual labor may also have been a factor in the retreat from the high levels of total calories reached at the end of the nineteenth century.

5.2.6 Heights

France provides the best data for the study of long-term changes in male heights of any European country. The main source of height data after 1800 are the records of conscripts into the French armies. Prior to the Revolution of 1789, French armies were volunteer armies, like those of the rest of Europe. Conscription began with the first revolutionary wars, but the data only become regular and reliable in the years after 1815. For constructing representative samples, conscription records have distinct advantages over the records of volunteer services. French conscripts were selected by lottery from all the 20-year-olds in the district. In volunteer services there are two selection processes at work, neither of which can be considered random: the demand of the recruiting services for men of certain heights (or other characteristics correlated with height) and the supply of potential recruits. If the estimation methods do not fully eliminate the influence of selection, then changes over time in the strength of selection can appear as changes in the estimated height.

The statistical methods that have been developed to cope with selection problems depend crucially on the assumption that there is a range of heights

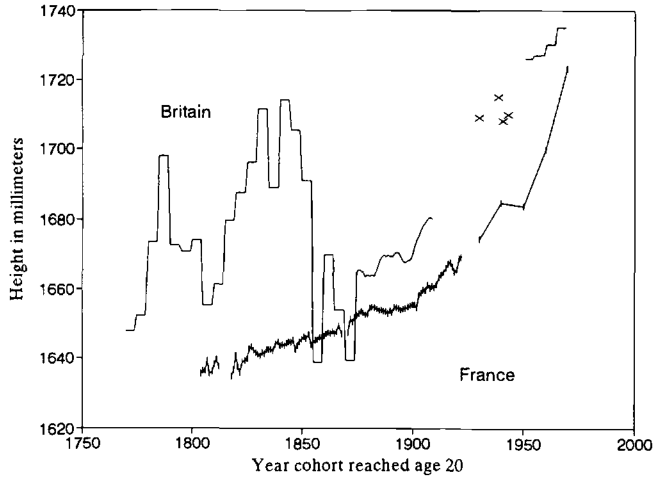

Fig. 5.8 Male height at age 20 in France and Britain, 1770–1980

(typically the upper tail of the distribution) in which selection effects do not operate. The shape of the observed distribution over this selection-free range provides enough information to identify the mean and variance of the underlying population distribution. This works well when the recruiter's selection excludes persons below some minimum height. But if selection is continuous, in the sense that the probability of inclusion increases with height throughout the entire observed range, then the available estimators break down. Moreover, it is possible for the selected sample to closely resemble a Gaussian distribution with a mean well above the mean of the whole population (and, typically, a smaller standard deviation). An extreme example is the distribution of heights of players in the National Basketball Association (Fogel et al. 1983, 459–62). That distribution appears roughly normal in shape and yet comparison with the true population distribution reveals that the probability of playing in the NBA rises exponentially with each inch of added height. No one would suggest that historical military height preferences were as extreme as those of modern professional basketball, but neither would we expect a bias of 20 cm or more in the estimated mean. Errors of 5 cm (2 inches) would be quite large relative to historical variations over time or between countries.

Figure 5.8 displays my estimates of the median height of 20-year-olds in France from 1803 to 1970, compared with estimates of British heights. The French data, which differ slightly from those of van Meerten (1990), are described in appendix B; data for later years come from Chamla (1964) and Olivier et al. (1977). The British data are derived from Floud, Wachter, and Gregory (1990) as described in appendix A.

In France, heights confirm the general patterns found in economic data. The overall impression is one of slow but steady increase in height from 1820 to

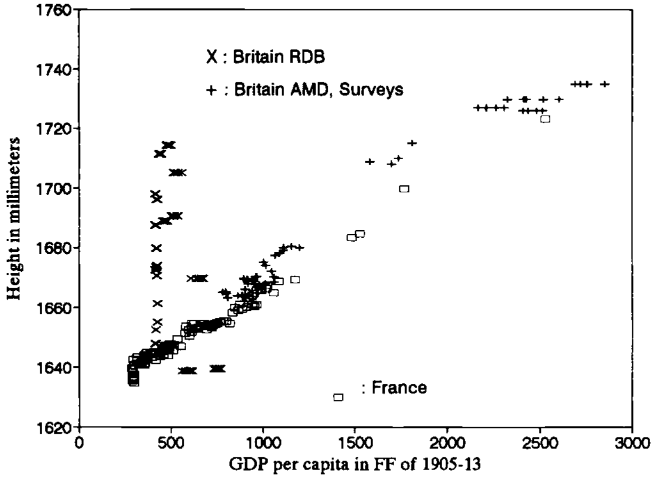

Fig. 5.9 Male height by real GDP per capita in France and Britain, 1770–1980
Note: RDB, recruit description books; AMD, Army Medical Department.

1913 (birth cohorts of 1800 to 1893), with a total gain of about 1 inch or 2.5 cm from 164 cm to 166.5 cm. On closer inspection one might detect slightly faster growth at the beginning and the end of the period, with a period of near stability from 1880 to 1900. The rate of growth was substantially faster in the twentieth century, with a gain of 4 cm by 1970 (cohort of 1950), despite severe setbacks in the two world wars. The data before 1815 are less reliable because I needed to make corrections for incomplete regional coverage and for changes in the age at recruitment. It seems fairly clear, however, that the heights of the classes of 1804–5 and 1810–11 were on a par with those of the early years of the Restoration and thus that there was probably little trend in heights over the first 20 years of the nineteenth century. No reliable estimates can be made prior to 1800.

British men were generally taller than French, but the patterns were quite unstable, at least in the years before 1860 for which the estimates are based on recruit description books. Heights in Britain climbed rapidly in the early years of the nineteenth century, when real wages and per capita incomes were stagnant, and then fell dramatically after 1840 (cohorts born 1820), when the economic evidence suggests that living standards were improving.

Another perspective on heights and living standards is given by figure 5.9, which sets the mean height of a birth cohort against the level of per capita GDP prevailing around its tenth birthday. In France, the scatter of observations traces a very regular and nearly linear relationship between per capita income and height. From the British data after 1860 it appears that the British height advantage at any given date was only partially due to higher British per capita incomes. Other additional factors, including possibly genetic differences, con-

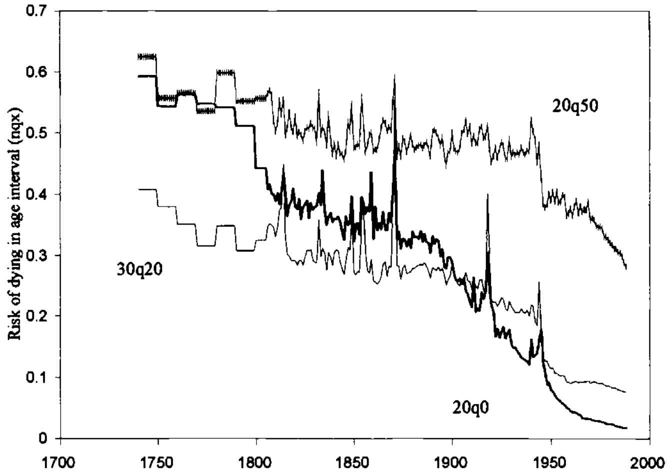

Fig. 5.10 Life table mortality rates by age in France, 1740–1990

tributed to the gap. Heights in northern France were systematically higher than in the south, so the British-French difference may be an extension of the same phenomenon. Figure 5.9 also illustrates the magnitude of the puzzle raised by the pre-1860 British height estimates. Based on the crude height-GDP profile, the heights attained in the pre-1840 peak would have been consistent with per capita incomes three to four times higher than the actual levels. That is far beyond any plausible range of measurement error in GDP and suggests that there must have been other very powerful forces driving the heights of British volunteer forces.

