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## MEASURING THE TRANSFORMATION OF THE EUROPEAN ECONOMIES: INCOME, HEALTH AND WELFARE

Roderick C. Floud(+)

**Abstract:** The measurement of national income has added greatly to our understanding of economic and social change in Europe over the past hundred years. But national income analysis does not take full account of changes in welfare and particularly of the causes and effects of long-term changes in the health of the European populations. The paper surveys methods which have been used to adjust national income estimates and shows that they can be supplemented, if not replaced, by measures of growth in human physical height as an indicator of changes in the nutritional status of national populations, of the peoples of particular areas and of social classes.

National income analysis is central to our present knowledge of the transformation of the European economies. By their painstaking work, a generation of scholars such as Bairoch, Feinstein and Hoffmann have delineated that transformation as it appears in the national accounts which they have compiled; they have enormously facilitated comparisons between the national economies as well as the description and analysis of changes within those economies (Bairoch 1976; Feinstein 1972; Hoffmann 1965 and survey in Crafts 1983). As a result of their work, economic historians in western Europe turn naturally to such concepts as gross domestic product per capita, factor shares of labour or capital and growth rates of gross national product and use them as basic building blocks in their endeavour to describe and analyse the European economies and the relations between them.

It is in the nature of scholarship, however, that the work of one generation should be questioned by the next. Just as the great compilations of historical national income statistics are completed and used in such works as *British Economic Growth 1856-1973*, by Matthews, Feinstein and Odling-Smee (1982), so questions are raised about the suitability of the national income framework for the analysis of economic development in the long-run. Doubts are expressed about the assumptions concerning the structure and workings of economies which underlie this mode of analysis, about the irrelevance of national frontiers to many of the processes of economic growth and, most fundamentally, about the significance of national income itself, either as a measure of production or as a measure of welfare.

Many of these doubts arise from uncertainty about a fundamental question - what is the purpose of measuring national income, at one moment in time, or growth in national income over time? Are we concerned with the productive power, technology or organisation of the economy or with the outcome of its work? The answer must surely be that we measure economic growth to discover something about the welfare of people within the community. As Dan Usher puts it in his stimulating book *The Measurement of Economic Growth*:

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"The major premise of the book is that statistics of economic growth may be interpreted and proposals for improvement may be judged appropriate or otherwise by means of an analogy between a country and a person: economic growth to a country is like a raise in salary to an individual ... For without such a translation, measures of real income and economic growth are mere numbers with no apparent effect upon our lives and no status as indicators of progress towards goals that people might want the economy to achieve. Without the possibility of such a translation, the measurement of economic growth is nonsense. Why, after all, would we want to measure economic growth, why is public policy directed to the promotion of economic growth, why do economic historians and specialists in economic development search for the explanation of economic growth, if we are not better off after economic growth than we were before?" (1980: 1-2)

Unfortunately, the traditional measures of welfare which are based upon national income often appear to have serious deficiencies as measures of how much 'better off' we are, either than people in the past or than people in other societies at the same point in time. As Usher and others have pointed out, economic change has had many more dimensions and consequences than those which appear to be measured by the traditional computations of real income per capita. For example, modern European societies are certainly much richer than they were a century ago, in terms of income per capita, but in addition the average citizen of those countries also enjoys that higher income for much longer, because of the major changes which have occurred in expectation of life. Most of us would probably regard this reduction in mortality as a major improvement in welfare, but it is one that is largely ignored by conventional measures. Similarly, those longer lives are, in most cases, lived within environments that are notably less polluted than the towns and cities of nineteenth century Europe but, once again, this environmental improvement is hardly reflected in measures of real income.

Another difficulty with conventional measures lies in their failure to take account of the amount of work effort that is required to produce a given level of income. Not only have hours of work within the working day, and weeks of work within the working year, fallen drastically within the past century - a change which is easy to document - but in very many occupations work is now easier, pleasanter and less dangerous than in the last century, while many of the most arduous and hazardous of occupations have entirely disappeared. Higher incomes are thus more easily earned, which again would seem to most of us to make us 'better off'.