5.2.7 Mortality Decline

The pace of mortality decline in France is shown in figure 5.10. It displays rates for three broad age groups. Infant and child mortality (20q0) declined much more than that of other ages, and young adults (30q20) progressed slightly faster than older adults (20q50). This is a typical pattern and not unique to France. The long trend of mortality decline can be divided into three phases: rapid declines from the late eighteenth to the early nineteenth centuries, slow decline during most of the nineteenth century, and rapid declines beginning toward the end of the nineteenth century for children. Real progress for older adults did not occur until after World War II.

It is the early period of rapid decline that merits most attention. Per capita incomes grew relatively slowly between the 1780s and 1820s, while real wages appear to have risen more substantially. It is certainly possible that the Revolution did have egalitarian consequences for income distribution, with working people and their children benefiting most. We should note, however, that the early phase of decline in infant and child mortality brought French rates down to the general range of European rates from what had been comparatively high levels. It may have been a "catching-up" phase in which France adopted the better child-care "technologies" already in place elsewhere. For example, there is evidence that maternal breast-feeding became more widespread at this time (Mroz and Weir 1990). Although infant feeding is well established as a determinant of infant mortality, its effects on mortality after age one or two are not so clear, so there must have been other complementary changes.

I am not generally inclined to credit the Enlightenment for everything that happened in French society at the end of the eighteenth century, but it is worth noting that the same Rousseau, who advocated maternal nursing, also advocated improved hygiene, calling hygiene "the only useful part of medicine." The same viewpoint was reflected in the *Encyclopédie,* which urged each individual to be "his own doctor." Even if the scientific basis for connecting hygiene to mortality was not yet established, it is certainly possible that changes in hygienic practice within families and households, adopted for other reasons, contributed to the mortality decline during the Revolution that brought French infant health in line with European norms.

The scientific breakthroughs of Louis Pasteur had their greatest impact in mobilizing public health efforts (including hospital practice) rather than in changing family behavior. The effects on mortality began to be felt at the end of the nineteenth century and can be seen in infancy through early adulthood, where epidemic disease was most important. Older adults, who were after all survivors of earlier exposures to infectious disease, benefited less from reductions in the extent of exposure.

Figure 5.11 shows crude death rates in Paris, all other French cities, and rural areas. Crude rates understate the magnitude of urban excess mortality because cities had a "favorable" age structure dominated by young adults with lower mortality rates, and because many infants were sent out of cities to be wet-nursed where their deaths were counted in rural totals. In 1876, urban crude death rates were perhaps 2 per 1,000 lower (and rural 1 per 1,000 higher) than corrected age-standardized rates would show (see Weir 1994b).

Much of the limited mortality decline that did occur between 1820 and 1880 occurred in the cities. Paris and the other cities differed little, and the gap between them and rural areas closed considerably. Paris suffered more than the average city during the epidemics prior to 1860, as it did in the fighting of the Franco-Prussian War. It also gained more in the more rapid mortality declines after 1880, dropping well below the urban average and reaching the rural level by the end of the nineteenth century (though an age-adjusted Paris rate would be higher). Public health investments have commonly been cited in explaining the different pace of change in different urban areas (Preston and van de Walle 1978). The capital led the more provincial cities in modernizing its water and sewage systems.

The big urban-rural mortality differential in the early nineteenth century suggests that there were large potential negative externalities from rapid indus-

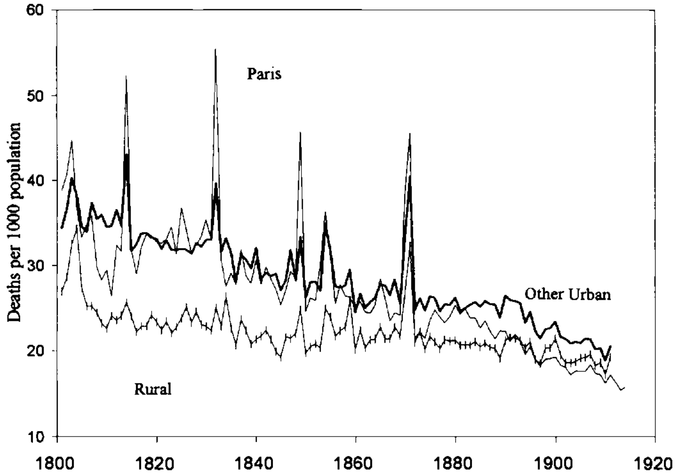

Fig. 5.11 Crude death rates by place of residence in France, 1806–1913

trialization. The low level and slow rate of urbanization in France compared with other countries therefore had beneficial public health consequences.

5.2.8 The Impact of Economic Welfare on Physical Well-Being

The relationship between the narrowly defined material standard of living (as captured by real wages or per capita consumption) and physical health is extremely complex. We do not know the full extent of how food and other consumption might have influenced health and mortality, and there is the very real possibility that improved health contributed to higher productivity and living standards. Here I present a few descriptive analyses that provide some empirical input to the speculations. By using a cross-section time-series "panel" data set of 81 French departments at 10-year intervals in the nineteenth century we can explore these relationships in more depth than would be possible from aggregate time-series data alone.

Tables 5.3–5.6 report various specifications of the determinants of height at age 20. Unless otherwise indicated, the right-hand-side variables are measured at about the 10th birthday of the cohort whose height is the dependent variable. Most of the variables are not measured frequently enough to attempt any more finely distributed lag structure. Within each table there are four models corresponding to different treatments of time and region effects. The tables differ slightly in the specification of the basic equation. A good case could be made for the exogeneity of the (log) real wage, proportion urban, and literacy of the parent's generation as in table 5.3. Table 5.4 includes the crude death rate (around the cohort's 10th birthday) as an independent variable. Tables 5.5 and 5.6 repeat 5.3 and 5.4 but use logarithms of the urbanization, literacy, and death

Table 5.3 Determinants of Heights by Department, 1840–1911

Variable	(1a)	(1b)	(1c)	(1d)
Constant	1,607.8***	2,018.6***	1,641.4***	1,629.6***
	(3.27)	(48.11)	(60.75)	(14.97)
Log real wage	7.71***	18.21***	15.34***	9.93*
	(1.79)	(2.10)	(2.01)	(4.54)
Proportion urban	13.08***	14.47***	11.18***	−8.82
	(2.95)	(2.81)	(2.68)	(10.47)
Female literacy	8.87*	14.95***	−4.35	−5.43
	(4.55)	(4.40)	(4.55)	(5.57)
Male literacy	24.45***	20.34***	25.87***	18.61**
	(5.27)	(5.05)	(4.81)	(6.08)
Crude death rate				
Year		−0.232***	−0.061	
		(0.027)	(0.031)	
Northeast			1.451***	
			(.155)	
Fixed effects	No	No	No	Yes
R^2	.53	.58	.62	.80

Notes: The dependent variable is the median height of the cohort of 20-year-old men in a given department in a given year (s.d. = 15). Independent variables are measured at approximately the 10th birthday of the cohort, except for literacy, which is measured at marriage for marriages in the five years prior to the birth of the recruitment cohort and thus corresponds to the parents of the cohort. The fixed effects in model d are (80) dummy variables for the departments and (8) dummy variables for cohorts. The total sample size is 81 departments in nine cohorts, or 729 observations. Regressions were ordinary least squares; standard errors are in parentheses. Asterisks following coefficients indicate statistical significance of a t-test of the null hypothesis that the true coefficient is zero.

$^*p < .05.$

$^{**}p < .01.$

$^{***}p < .001.$

rate variables. Within each table the model is run in four variants corresponding to different treatments of possible time and region effects: (a) with no controls, (b) with a continuous time trend, (c) with a continuous time trend and a continuous regional variable (northeast = latitude + longitude), and (d) with dummy fixed effects for year and department.

Consider first the impact of the different controls for time and region effects. The fixed effects explain a lot of variance in all four tables. Compared with model c, the fixed-effect model d tends to have smaller coefficients and larger standard errors, but the general pattern of results is the same. That is not surprising, given the much higher ratio of measurement error to "signal" variance when we take out the regional means. The one exception is urbanization (and to a lesser extent female literacy), where the inclusion of fixed effects has a big effect on the results in tables 5.3 and 5.4, using levels, but not in tables 5.5 and 5.6, using logs. Tables 5.5 and 5.6, using logs of the independent variables,

Table 5.4 **Determinants of Heights by Department, 1840–1911**

Variable	(2a)	(2b)	(2c)	(2d)
Constant	1,622.4***	2,115.6***	1,709.8***	1,650.9***
	(5.67)	(49.99)	(58.68)	(15.88)
Log real wage	5.94**	16.88***	13.06***	9.97*
	(1.79)	(2.07)	(1.94)	(4.49)
Proportion urban	16.09***	20.08***	18.23***	−13.00
	(3.08)	(2.92)	(2.70)	(10.42)
Female literacy	8.59	15.51***	−6.80	−3.52
	(4.52)	(4.30)	(4.44)	(5.54)
Male literacy	23.63***	18.17***	23.87***	9.87
	(5.25)	(4.96)	(4.60)	(6.45)
Crude death rate	−0.467***	−0.831***	−1.126***	−0.620***
	(0.149)	(0.144)	(0.136)	(0.165)
Year		−0.272***	−0.086**	
		(0.027)	(0.030)	
Northeast			1.692***	
			(.151)	
Fixed effects	No	No	No	Yes
R^2	.54	.59	.65	.81

Note: See notes to table 5.3.
*$p < .05$.
**$p < .01$.
***$p < .001$.

have very slightly higher R^2 values, but one can hardly claim that as sufficient reason to prefer them.

Real wages have a significant positive effect on heights in all models. In the fixed-effect model (d) the wage effect is smaller than in models using continuous time, but larger than in the model (a) with no time or region controls. Its effect is pretty much the same between tables.

The literacy results give little support to the idea that mother's literacy was particularly important for children's health in nineteenth-century France, in contrast to what is often found in developing countries today. Male literacy was much more strongly related to heights in all the models and specifications. In the models without regional controls (a and b), female literacy has a barely significant positive effect. Adding either type of regional control generally reverses its sign, although in the log version (tables 5.5 and 5.6) it is very weakly positive with fixed effects. It may be that in the economy of the nineteenth century women's literacy did not translate readily into higher potential wages or domestic bargaining power. Because male literacy was always higher than female (and because literate women almost always married literate men), it may be that male literacy was sufficient for the family to acquire whatever knowledge was available about hygiene and the like, rendering female literacy superfluous.

Table 5.5 Determinants of Heights by Department, 1840–1911

Variable	(3a)	(3b)	(3c)	(3d)
Constant	1,648.5***	2,064.8***	1,694.1***	1,642.3***
	(4.63)	(47.40)	(59.18)	(13.03)
Log real wage	7.86***	18.86***	14.86***	8.90*
	(1.66)	(2.01)	(1.94)	(4.45)
Log proportion urban	4.21***	4.64***	3.86***	7.41**
	(0.80)	(0.76)	(0.72)	(3.03)
Log female literacy	5.92**	7.95***	−0.42	2.57
	(4.55)	(1.79)	(1.90)	(2.25)
Log male literacy	11.52***	9.99***	13.89***	9.45**
	(2.77)	(2.64)	(2.53)	(3.24)
Log crude death rate				
Year		−0.234***	−0.071*	
		(0.027)	(0.030)	
Northeast			1.418***	
			(0.148)	
Fixed effects	No	No	No	Yes
R^2	.54	.59	.64	.81

Note: See notes to table 5.3.
$*p < .05$.
$**p < .01$.
$***p < .001$.

Urbanization is the most perplexing. Its effect is clearly positive in all the models except some of the fixed-effect models. In tables 5.3 and 5.4, using levels, the inclusion of fixed effects causes a huge change and sign reversal. In tables 5.5 and 5.6, using logs, the effect remains positive and statistically significant even when fixed effects are used. Adding the (potentially endogenous) crude death rate adds very little to R^2 but is itself highly significant and negative in its effect on height. A plausible interpretation would be that local health conditions were correlated with urbanization, literacy, and real wages but nevertheless operated independently to improve heights and mortality. On the one hand, these results suggest that the real wages of unskilled workers are a narrow measure even of economic welfare. Both urbanization and literacy, which were certainly correlated with the income of other factors of production, including especially human capital, had independent beneficial effects on the development of children. On the other hand, urbanization had negative consequences for mortality. This suggests that heights and mortality are not simply interchangeable measures of some general notion of "health." They responded differently to economic progress. For mortality, the most plausible explanation is that urbanization increased the incidence of exposure to disease and this effect overwhelmed the beneficial effects of higher consumption at improving resistance, as suggested for Japan by Johansson and Mosk (1987; Mosk and Johansson 1986). Economic progress unambiguously raised heights because

Table 5.6 Determinants of Heights by Department, 1840–1911

Variable	(4a)	(4b)	(4c)	(4d)
Constant	1,675.0***	2,181.7***	1,801.4***	1,672.5***
	(12.72)	(52.48)	(58.44)	(17.63)
Log real wage	6.71***	18.05***	12.84***	9.24*
	(1.73)	(1.99)	(1.88)	(4.43)
Log proportion urban	4.72***	5.78***	5.46***	7.06*
	(0.83)	(0.78)	(0.72)	(3.02)
Log female literacy	5.61***	7.59***	−2.60	2.28
	(1.86)	(1.76)	(1.84)	(2.25)
Log male literacy	11.36***	9.43***	13.80***	6.86*
	(2.77)	(2.61)	(2.42)	(3.39)
Log crude death rate	−7.54***	−15.95***	−24.41***	−9.95*
	(3.37)	(3.73)	(3.10)	(3.94)
Year		−0.268***	−0.092**	
		(0.027)	(0.029)	
Northeast			1.692***	
			(.147)	
Fixed effects	No	No	No	Yes
R^2	.55	.60	.66	.81

Note: See notes to table 5.3.
*$p < .05$.
**$p < .01$.
***$p < .001$.

the higher level of nutritional intake was more than enough to offset the negative effects of increased morbidity from exposure to disease.