Yet a further problem is that conventional measures of welfare based on national income are derived by dividing estimated national product by the estimated population, to give, for example, gross domestic product per capita. When the benefits of economic growth are being assessed over periods in which there were major changes in the age structure of the population or in the degree of inequality of the income and wealth distributions, this procedure may give misleading results. It is straightforward to suggest that, in such cases, an adjustment should be made to take account of the different consumption levels and requirements of children, working adults and retired people. It is much less straightforward, as Atkinson has shown, to take account of changing inequality in measuring national income per head since to do so implies judgements about the desirability of different degrees of inequality. (1975: 47-9)

These difficulties, which make conventional measures of income seem to be inadequate measures of welfare, have of course long been known to econo-

mists. To some, the advantages which stem from the use of standardised methods of measurement and from the link which they have with measures of money income have stifled doubts; they are essentially content to define welfare within the confines of national income analysis. Other economists have, however, made attempts to adjust conventional measures to make them more representative of lay ideas of welfare. In particular, Usher has proposed a method by which changes in real income might be adjusted for changes in mortality. Applied to Canadian data for the period from 1926 to 1974, his 'imputation for life expectancy' raised the rate of economic growth "by about one-half of one per cent per year from 2.83 % without the imputation to about 3.35 %, give or take 0.03 %" (Usher 1980: 245). As he comments, this is by no means negligible; it increases the measured rate by about 20 %. Perhaps more significant, when one is considering the implications for historical study, is that Usher's attempts to make similar estimates for under-developed countries had even more dramatic effects on measured growth. Sri Lanka, for example, experienced a growth rate between 1946 and 1968 of 1.43 % per year by conventional measures, but of between 3.23 and 3.70 % after an imputation for changes in life expectancy. Even for a relatively rich country like Japan, the imputation raises growth between 1930 and 1974 from 3.99 % per year to between 5.23 and 5.45 %. As one would expect, in fact, the greater the rise in life expectancy, the larger the effect of adjusting for it.

Very recently, Jeffrey Williamson has applied Usher's method to the description of economic growth in nineteenth century Britain. (1984) Although Williamson has reservations about Usher's arguments, he concludes that life expectancy gains have played a very important role in British growth performance and that "... conventional indices of real income growth may understate true living standard growth by 25 % or more", with the greatest effects being seen in the second half of the nineteenth century and the first third of the twentieth. Thus British growth is seen, on these grounds, to have accelerated much more sharply since the middle of the nineteenth century than is suggested by more conventional measures.

While mortality decline has been one of the most spectacular changes which have affected welfare in the past two centuries, other environmental changes deserve attention. It has long been argued that one of the worst effects of industrialization was the pollution from smoke, other chemicals and human ordure which characterised nineteenth century cities. While mortality trends during the eighteenth and nineteenth centuries are still a subject of dispute, their general improvement is beyond question. Pollution, on the other hand, probably got very much worse during the nineteenth century before substantially improving in the twentieth. In another piece of work, Williamson has attempted to estimate the compensation which English labourers required to induce them to move from countryside to town during the industrial revolution (1982). He found, for example, that between 7 % and 13 % of the difference in wages between urban and rural workers could be attributed to the need for such compensatory or persuasive wage increases. While his estimates are not cast in the form of adjustments to national income and they would need substantial modification on the basis of additional research if they were to be extended to all classes of worker and to other sections of the population, in principle such adjustments should be made. Pollution did reduce the welfare of those who lived under a pall of smoke and larger parts of European populations did so during the nineteenth century.

Pollution damages health. It seems clear, for example, that smoke pollution was a contributory cause of the rickets which disfigured large numbers of

the working class of Britain whose diet was already deficient in vitamin D (Loomis 1970). It might be argued, of course, that any adjustment for pollution, based upon compensating wage payments, would include such health effects, although it is stretching market economics rather a long way to suggest that wage labourers in nineteenth century England required extra pay to compensate themselves for rachitic children. Other changes in health are, however, certainly not to be subsumed within adjustments for pollution or even for changing life expectancy.

Williamson (1984) begins his discussion with the words: "Like all concepts of economic value, the value of longevity gains has two multiplicative parts: price and quantity." He and Usher concentrate, therefore, on measuring quantity, in the form of numbers of people living extra years, and price, in the form of an assessment of the price those people are prepared to pay for an improvement in their chances of survival. These computations, however, appear to ignore the fact that, typically, individuals do not enjoy perfect health from the time they are born until the moment that they drop down dead. As Oddy (1982:121) has recently pointed out, we know very little about the health of people in the past, as opposed to knowing a great deal about why they died; common-sense and contemporary observation both suggest, however, that societies, and sub-groups of societies, with higher levels of life expectation also have less ill-health than do societies with lower levels of life expectation. In other words, not only have people in Europe come to live longer, but they are also probably healthier at each age than they were two hundred years ago. This is a notable addition to welfare (and probably also a notable addition to the productive capacity of the economy) but one that has been almost entirely ignored by economists and economic historians.

The same mistake, it should be said, has sometimes been made even by historians of health. In *The People's Health, 1830-1920*, for example, F.B. Smith suggests that increasing life expectancy in the late nineteenth century increased the number of ill and old people in the community, implicitly assuming that health did not improve commensurately with declining mortality (1929:320). A similar error is often made by those who speak today of the 'burden of the aged' on contemporary European populations.