5.3 Conclusions

In contrast to some other countries for which physical well-being and material economic indicators apparently moved in contrary directions (Fogel 1986; Sandberg and Steckel 1988; Komlos 1989; Floud et al. 1990), none of the indicators reviewed here suggested that the standard of living declined in France during the early stages of industrialization. For the period after 1820, when the data sources are better, we found that steady advance in economic measures was accompanied by slow but steady advance in heights and life expectancy. In the twentieth century, all the indicators showed accelerated progress.

Low fertility and the resulting slow population growth contributed to this distinctive French pattern of slow but steady improvement in physical well-being during industrialization. Given the higher mortality in urban areas, the urbanization that accompanied economic growth in the nineteenth century did generate negative externalities, but slow population growth led to a slow pace of urbanization that did not outstrip the pace of mortality decline. Moreover, urbanization was associated with improvements in real incomes and in consumption that contributed to male heights. Finally, the decline of marital fertility itself may have been related to increased familial investments in the health of children (Weir 1993).

Doubts about the early stages of economic development in France will focus, as they now do in the English standard of living debate, on the period 1780–1820. The disruptive effects of the Napoleonic Wars on Britain's economy have complicated the picture there, but that is nothing compared to the complexity of the French case. Sorting out the effects of economic growth from those of the Revolution, legal reform, war, the Continental Blockade, and the other tumultuous events is made still more difficult by the shortage of sources and of scholarly work on the economic history of the period.

Because the various economic and noneconomic indicators of living standards tended to move in the same direction in France, we did not need to specify their interrelationships in order to draw an unambiguous conclusion that the welfare of the population improved during industrialization. The cross-sectional time-series analysis suggested, however, that the different economic indicators measured different aspects of economic welfare just as the different demographic indicators measured different dimensions of physical well-being. We can, therefore, still learn more about the interaction of economic welfare and physical health during French development.

Appendix A
Data Sources and Methods

Nominal GDP at Market Prices

France: 1781–1938, Toutain (1987, V41); 1948–89, *Annuaire Statistique.*

United Kingdom: 1949–80, *National Accounts* expenditure-side estimates, as reported in Mitchell (1988, 834–35); 1855–1948, Feinstein's (1972) "compromise" estimate at factor cost, reported in Mitchell (1988, 836), plus Feinstein's factor cost adjustment reported in Mitchell (1988, 831–35); 1830–54, Feinstein's expenditure-side estimate at market prices from Mitchell (1988, 837), ratio-spliced in 1855 to the "compromise" estimate; 1760–1829, new estimates and conjectures about GDP at factor cost in Great Britain and Ireland, converted to GDP at market prices by ratio splicing in 1831 to the estimates based on Feinstein's compromise series for the United Kingdom. The main benchmarks for Great Britain are from Deane and Cole (1962, 166) for 1801, 1811, 1821, and 1831, and from Crafts (1985) based on Lindert and Williamson (1983) for 1760. Annual variation between the benchmarks is based on smooth trends in real growth and annual fluctuations in prices.

Real GDP

France: Real GDP in constant francs of 1905–13 formed by creating an index of real GDP base 1905–13 = 100 and reflating to the level of nominal GDP in 1905–13. The index is formed by: 1781–1960, Toutain (1987, V40); 1960–70, INSEE estimates of GDP in constant prices of 1970 from *Annuaire Statistique,* spliced to index at 1960; 1970–89, INSEE estimates of GDP in constant prices of 1980 from *Annuaire Statistique* spliced to index at 1970.

United Kingdom: Real GDP in constant pounds of 1913 formed by creating an index base 1913 = 100 and reflating to the level of nominal GDP in 1913. The index is formed by: 1965–80, real GDP at 1980 market prices (Mitchell 1988, 841), spliced to index at 1965; 1948–65, real GDP at 1958 market prices (Mitchell 1988, 841), spliced to index at 1948; 1913–48, Feinstein's compromise GDP at factor cost in 1913 prices (index 1913 = 100 and nominal GDP from Mitchell 1988, 836), plus factor cost adjustment in constant prices (Mitchell 1988, 839–40, gives figures in 1938 prices, which I converted to 1913 prices by the ratio of the 1913 estimate in nominal 1913 prices [Mitchell 1988, 833] to the 1913 estimate in 1938 prices); 1855–1913, Feinstein's compromise GDP at factor cost in 1913 prices (index 1913 = 100 and nominal GDP from Mitchell 1988, 836), plus factor cost adjustment in constant prices (Mitchell 1988, 837–39, gives figures in 1900 prices, which I converted to 1913 prices by the ratio of the 1913 estimate in nominal 1913 prices [Mitchell 1988, 833] to the 1913 estimate in 1900 prices); 1830–55, as for 1855–1913, with compromise GDP at factor cost in 1913 prices estimated by splicing Feinstein's expenditure-side estimate of GDP at factor cost in constant 1913 prices to this 1855 compromise GDP estimate at factor cost in 1913 prices; 1760–1829, nominal GDP at market prices for the United Kingdom as described above, deflated by my implicit price deflator for Great Britain based on Crafts (1985). The overall trend rate of growth in real GDP for Great Britain is that of Crafts for 1760–80, 1780–1801, and 1801–31. Growth rates within the period 1801–31 have been allowed to vary to match the nominal GDP benchmarks. Irish real GDP per capita was assumed constant.

Exchange Rates

The general approach taken was to obtain real output series using domestic prices as deflators and then convert the level of the U.K. series to its equivalent in French francs of 1905–13. In principle, the conversion could be done for any year in which nominal output and the exchange rate were known for both countries. In practice, the choice of year and exchange rate basis can have a large influence on the relative levels of the converted real output series (U.K. expressed as constant francs). Under the stable gold standard regime prior to 1913 there is ample evidence that the fixed exchange rate imposed by free convertibility exercised a strong influence on international relative prices and that purchasing-power-parity (PPP) exchange rates did not stray far from the par exchange rate. I have therefore used the par rate of exchange up to 1913.

In the years since World War I the deviations of PPP from market exchange rates have been substantial. A serious effort at making internationally comparable real output estimates after World War I would require detailed attention to the evolution of international relative prices. For simplicity, I have followed Maddison (1991, 187) and used the 1985 PPP exchange rate for the period 1914–90, even though it creates an inconsistency with the pre–World War I years. In 1905–13, British GDP per capita in 1905–13 pounds was £48.1. Converted at the prewar par of exchange it was 1,214 francs of 1905–13; Maddison's conversions would place it at 1,598 francs of 1905–13. French real GDP per capita in 1905–13 was 1,030 francs of 1905–13.