The adjustments made by Usher and Williamson on the basis of mortality rates therefore certainly understate, probably by a large amount, the benefits to human welfare which have accrued during the past two centuries. But health improvements do not exhaust the factors which need to be taken into account in assessing changes in welfare. Paradoxically, as European populations have become healthier and stronger, more capable of undertaking sustained physical work, so increases in the use of machinery and other forms of capital have reduced and in some cases removed the need for such work. In addition, it is reasonable to attribute to such technological changes the fact that we now need to work far shorter hours to secure a given level of income. To most people, as they watch television or fly to Mediterranean holidays, the increase in leisure time is unambiguously an addition to welfare; the ability to dig holes from the seat of a bulldozer rather than by wielding a spade may be less obviously of benefit, but the reduced danger of manual occupations certainly is. Usher reports and comments upon imputations for leisure made by Sametz (1968); he also calculates an imputation for increased leisure in Canada from 1926 to 1971, whose effect is "to increase the rate of growth of real consumption per head over the whole forty-eight year period by almost a full per cent per year from 2.49 % to 3.37 %" (1980:146-147). He does not, however, consider the effects of increased ease of work.

As this discussion has shown, it is very easy to suggest ways in which measured trends in national income should be adjusted for improvements in welfare and to demonstrate that such adjustments would be substantial. There are, however, formidable obstacles in making the adjustments. There are two principal difficulties; first, it is important to consider how far the improvements are truly exogenous to, and therefore not already to some degree reflected in, increase in real income as it is conventionally measured. Second, there is a substantial problem of double counting; how can we separate, for example, the effects of increased life expectancy from the effects of improved health.

Usher and Williamson differ substantially when they discuss whether improvements in life expectancy are truly exogenous. This point is extremely important; if all the improvements in health and life expectation were bought by people devoting part of their current consumption expenditure specifically to buy improved health and longer life, then there would be no reason to adjust measured national income for improvements in health and mortality. As Williamson rightly argues, Usher assumes "that all mortality changes ... are exogenous to the household, totally independent of household investments in health via the mix in and the level of C (current consumption) itself." (1984:160). Williamson is wrong, however, in asserting that "... nowhere does Usher admit the possibility that current measured consumption influences mortality experience" (1984:162), since Usher considers exactly that point on pp. 247-252, where he concludes that:

"... I feel that the environmental component of observed mortality rates is a large enough portion of the total that the bias in treating mortality rates as though they were largely environmental need not have a significant impact on our results." (1980:251).

Williamson argues, by contrast, that Usher does not take sufficient account of "endogenous household response to changes in 'health technology', like lower fuel prices offering better food preparation or warmer residences", or of "endogenous changes in morality attributable to workers' investment in health, made possible by increase in income." (1984:162). For this reason, Williamson does not consider that the whole of the increase in life expectancy should be used in adjusting national income, although he considers that over time an increasing proportion has been exogenously determined.

Similar objections can be raised to all the other adjustments which have been proposed. To the extent that increased leisure has been bought by investment in capital equipment, that improvement is already subsumed within increasing income. Similarly, as Williamson suggests, current consumption of fuel may warm houses and thus improve health. The relative degree of endogeneity and exogeneity in such improvements is very subjective; while Williamson quotes McKeown and Record to the effect that "... change in the character of these infectious diseases, essentially independent of human intervention, may have been responsible for not less than one-fifth and - as a very rough estimate - for not more than one third" (of the nineteenth century mortality decline) it seems very unlikely that McKeown and Record would go to the stake for such precise estimates (1984:164, quoting 1962: 119).

A second cause of difficulty lies in the extent of double counting that may be involved when imputations are made for more than one improvement in welfare. More leisure and less hard work may lead, for example, to better health and a longer life; imputing separately for leisure, health and mortality changes will, therefore, considerably overstate the size of the impro-

vement in welfare. It is not unreasonable to conclude, in fact, that imputations to national income may be more trouble than they are worth.

Conventional measures of welfare do not, however, emerge very well from discussions such as this. There are, in addition, other objections to their use which are, broadly, that societies are so lacking in homogeneity that conventional measures of mean income per capita are misleading if not useless. It is an obvious feature of the transformation of the European economies that there have been very marked changes in the extent of income inequality, measured on a national basis. In addition, many European countries have exhibited marked geographical inequalities, so marked that some historians have doubted whether national economic histories have much meaning. It has become increasingly common, in addition, for economic historians to emphasise the importance of regional development, sometimes spreading across one or more national frontiers. As Pollard writes in *Peaceful Conquest* his study diverges from work in the Gerschenkron tradition and from the

"almost axiomatic assumption of Gerschenkron, Kuznets and others that countries within their political boundaries are the only units within which it is worthwhile to consider the process of industrialisation.

It is a major premiss of this study that this process, on the contrary, is essentially one of regions, operating in a European context and that in the early phases, when the foundations were being laid for the industrial transformation of society, governments were at best irrelevant, and frequently took a negative part, in a development which drew its main driving force from outside the political and governmental sphere." (1981:vii).

If this is so, conventional measures of mean national income within national boundaries are of little value to the economic historian. What is required instead is measures of real income, or analogous measures of welfare, for the population of defined regions or for other occupational or geographical sub-groups within the European population, sometimes within and sometimes straddling national boundaries. Conventional national income calculations, which rely heavily on governmental sources for their statistics and which must take account of trade flows as a major item within the national accounts, are ill suited for such purposes.

A traditional answer to such difficulties, indeed one which pre-dates national income analysis, is the computation of measures of the standard of living or welfare of sections of the population in the form of measures of real incomes or real wages. Unfortunately, as generations of economic historians have discovered, such computations are also fraught with difficulty, principally because of the enormous problem of obtaining matching and satisfactorily weighted series of price and wage observations which can be merged to give real wage indices. Despite the intensive study to which historians have subjected the price and wage series for the British industrial revolution, there is still no agreement on what they show, and the British economic history profession is about to embark on yet another attempt to collect more satisfactory statistics (Flinn 1974; Von Tunzelmann 1979; Lindert and Williamson 1983). Even for Britain in the late nineteenth century, where the wage and price series compiled by Bowley and Wood have long been used without much disagreement, Gazeley has recently shown how simple improvements to their work can significantly alters the course of real wages during the period (1983). For both periods, it has proved to be remarkably difficult to obtain appropriate price series which reflect what the consumer

actually paid, rather than bulk import prices or wholesale prices within the home market. Another major problem has been that of taking account of the fact that incomes are typically earned and consumed within the framework of the family. Not only is it extremely difficult to link together the incomes of different family members to compute total family income, it is also virtually impossible to know how consumption was distributed within the household; moreover, as the work of Laslett and others has shown, there are many conceptual problems in defining a typical or average family unit for such purposes. (1972).

To sum up this catalogue of problems, neither computations of the real wage nor those of national income per head seem easily to meet Usher's criterion that they should be more than "mere numbers with no apparent effect upon our lives and no status as indicators of progress towards goals that people might want the economy to achieve." (1980:2). They give us only a most inadequate idea of the impact which the transformation of European society has had upon the lives of Europeans.

This is a dispiriting conclusion. But there has recently emerged an alternative source of information about the welfare of Europeans in the past which will at least supplement, and for some purposes replace, the traditional measures of welfare. This information lies in the millions of observations held in European archives of the physical height of people in the past. It has long been known - both from academic study and from common observation - that people have been growing taller, but it has only recently become clear that that fact carries with it much information about their welfare.

Figure 1 summarises a small part of what is currently known about the changes which have occurred in the average height of young adult males in western Europe during the past two hundred years. The data, which have been described in more detail in another paper (Floud 1984), owe much to the work of Marie-Claude Chamla (1964) but they have been supplemented here by other sources and by statistical analysis. As Figure 1 shows, the changes in mean height within Europe have been substantial, as indeed they have been in the United States, Japan and many other countries (Fogel et al. 1983; Greulich 1976; Eveleth and Tanner 1976; Tanner 1981). But are such changes merely an historical curiosity or do they contain information of value to economic historians?

Judgments on the value of data on historical height must rest on two foundations. The first is the work of contemporary human biologists, anthropologists and social scientists who have demonstrated the significance of height and its relationship to other socio-economic indicators within the modern world. The second is the relationship of height measurements to other socio-economic indicators in the past. The conclusion from the first group of studies can be briefly stated, although to do so is to summarise an enormous range of literature; Eveleth and Tanner's book, for example, contains many hundreds of series of height measurements from the modern world. Briefly, however, these studies show that height - and indeed other measures of physical growth - are extremely sensitive indicators of what is best called the 'net nutritional status' of the child, adolescent or adult, considered as individuals and also as members of an homogeneous socio-economic group. Figure 2 shows the pattern of growth in the average height of groups of children (measured cross-sectionally at each year of age) which is characteristic of all human populations - although the height that is achieved and the speed with which it is achieved differ between one population and another and between sub-groups of each population. Humans require energy, in childhood and adolescence, for three purposes: body maintenance, growth and

physical effort in work or play. Insufficient energy intake in the form of food and warmth, or the unusual expenditure of energy in combatting disease, will affect the ability of the body to grow, to work and finally to live, the effects being seen in that order; famine and chronic disease will first affect growth, then diminish the ability to move and work and finally cause death.