U.K. real GDP in francs of 1905–13: 1750–1919, the series in pounds of 1913 converted to a 1905–13 pounds base and then converted to francs at the par exchange rate of 25.22 francs per pound; 1920–89, conversion via the PPP exchange rate for 1985. According to Maddison (1991, 187), the PPP exchange rate in 1985 was 12.681 francs per pound, which, using nominal output and population data, implies that U.K. real GDP per capita was 93.11 percent of French in 1985. French real GDP per capita in 1985, expressed in constant francs of 1905–13, was 5,308.1, implying U.K. GDP per capita was 4,942.2 francs of 1905–13. Expressed in constant pounds of 1905–13, U.K. GDP per capita in 1985 was £148.85. The ratio (4,942.2/148.85) was used to convert the series in constant pounds of 1905–13 to constant francs of 1905–13.

Population (Variable Borders)

France: For 1740–1860, Henry and Blayo (1975, 92–93) give quinquennial estimates based on population reconstruction for the territory of 1861 (present-day territory). I made annual interpolations using annual births and deaths (corrected for underregistration) and assuming constant migration rates between quinquennial estimates. These were converted to the territory of 1815 by dividing by 1.0182, and midyear population estimates made by averaging adjacent 1 January estimates. For 1861–1911, Bourgeois-Pichat's (1952, 320–21) similar population reconstruction estimates were used and interpolations made. For consistency with GDP data the territories of Alsace and Lorraine were included through 1870 and excluded beginning 1871. From 1912–90, the official census and *Statistique Générale de la France* estimates were used, with Alsace and Lorraine restored beginning 1919.

United Kingdom: For 1921–80, Mitchell (1988, 11–14) gives midyear population estimates for England and Wales, Scotland, and southern Ireland; for 1801–1920, Mitchell (1988, 11–14) gives midyear population estimates for England and Wales, Scotland, and Ireland. Wrigley and Schofield (1981) noted some underregistration in censuses of England and Wales, especially before 1841. The data reported in Mitchell apparently contain some correction vis-à-vis the census. To determine the remaining extent of correction needed, I compared the figures for England and Wales in Mitchell with the estimates of Wrigley and Schofield (multiplied by 1.073 to account for their exclusion of Monmouth). The Wrigley and Schofield estimates were 2.6 percent higher in 1801 and 1811, and 1.86 percent higher in 1821 and 1831, with the differences essentially eliminated by 1851. I interpolated between census years to get annual correction factors and applied the same correction factor to the population of Great Britain and the United Kingdom. For 1760 to 1801, I assumed that the populations of Ireland and Scotland grew at the same rate as the population of England and Wales estimated by Wrigley and Schofield and extrapolated the 1801 U.K. total back on the English growth rate.

Consumption

Consumption was estimated as a residual from the national income accounting identity:

$$C = Y - G - I - (X - M).$$

The estimates of nominal income (Y) are the nominal GDP estimates described above. The other elements are taken from the following.

France: 1820–1913, government spending excluding transfer payments (G) given by Toutain (1987, V25), gross domestic investment (I) from Lévy-Leboyer and Bourguignon (1985, table A-III, col. 4 + col. 6 + col. 8), net foreign investment ($X - M$) from Lévy-Leboyer and Bourguignon (1985, table A-III, col. 5 minus col. 7); 1803–20, consumption share assumed at 85 percent of GDP; 1781–90, consumption share assumed at 89 percent of GDP.

United Kingdom: For 1830–1913, I estimated the share of nominal GDP at market prices going to consumption from Feinstein's expenditure-side data (Mitchell 1988, 831–33) and applied that ratio to the nominal GDP series described above to obtain nominal consumption, and to the real GDP in 1913 prices to obtain real consumption; 1760–1831, aggregation of separate series for Great Britain and for Ireland. For Britain, Feinstein's (1978) estimates of domestic and foreign investment have been slightly revised and are reported in Feinstein and Pollard (1988, 462) in current prices. They are reported as decade averages, and it was necessary to assume the same value for each year within decades up to 1830. For 1831 it was possible to use his annual estimates of investment in the United Kingdom to determine the ratio of 1831 to its decade average. Government expenditures are reported in Mitchell (1988, 578–89). I deducted total debt charges from total net expenditure to arrive at an estimate of government purchases of goods and services. The bulk of remaining expenditure was on the military. Data are for Great Britain up to 1801 and the United Kingdom thereafter. It then remains to estimate investment in Ireland and government spending in Ireland prior to 1801. I assumed investment and government combined to be 5 percent of Irish GDP at factor cost from 1760 to 1801, and investment at 3 percent of GDP from 1801 to 1831.

Labor Force Distribution by Sector

France: Marchand and Thélot (1991, 170). Women were weighted at 62 percent of men.

United Kingdom: Deane and Cole (1962) for Great Britain 1801–1951 (p. 142) and United Kingdom 1851–1911 (p. 147). Prior to 1846, the data for Britain were converted to the United Kingdom on the assumption that the Irish labor force was 32 percent of the U.K. total and that 20 percent of the Irish labor force was in industry. From 1921 on, the Irish share of labor force was sufficiently small that British figures were used without modification.

Nutrient Consumption

Coefficients representing average nutritional content were applied to estimates of the availability for human consumption of foods of various kinds (including wine). Food availability estimates: 1781–1938, Toutain (1971) decade averages; 1950–89, Organisation for Economic Co-operation and Development (1975).

Nominal Wages

France: The index is of unskilled construction labor in Paris.

Britain: Several nominal wage indexes (fixed-weight labor force composition) were spliced together at adjoining years. 1881–1913, Feinstein (1990, 612), index of changes *within* sectors; 1851–81, Wood (1909, 102–3), index for workman of unchanged grade; 1750–1851, Crafts and Mills (1994), the general movement of which is governed by benchmark-year estimates for blue-collar workers from Lindert and Williamson (1983).

Cost-of-Living Indexes

France: The index is for Paris. 1840–1913, Singer-Kérel (1961, 452–53), index of 213 articles; 1726–1840, data underlying Weir (1991), subindexes based 1851 = 100 for comparability with British index.

Britain: 1870–1913, Feinstein (1991, table 6.4); 1851–70, Bowley's index given in Mitchell (1988, 738); 1781–1851, Lindert and Williamson's (revised) "southern urban" index based 1851 = 100 given in Mitchell (1988, 737); 1750–81, Crafts and Mills (1994, 179–82).

Purchasing Power Parity

To compare the levels of real wages in France and England it is necessary to compare directly the nominal wages and the prices of a fixed consumption bundle for some year. This was done for circa 1905 in a study published by the (British) Board of Trade (1909), which has recently been reworked by Williamson (1995). Because the cost of living includes substantial nontradables (notably house rent), it could deviate substantially from the par exchange rate even under the gold standard. Nevertheless, Williamson finds that the French cost of his standard consumption bundle was only 2 percent higher at market exchange rates than the British cost. Nominal wages of French workers were about 76 percent of the wages of similar British workers, implying that French real wages were 75 percent of the British level in 1905.

Meat Consumption

National averages for France are given by Toutain (1971) for 1781–1939 and by the Organisation for Economic Co-operation and Development (1975) for the postwar years. Toutain's estimates derive mainly from the agricultural surveys of 1840, 1852, 1862, 1882, 1892, and 1929, which also provide the data by departments used in the cross-sectional regressions in this paper.