It must not be thought, however, that growth is affected only in conditions of famine or chronic disease still characteristic of too much of our world. Even within rich, developed nations there is a clear class gradient in growth, in which the upper classes grow more rapidly and attain greater height than do the lower social classes. Moreover, even within particular income groups, both physical and psychological health affects growth, so that children grow less rapidly, for example, during periods of institutional care than when they are cared for within the family.

The net nutritional status - the interplay between energy inputs, health and bodily activity - can clearly affect a human being only during the period of growth in childhood and adolescence. Once growth ceases in early adulthood, the body is set in the height which it has acquired, at least until shrinking occurs in late middle and old age. Yet the factors that have affected growth are so pervasive that their effects can still be seen in adulthood; height is, for example, a good predictor of morbidity and mortality from heart disease, even after controlling for social class and income. In extreme environments, mortality has been shown to be highly predicted by height (Friedman 1982).

For all these reasons, physical growth in height is of great interest to contemporary social scientists and medical researchers. But, because height represents the net effect of income in the form of the intake of food and warmth, combined with the effects of environment in the form of disease, and societal and technologically determined requirements for work effort, it should also be of great interest to economists and economic historians concerned with measuring welfare. Figure 1, therefore, represents the incarnation of changes in welfare within the bodies of the European populations.

This is easy to assert, but it is sensible to enquire into the relationship which exists between height and more traditional measures of welfare such as those which I have criticised earlier in this paper. Three illustrations must suffice.

First, Steckel has shown that, in the modern world, mean height is highly correlated with national income and with measures of inequality in the distribution of that income; table 1 shows his results. (1983).

Second, I have demonstrated an equally close relationship between height, (based on a subset of the data shown in figure 1), and measures of gross domestic product per capita (in real terms) and infant mortality in western Europe during the past hundred years. These results are shown in table 2. It was not possible, because of lack of data, to incorporate either measures of income inequality or other environmental variables into this historical analysis, but it seems likely that the dummy variables representing country of measurement incorporate such effects (1984). A particularly interesting feature of these results, when they are compared to those of Steckel, is that the relationship between national income per capita and height appears to vary very little over time, when other variables employed by Steckel and myself are held constant. The comparison is shown in table 3.

Third, in recent studies which are so far unpublished I have shown that a clear relationship exists in historical data between height and socio-economic status; table 4, for example, is a comparison between the mean height of a group of children from the London slums in the early nineteenth century with a group of children, the sons of aristocrats, gentry and the higher ranks of the army and navy, who joined the Royal Military Academy at Sandhurst. Table 4 shows that, for example at the age of 14, the children of the upper classes were about 8 inches (20.3 cm) taller than those from the London slums. Since we know that the distribution of heights at a given age is normal, with a standard deviation of about 2.5 inches (6.4 cm) this allows us to say that 94.5 % of children of the upper classes were taller than all except 5.5 % of children of the slums. This substantial class variation in heights had diminished in Britain by the end of the nineteenth century but was still clearly visible when measured heights were classified by social class, as indeed it is today.

While these examples substantiate the assertion that economists and economic historians should pay attention to height measurements, it is perhaps not obvious that height data are superior to other data as measures of welfare. Why, a sceptic might ask, should we bother to collect large quantities of height data when the result is merely to show that average height is highly correlated with measurements which have already been made? The advantage of height over other measures of welfare is, however, that height measures already include the effects of environmental or exogenous influences on welfare which are not included within conventional measures of income. Thus there is no need to impute for such influences in the manner of Usher or Williamson.

This statement, which may appear to be making a large claim, is in fact implicit in the regression analyses shown in tables 1 and 2 and in the analysis of class differences. For in table 1 height is shown to vary in close relation to the joint variation in gross domestic product per capita, in inequality of income and in a number of other environmental variables. In table 2, similarly, height reflects joint movements in income and infant mortality (used as a proxy for health), while the country dummies in the equation pick up other environmental factors. While these sources of variation operate at a national level, table 4 shows that height is equally useful as a discriminator between social and economic conditions within a particular society. In other words, height data are a direct measure of welfare, much closer to what we think of as welfare or the standard of living than artificial constructs such as national income per capita or the real wage.

It is very easy, in addition, to apply height data as a measure of welfare to sub-groups of national populations, either on a regional or on an occupational basis, since most sources of height data also contain details of place of birth or residence and of occupation. The data used by Aron, Dumont and le Roy Ladurie, for example, in their description of the *Anthropologie du conscrit français* contains much more information than they realised about variation in standards of living between departments in France, information which is also available in many other records of conscription throughout Europe. They calculate, for example, that the conscripts from the departments of Allier and Landes in 1819-1820 were on average 164.1 cm (64.6 in.) tall, while those from Nord were 168.7 cm (66.4 in.), heights which correspond, as table 3 suggests, to very different levels of mean income.