Urban consumption data were also reported in some of the agricultural surveys, derived from records of the *octroi,* the urban consumption tax system. Retrospective data for 1816–33 are reported in *Archives Statistiques* (France 1837) and for 1839–62 in the agricultural survey of 1862. Per capita urban consumption was calculated by dividing the reported consumption by the population of the cities included in the report. Rural meat consumption and population were then calculated by deducting the urban totals from the national total. The residual rural sector therefore includes some cities not included in the urban consumption reports (about 10 percent of the total "rural" population), and its per capita consumption may be slightly overstated as a result.

Parisians consumed meat from three sources: by far the largest was the slaughter at the city's main slaughterhouses of "butcher's meat," that is, beef, veal, mutton, and lamb. Pork was accounted for separately, and over the course of the nineteenth century external sources of prepared meat became increasingly important. For the eighteenth century the number of animals and their average weights are reported by Lachiver (1984). Similar data for 1799 to 1854 are reported by Husson (1856), along with data on external supplies. For the later nineteenth century, Parisian meat consumption was the subject of annual reports in the *Statistique Agricole.*

Heights of Men at Age 20

France: See appendix B.

Britain: For men born before 1890, Floud et al. (1990, table 4.1). The data are estimated mean heights by year of birth and age at measurement from two different sources: recruit description books (RDB) and the Army Medical Department (AMD). I separated the estimates by source. The RDB estimates are for five-year birth cohorts 1740–44 to 1855–59. To reduce variability due to the small sample sizes measured at single year of age 20, I converted other age groups to an age-20 basis by the average ratio of height at age 20 to height at age x for all birth cohorts and then averaged the single-year-of-age series by birth cohort. A check against the age-20-only series shows that the main movements and levels are indeed similar. A similar age-20 index was constructed from the AMD estimates by single-year birth cohorts. The quinquennial RDB estimates are used for cohorts 1740–1854 (recruitment years 1760–1874) and a five-year centered moving average of the annual AMD estimates for birth cohorts 1855–1889 (recruitment years 1875–1909). Data for subsequent years are based on numerous studies discussed by Floud et al. (1990, 153–62).

Life Table Mortality Rates

Life tables for 1740–1829 were produced by Blayo (1975). For the twentieth century life tables have been published by Vallin (1973) and in annual volumes of the *Annuaire Statistique*. For the years 1830–1900 it was necessary to calculate life table values from estimated age-specific mortality rates. Deaths by age and births were reported annually by the Statistique Générale de la France. The age distribution of the population was taken from the population reconstructions of Bourgeois-Pichat (1951, 1952) and Henry and Blayo (1975). For further discussion of data sources and reconstruction methods see Weir (1994a).

Crude Death Rates by Urban-Rural Residence

Total deaths were reported separately for urban and rural communes beginning in 1854, with the classification of urban updated at each quinquennial census using the official definition of urban (population of 2,000 or more in an agglomerated area). Prior to that date records were kept for cities of over 10,000 population and the capitals of the arrondissements, which together accounted for over 70 percent of the urban population. A total of urban deaths was estimated by multiplying the crude death rate in the covered cities by the total urban population according to the census definition. Rural deaths were then calculated by subtracting the urban total from the national total. Deaths in Paris were reported retrospectively in the *Annuaire Statistique de la Ville de Paris*. They were deducted from the total of urban deaths to obtain the category of "other urban."

Appendix B
Heights of French Men Born 1784–1902: Sources and Methods

Time Periods Covered

For the purpose of estimating the median heights shown in table 5B.1, there are four distinct periods with different methodological challenges. The problems are relatively simple in the two periods after 1871. The simplest of all is the recruitment period 1872–1912, for which my estimates are identical to those of van Meerten (1990). After 1886, everyone was measured and the complete distribution of heights was reported. This is about 300,000 individuals in total each year, or an average of about 3,400 in each department. From 1872

Table 5B.1 **Estimated Median Height at Age 20–21, by *Classe* (year cohort reached age 20)**

Year	Height (mm)	Year	Height (mm)	Year	Height (mm)
1804	1,635.4	1844	1,644.7	1884	1,654.3
1805	1,636.2	1845	1,644.6	1885	1,653.7
1806	1,636.3	1846	1,645.1	1886	1,653.9
1807	1,639.4	1847	1,642.5	1887	1,653.6
1808	1,635.5	1848	1,643.5	1888	1,653.7
1809	1,636.1	1849	1,644.8	1889	1,652.9
1810	1,638.3	1850	1,645.4	1890	1,653.7
1811	1,639.6	1851	1,646.1	1891	1,653.2
1812	1,637.6	1852	1,645.8	1892	1,654.8
1813		1853	1,646.7	1893	1,654.7
1814		1854	1,643.9	1894	1,654.4
1815		1855	1,644.3	1895	1,654.1
1816		1856	1,645.2	1896	1,654.1
1817	1,632.2	1857	1,645.4	1897	1,654.4
1818	1,634.9	1858	1,645.9	1898	1,654.9
1819	1,636.7	1859	1,645.9	1899	1,655.1
1820	1,640.8	1860	1,646.5	1900	1,655.4
1821	1,637.5	1861	1,647.1	1901	1,655.4
1822	1,636.0	1862	1,647.4	1902	1,654.7
1823	1,638.8	1863	1,647.2	1903	1,658.3
1824	1,639.5	1864	1,647.7	1904	1,659.0
1825	1,639.8	1865	1,647.3	1905	1,659.8
1826	1,642.7	1866	1,647.7	1906	1,659.5
1827	1,643.3	1867	1,649.4	1907	1,661.1
1828	1,642.2	1868	1,647.0	1908	1,660.2
1829	1,641.6	1869		1909	1,660.8
1830	1,641.2	1870		1910	1,660.5
1831	1,640.7	1871	1,647.5	1911	1,661.1
1832	1,641.7	1872	1,651.3	1912	1,663.3
1833	1,641.2	1873	1,650.4	1913	
1834	1,642.5	1874	1,651.6	1914	1,664.7
1835	1,642.5	1875	1,652.5	1915	
1836	1,642.5	1876	1,652.9	1916	1,667.1
1837	1,642.1	1877	1,653.6	1917	1,667.5
1838	1,644.1	1878	1,653.3	1918	1,666.5
1839	1,644.8	1879	1,652.5	1919	1,664.9
1840	1,643.4	1880	1,652.7	1920	1,665.6
1841	1,643.9	1881	1,654.5	1921	1,668.9
1842	1,643.4	1882	1,654.7	1922	1,669.2
1843	1,644.3	1883	1,654.7		

to 1885 only about half of each cohort was measured. Lotteries determined who was called in for examination, so the selection was random, and a full distribution of heights was reported, including the heights of men exempted from service. For the years after 1872 it is therefore a simple matter to calculate conventional medians from the reported height distributions, which were published in centimeters. The years 1913–22 were affected by the war, and especially by early call-up of some cohorts, which resulted in mean ages at recruitment as much as two years younger than usual. The medians require adjustment in those years.