Last, height measures require no adjustment for inflation, while both measures based on national income and measures of real wage are extremely

sensitive to particular choices of deflator and to particular choices of exchange rates for international comparisons. It is true, of course, that the exact functional form which relates height to its various determinants has still to be fully specified, but the number and range of observations of height is so great that the chances of progress in this direction are very good.

There are, however, several difficulties in using height as a measure of welfare. Usher argued, it will be recalled, that statistics of economic growth may be judged or interpreted "by means of an analogy between a country and a person: economic growth to a country is like a raise in salary to an individual" (1980:2). Height data cannot be similarly translated for two main reasons. First, a country may pursue policies which will tend to raise the average height of its citizens - by increasing their income and health or by decreasing inequality - but such a policy is not feasible for an individual in relation to himself or herself, although it may be feasible in relation to his or her children. Second, while it is clear from the literature of growth that almost all variation in heights between populations is environmentally determined, the same is definitely not true of individuals, where genetic or inherited factors account for a large part of an individual's height; assessment of an individual's welfare from his or her height is thus impossible without knowledge of the heights of parents and siblings. In other words, it is very difficult to see height as an argument in an individual utility function and, to that extent, height is inferior to such measures as the real wage, if it were ever possible to calculate that measure in the ideal manner.

Height measures also possess the deficiency that, just because height reflects so many influences upon growing children, it may be extremely difficult to identify just which change in income or environment has produced a given change in height. In addition, a particular measurement of mean height of a group of children at a particular age reflects all the influences upon children from their birth up to that age; their mean height is in a sense a summary of their welfare up to the time they are measured, rather than of their welfare at that moment in time.

It is impossible to claim, therefore, that the measurement of the heights of European populations in the past can entirely settle the issue of how far their standard of living has altered, particularly since it has so far proved to be difficult to find many measurements in the past for women, more than half of the human race. Yet it is reasonable to claim that height measures do possess very substantial advantages over measures of welfare which have traditionally been estimated and that they do throw much new light on the welfare outcome of the transformation of the European economy.

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Figure 1: Cross-sectional standards for height of boys

(source: J.M. Tanner, R.H. Whitehouse and M. Takaishi: "Standards from Birth to Maturity ... Archives of Disease in Childhood 41 (1966), p.626).

This points plotted are for the 50<sup>th</sup> centile of the height distribution.

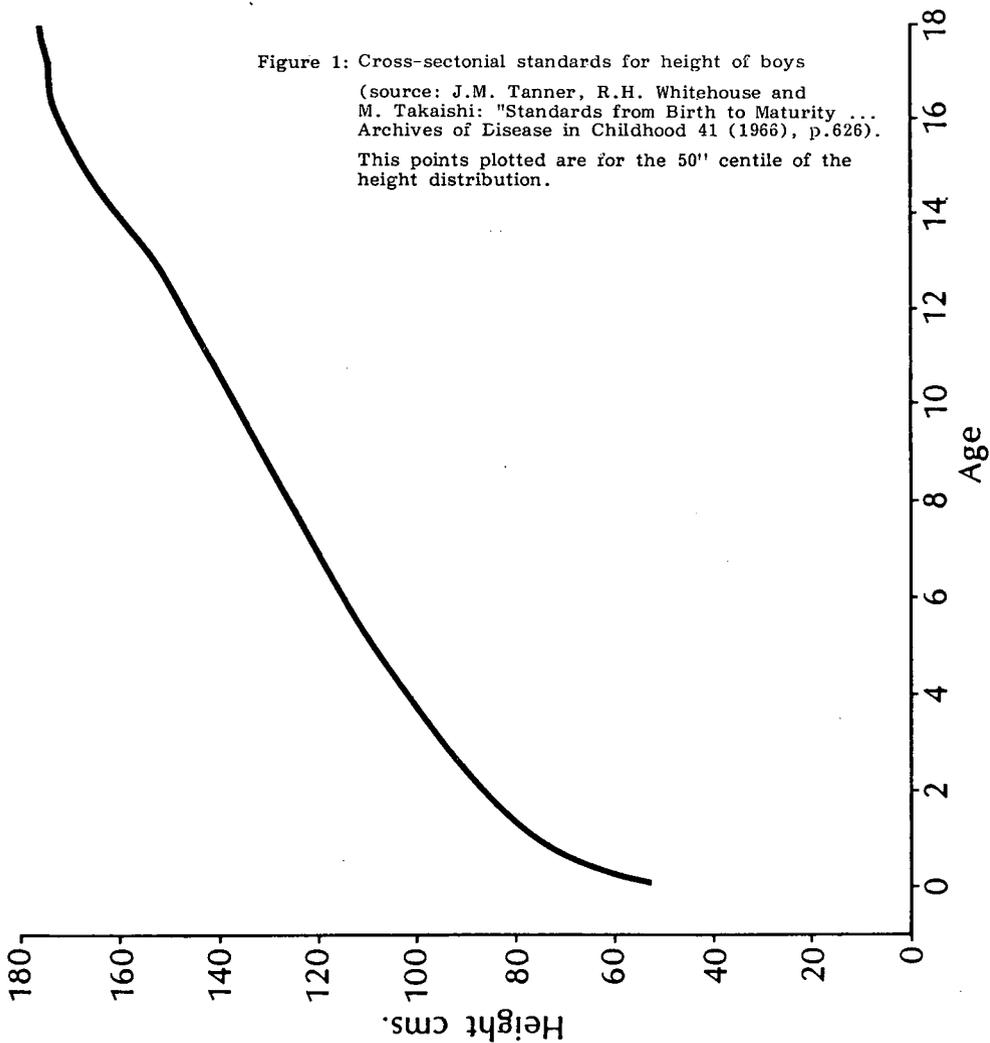


Figure 2: HEIGHTS OF EUROPEAN POPULATIONS: MALES AGED 19-22

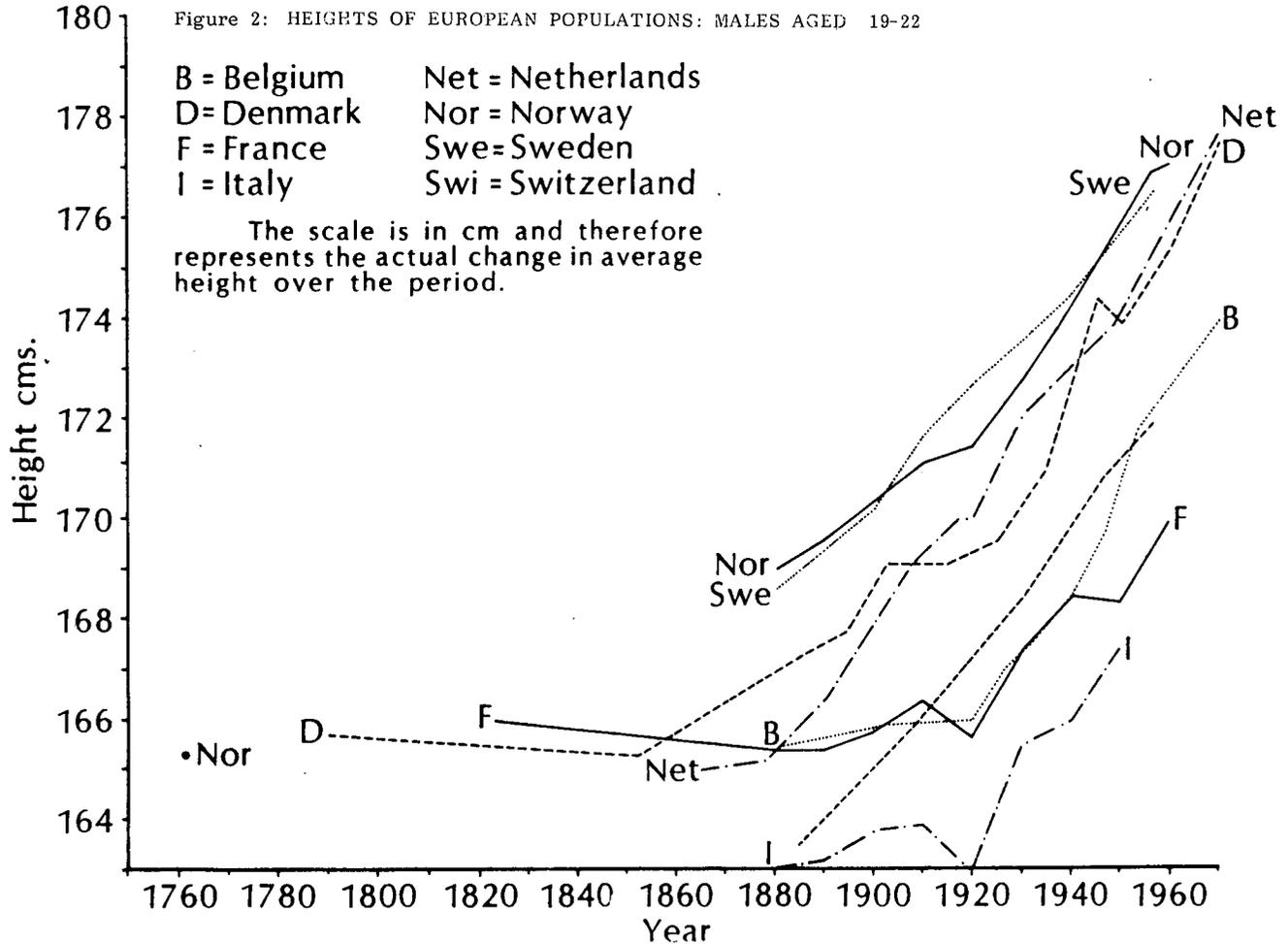


TABLE 1. REGRESSIONS OF HEIGHT ON INCOME, GINI COEFFICIENT, PLACE OF RESIDENCE, SEX, ETHNIC GROUP AND AGE.