Prior to 1871, height data were kept only on men actually recruited into the army, which requires us to assess the number exempted below the minimum height requirements. Here my methods differ slightly from van Meerten's. There was also apparently a problem associated with conversions between metric units and the older traditional units of measure prior to 1867. Beginning in 1867 the data are reported in pure metric units. Between 1866 and 1867 uncorrected medians such as estimated by van Meerten leap up by 8 mm: a larger increase than had occurred over the entire preceding 40 years! An alternative estimation procedure described below can overcome the problem. For the period of the First Empire there are two additional problems: we have data only on a regionally biased subset of departments, and the ages at recruitment varied. We must address four issues before advancing an estimation method: recruitment procedures, minimum height standards, replacement, and units of measure.

Recruitment Procedures

Local officials maintained a *tableau de recensement,* keeping track of men by birth cohort. The *classe* of a given year, say 1831, consisted of all men born 20 years prior, in this case 1811. They would be examined early in the next year (1832), when the men were aged approximately 20 years, 8 months (plus or minus 6 months depending on birthdate within the year). On average, about 61 percent of the male births survived to be counted in the *classe,* and the average year's *classe* consisted of just over 300,000 men. The selection of conscripts from the *classe* varied over time, as did the role of height measurement.

From 1816 to 1871 heights are reported only for those actually recruited into the *contingent.* The total size of the *contingent* was set each year by the army according to its manpower needs and was then allocated across departments roughly in proportion to the size of *classe.* The *contingent* increased from 40,000 in 1816–23 to 60,000 in 1824–29 to 80,000 in 1830–52 to 100,000 from 1853 to 1870, with a few years of higher demands. After 1870 the numbers were somewhat more variable around 170,000 per year. All the members of the *classe* were assigned numbers in a lottery (*tirage au sort*). In theory, local recruiters examined the men in the order determined by lottery until they had found enough eligible men to fill out the required *contingent.* The total number of men examined (*examinés*) therefore depended on the rate of exemptions (*exemptés*). On average, just under half the *examinés* made it into the *contingent,* so the number of *examinés* was about half the *classe* up to 1852, and nearly two-thirds thereafter. About 19 percent of the *examinés* were exempted for physical deformities, 17 percent for legal reasons, 9 percent for constitutional weakness (*faiblesse de constitution*), and 7 percent for insufficient height (*défaut de taille*).

Minimum Height Standards

There was a minimum height standard of 1.57 meters before 1830, 1.54 in 1830, 1.56 from 1831 to 1867, 1.56 to 1871, and finally 1.54 from 1872 until its abolition in 1886. Prior to 1871, the reported height distributions refer only to the *contingent,* that is, the men actually conscripted, all of whom were above the minimum height. They are thus truncated distributions, and the mean heights of recruits will be greater than the true mean of the population. There are two ways to make use of such data: estimate the population mean from the truncated distribution using maximum likelihood techniques, or obtain separately an estimate of the proportion of men below the minimum standard.

The first strategy could be applied quite easily in France. The minimum height standard is known precisely. By contrast, in the English data the minimum standard was variable and so the truncation point itself had to be estimated. The Quantile Bend Estimator is an iterative procedure designed to estimate simultaneously the maximum truncation point and the parameters of the population distribution. With a known minimum standard, estimation is much easier. Moreover, the minimum was sufficiently low in France that the reported "upper" tail was probably in the vicinity of 90 percent of the whole distribution. By contrast, some recent estimates for Sweden relied on data for which only that part of the distribution above the mean could be considered reliably recorded (Sandberg and Steckel 1988).

For reasons given below, complete reliance on reported heights above the minimum standard presents other problems. It is preferable to make use of the available information about the number of persons below the minimum. Insufficient height was one of several possible reasons for exemption from service, and the number of exemptions for *défaut de taille* was usually reported, along with those for other reasons. Each individual was only counted once, no matter how many exemptions he may have been eligible for. We thus have a numerator: a count of men below the minimum height standard. We need a denominator; that is, we need to know the number of men who were "at risk" of being found below the minimum. The upper limit is the total number of men who were examined. From this we should deduct men who were dismissed prior to height measurement, or for reasons that were unrelated to their height.

Obviously, the men taken into the *contingent* were at risk, including those whose heights were listed as unknown. The problem is classifying the other exemption categories. If a particular exemption was granted before height measurement took place, then we may assume that the men who were granted that exemption were not at risk for a finding of insufficient height and so should not be included in the denominator. This was certainly the case for exemptions on legal grounds, primarily for the only sons of widows and other special family situations. Ambiguities arise when dealing with exemptions for other physical problems. In principle, other physical exemptions were supposed to take precedence over *défaut de taille;* for example, someone who was both short and missing a few fingers (*perte des doigts*) would be classified as missing a few fingers. Since many of the exemptions for deformities carried some advantages to the family, it seems likely that the precedence rule would be followed. The large and vague category of *faiblesse de constitution* (constitutional weakness) poses a different case. There were no advantages to the family from this exemption, and it was the most subjective of all the possible reasons, raising the specter of challenge. It therefore seems reasonable that a young man of insufficient height would be classified by the absolute standard, and that *faiblesse de constitution* would be reserved for men of adequate height and no obvious deformities but who nevertheless presented an unappealing prospect to the local recruiter.

The most sensible procedure, therefore, is to construct the denominator as the sum of the number in the *contingent,* including unknown heights, plus the number exempted for *défaut de taille,* plus the number exempted for *faiblesse de constitution.* One arrives at the same total by deducting from the total number of men called for examination (*examinés*) the number of legal exemptions and the number of exemptions for physical deformities other than *faiblesse.* This is the procedure used from 1831 forward. Using the same procedure before 1830 creates a big discontinuity in the estimated share of the population under 1.57 meters, which is a key parameter in the estimation method described below. It is possible that the exemption for insufficient height took precedence over other infirmities in the years before 1830. If we include all exemptions for infirmities in the denominator used to calculate the share below the minimum height standard before 1830 we obtain a series that appears more consistent with the later years.

Replacement

Prior to 1872, service in the army could be avoided by hiring a "replacement." On average, about 23 percent of draftees hired replacements, but the rate varied considerably by region (Schnapper 1968). The price was typically around 1,000 francs at a time when the average yearly earnings of an agricultural laborer probably did not exceed 500 francs. The result would be a substitution of a poor (and, therefore, perhaps shorter) man for a wealthier one. Men ultimately replaced were examined and measured. It seems that the reported distributions were based on the original cohort of draftees *prior* to replacement. Obviously, there was no reason for the family to pay a replacement if the son could obtain exemption on other grounds, so he would go through the examination. Moreover, we do not observe any discontinuity in the trend of heights when replacement was abolished.