(Full details of the sources and definition of variables are given in Steckel, Richard H. "Height and Per Capita Income" *Historical Methods* 16,1:5)

Variable	Adolescents		Adults	
	Coeff.	t value	Coeff	t value
Intercept	116.0	33.38	160.5	13.99
Log per capita income	3.545	7.644	3.490	2.223
Gini	-8.260	1.283	-36.74	4.408
Urban	-0.3085	0.359	-0.148	0.0909
Rural	-3.392	3.359	-2.524	1.315
Poor	-7.968	4.938		
Rich	5.483	6.426		
Student			1.225	1.148
Military			2.599	1.765
Female	0.1171	0.263	-11.24	16.05
European ancestor	-4.452	3.313	-1.170	0.5954
African	-0.6789	0.318		
African ancestor	-3.328	2.010	-1.903	0.9970
Asian	-6.315	4.582	-1.673	0.6294
Indo-Mediterranean	-4.531	2.166	2.321	0.7658
Age 11	5.250	7.961		
Age 12	11.11	16.85		
Age 13	16.81	24.80		
Age 14	21.43	31.32		
R squared	.92			
N	163		30	
Method	OLS		2SLS	

Omitted variables are National (i.e. case based on a national study rather than a study of a sub-group), European and age 10.

TABLE 2. THE DETERMINANTS OF EUROPEAN HEIGHTS, 1880-1971.

(Full details of sources and definitions of variables are given in Floud 1984).

Variable	Coefficient	t value
Intercept	165.438	229.073
Infant mortality	-0.020	-5.335
G. D. P. per capita	0.003	11.050
CD5 (Norway)	5.018	13.449
CD6 (Sweden)	4.880	14.191
CD4 (Netherlands)	4.507	15.140
CD2 (Denmark)	3.008	9.685

CD1 (Belgium), CD3 (France), CD7 (Switzerland), TD1 (1920-1945) and TD2 (1946-1971) were not significant at the 5% level.

N= 64

Adjusted R squared = 0.964

Method: OLS, pooled cross-section and time-series data.

Omitted variables: Italy and time period 1880-1919.

TABLE 3. THE RELATIONSHIP BETWEEN HEIGHT AND PER CAPITA INCOME IN HISTORICAL AND CONTEMPORARY DATA. ADULT MALES.

Hypothetical income per capita	Predicted height in cm. on basis of:		
	Steckel	Floud 1	Floud 2
150	160.9	Out of range	Out of range
250	162.7	Out of range	Out of range
500	165.1	165.0	163.8
1000	167.5	166.4	166.9
2000	169.9	169.0	169.9
3000	171.4	171.6	171.7
4000	172.4	174.2	173.0
5000	173.1	Out of range	Out of range

Explanation of columns:

Column 1: Hypothetical income is in 1970 U.S. dollars.

Column 2: From Steckel (1983:6) table 3. The prediction is based on a national study for a population with European ancestors; the Gini coefficient is evaluated at the sample mean. The underlying regression equation utilised the log (base e) of per capita income.

Column 3: Calculated from table 2, assuming a national study for a European population (Italy); INFM is evaluated at the sample mean.

Column 4: Calculated from a regression model similar to that in table 2, but using the log (base e) of GDP per capita as the predictor.

Adjusted R square was 0.96. The model assumed a national study for a European population (Italy); INFM was evaluated at the sample mean.

TABLE 4. CLASS VARIATION IN HEIGHTS IN EARLY 19TH CENTURY ENGLAND.

AGE 14				AGE 15			
Marine Society		Sandhurst		Marine Society		Sandhurst	
Date	Height	Date	Height	Date	Height	Date	Height
1804-8	52.1	1806-15	61.4	1804-8	54.9	1806-15	63.5
1814-17	53.8	1816-25	61.8	1814-17	54.4	1816-25	64.3
1826-28	56.0	1826-35	61.5	1826-28	57.1	1826-35	64.2
1836-37	56.5	1836-45	62.0	1826-28	57.3	1836-45	63.6
1845-47	56.2	1846-57	62.1	1845-47	57.3	1846-57	64.1

Notes:

1. Dates are those of recruitment, at the age given.
2. The heights of Marine Society recruits have been adjusted for truncation, following the method described in Wachter and Trussell (1982).
3. A full description of the Marine Society data can be found in Floud and Wachter (1982).