Units of Measure

The other problem that must be corrected is not one that has ever been discussed in the literature. It becomes apparent only when looking at the height distributions. Prior to 1867 the data were grouped in old-style *pieds* and *pouces*

Table 5B.2 Exact Millimeter Ranges Corresponding to Round Units of Measure

Round *Pouces* (1)	Millimeter Range (2)	Round Centimeters inside Range (3)	Millimeter Range of Round Centimeter Scale (4)
<58	1,560–1,569	156	1,560–1,569
58	1,570–1,597	157, 158, 159	1,570–1,599
59	1,598–1,624	160, 161, 162	1,600–1,629
60	1,625–1,651	163, 164, 165	1,630–1,659
61	1,652–1,678	166, 167	1,660–1,679
62	1,679–1,705	168, 169, 170	1,680–1,709
63, 64	1,706–1,760	171, 172, 173, 174, 175, 176	1,710–1,769
65, 66	1,761–1,814	177, 178, 179, 180, 181	1,770–1,819
67+	1,815–	182, . . .	1,820–

(French feet and inches, one inch being approximately 27.07 mm). Each range was also labeled with approximate metric equivalents in millimeters. We know, however, that in many cases conscripts were measured in centimeters. Imagine a nineteenth-century French bureaucrat asked to put a distribution by round centimeters into a distribution by *pouces.* Table 5B.2 shows how it must have been done. Column (2) shows the millimeter ranges published by the army, and column (1) shows the (unpublished) old-style *pouces* to which they correspond. The round centimeter values would be placed within the appropriate millimeter ranges given by the army, as shown in column (3). These round centimeter values correspond to the millimeter ranges shown in column (4) if we assume that height measures were rounded down; for example, anyone of at least 160 cm but less than 161 cm in height would be recorded at 160 cm.

There are two notable features of this regrouping. The millimeter ranges corresponding to the round centimeter measurements are slightly higher than the millimeter ranges corresponding to the old units, and some *pouce* ranges have three and others only two exact-centimeter groups. If recruits were measured in round *pouces,* or in exact millimeters, we should use the millimeter ranges of column (2) to calculate median heights. If, on the other hand, they were measured in round centimeters and simply regrouped we should use the millimeter ranges of column (4), which would produce higher medians.

Unfortunately, neither assumption is completely accurate for all years. By the late 1860s the evidence suggests that nearly everyone must have been measured in centimeters and regrouped. The published data switched from *pouces* to centimeter ranges beginning in 1867. The (conditional) mean height of men over the minimum estimated from the metric data for 1867–68 was higher than a similar conditional mean calculated from the millimeter ranges of column (2) and virtually identical to the mean calculated from the ranges of column (4). Another indicator that the reported distributions were really a clumsy regrouping of centimeter data is the relative size of the range corresponding to

61 *pouces*. Since it corresponds to only two exact-centimeter groups it would have fewer observations than "expected" given the mean and standard deviation. That was certainly the case in the 1860s. Data in the 1830s appear to have had a less severe form of the same regrouping problem, suggesting that the use of the metric system at the individual level diffused over time.

One possible solution would be to estimate two versions, one metric and one old-style and then weight them according to the probable extent of metric usage. This is feasible for the national averages, but highly questionable for the departments. We need a procedure to estimate the median that is not affected by the regrouping problem.

The reported height data can be collapsed into groups for which the ranges in old-style inches correspond to whole-centimeter ranges. Unfortunately, the first such range is from 1,570 to 1,679 mm (roughly the 12th to the 70th percentile of the height distribution). The usual procedure of estimating a median by linear approximation within a range can create large errors when the range is so wide. Instead, I estimate the median by a nonlinear procedure using two observed parameters: the proportion of all men below 1,570 mm, and the share of the above 1,570 group who are under 1,680 mm. These two parameters are based on largely independent sources: the lower tail is based primarily on the estimated proportion exempted for insufficient height, while the other is based on the distribution of reported heights only.

The approximation formula for the median was obtained from simulations of normal distributions of height with means from 1,620 to 1,675 mm and a coefficient of variation equal to 0.035 in all cases. It is quite precise within that range (and thus for the samples studied in this paper), but better approximations could be obtained for samples with very different characteristics. The median is calculated by

$$h = 1745.78 - 92.3864*s1 - 132.698*s2,$$

where $s1$ is the proportion of all men in the population under 1,570 mm (58 *pouces*), and $s2$ is the proportion of men 1,570 mm or taller who were between 1,570 and 1,679 mm (at least 58 but less than 62 *pouces*).

Heights in the First Empire, 1803–12

The data were reported in the same nonmetric ranges as were used in the Restoration. It is not completely clear what rules governed who was included in the reported height distributions, and they may have varied from one region to another. The large number of men in the category of under 4 *pieds*, 9 *pouces* (154 cm) suggests that there was no effective minimum (or that all men were measured). There was no separate listing of exemptions. I therefore assume that lower truncation is not a problem with this data and calculate medians (using the nonlinear approximation formula) without further correction for missing observations below the minimum.

Villermé (1829) reports the ages at which men were called in each of these classes. I adjusted the mean height for those years in which the recruitment age fell below the norm of 20.5 years. Based on Floud et al.'s (1990) English data on heights by age, it appears that a fall of one year in the average age of recruitment lowered mean heights by about 0.7 percent. The correction formula was therefore $H = h * [1 + (20.5 - a) * .007]$, where h is the observed median height of recruits and a is their average age.

The regional composition of the sample was not representative of France as a whole. In the years 1820–40 the departments in the sample had a median height about 4 mm below the national average. I therefore augmented the estimated medians for 1803–12 by a further 4 mm to correct for regional composition.

World War I

The examination dates of cohorts mustered during and immediately after World War I (1913–22) varied considerably. At the extremes, the *classe* of 1912 was measured in the usual way in February and March 1913, while the *classe* of 1917 (born five years later) was called in and measured in summer 1915 (only two years later). Cohorts measured at younger ages had systematically lower heights. However, the correction formula used for 1803–12 and derived from the English data resulted in very obvious overcorrection of the data from 1913–22. Quite possibly the better nourished cohorts born at the end of the nineteenth century reached final adult height at younger ages. I used instead

$$H = h * [1 + (20.67 - a)*.0025].$$

No detail on height distributions was published for the *classes* of 1913 and 1915. Estimates were obtained by simple linear interpolation between adjacent single-year cohorts.

Sources

The army produced an annual report, the *Compte-rendu sur le recrutement de l'armée,* providing data for each department on the number of men in different height ranges, and the number of exemptions granted for different reasons. The *Comptes-rendus* were used for the department-level estimates of 1840, 1846, 1856, and 1866. Beginning with the recruitment class of 1873, the *Annuaire Statistique* published department-level data on an annual basis. For the years 1873–85 the *Annuaire Statistique* is the preferred source, because the *Compte-rendu* gives data by military district rather than department. After 1905 the *Compte-rendu* provides a more detailed distribution of heights than the summary in the *Annuaire Statistique* and was used for the department cross sections of 1905 and 1911. The *Annuaire Statistique* also published frequent retrospective tables of the national height distribution from 1836 forward. Although they were not used in this paper, department-level data for 1819–26 combined can be found in Aron, Dumont, and LeRoy Ladurie (1972).

National-level totals of the number of *examinés* and exemptions for various causes from 1816 to 1871 were found in Tschouriloff (1876, 636–47) and confirmed by other official sources. The *Compte-rendu* of 1835 gave height distributions for 1834 and 1835. Annual data on the heights of conscripts prior to 1834 were obtained from Villermé (1929, 399), Boudin (1863, 177–201), and Hargenvilliers (1817).

The height distributions for 1803–12 were found in France, Archives Nationales F20 439 and F20 440[1]. The cartons include reports from some occupied non-French departments as well.

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