ECONOMIC GROWTH AND SOCIAL DEVELOPMENT: A STATISTICAL INVESTIGATION*

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Some writers have emphasised the adverse environmental and social effects of economic growth, while others have claimed that countries with higher levels of social well-being also tend to enjoy higher levels of *per capita* output. The aim of this study is to see what statistical light can be thrown on these issues by collating and comparing seventeen different social indicators for twenty countries in two bench-mark years, 1951 and 1969.

Two methods of analysing data are employed. First, all the countries are ranked for each indicator in turn for a particular year. Each country is then given a score ranging from 1 to 20 for each indicator, and the scores aggregated over the indicators to obtain an overall ranking score for every country. Secondly, the data are subjected to a principal components analysis to examine the correlation between the indicators. The first principal component is a potential candidate for use as a social index number. Changes in these social variables are then related to the rate of economic growth, and no evidence is found of a negative correlation between economic growth and social development. On the contrary, the results suggest a positive correlation between the two, although the strength of this relationship may be diminishing. It is not claimed that the results are in any sense the most preferred test of the form of the relationship between economic growth and social welfare, which must be a matter for subjective evaluation; rather they are seen as a contribution to the body of empirical evidence on this subject.

1. THE BACKGROUND

The relationship between economic welfare and total welfare, to use Pigou's terminology, has once more become the subject of debate. The fears of many concerned about the possible adverse environmental and social effects of economic growth have led to a reappraisal of the desirability of pursuing a rapid rate of economic growth. Some have even implied that economic growth *per se* is responsible for many of these ills. The cause of economic growth, however, has not been without its advocates and one investigator has claimed that "countries with higher levels of social well-being also tend to enjoy a higher *per capita* product".[1]

How one measures a country's "level of social well-being" is a moot point, and has attracted much attention recently, especially from participants in what has been called the "social indicators movement". The aim of this study is to see what statistical light can be thrown on these issues by collating and comparing seventeen different social indicators for twenty countries, broadly characterised by developed market economies, in two bench-mark years, 1951 and 1969. We shall see how far changes in these social variables are related to the rate of economic growth. A word of caution, however; we are not trying to analyse the

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[1]Klaassen (1968). For a contrasting viewpoint see Prager (1973).

causal relationships between economic and social variables, but rather to describe the pattern of their variation between countries and over time. We are concerned with correlation, not causation.

The argument that changes in economic welfare produce closely related changes in total welfare was put forward by Pigou in his classic treatise on welfare economics, and it formed a basic tenet of his work:

> "there is a presumption . . . that qualitative conclusions about the effect of an economic cause upon economic welfare will hold good also of the effect on total welfare." [1932, p. 20].

Pigou did not, of course, mean to imply by this that economic welfare could be equated to some aggregate measure of national output. He would probably have agreed with the view expressed by Erlich,

> "We must acquire a life style which has as its goal maximum freedom and happiness for the individual, not a maximum Gross National Product." [quoted in Nordhaus and Tobin (1972) p. 1].

A case can thus be made for trying to measure those aspects of economic welfare which are not reflected in broad aggregates such as national income. Two quite different approaches have been followed in recent research. The first approach accepts that the statistics of national income, which were designed to measure the level of economic activity and which form the accounting framework for econometric models, are not suitable as measures of economic welfare. This suggests that the national accounts might be adjusted in some appropriate way. One notable recent attempt to estimate the difference between economic welfare and national income is that by Nordhaus and Tobin (1972) who adjusted the national income figures to allow for some of their most obvious deficiencies. They constructed what they called a "measure of economic welfare" by estimating the value of leisure and household work and the disamenity costs of urbanisation, by adding to capital consumption the investment required to maintain the level of capital equipment *per capita* in the face of a growing population, and by reclassifying certain components of final expenditure such as defence. These estimates were then used to adjust the national accounts. Even this, however, is not the whole story. As Nordhaus and Tobin say,

> ". . . we cannot measure welfare exclusively by the quantitative flows of goods and services. We need other gauges of the health of individuals and societies. These, too, will be relative to the value systems which determine whether given symptoms indicate health or disease. But the 'social indicators' movement of recent years still lacks a coherent, integrative conceptual and statistical framework." (*op. cit.* p. 9).

The second approach offers an alternative to using objective measurements to represent concepts such as "welfare" or the "quality of life". It is possible to try to measure these subjective attributes by interviewing a sample of individuals. The respondent is asked to place himself on a "happiness" scale between, for example, 0 and 10, and say whether he feels "better off" then at some specified date in the past. Whatever the merits of this method the work is still in its infancy,

and does not provide us with the kind of information we would like to be able to use in this study.[2]

Between these two approaches lies an intermediate course which consists of collecting statistics of various non-market activities which may then be used to supplement the national income measures. This paper is an attempt to see what comes out of an analysis of such statistics.

The desire to produce social indicators has been prompted by a growing feeling that economic statistics alone do not portray a complete picture of a country's development. The United Nations is now required to submit periodic reports on the world social situation to the General Assembly. The first report was issued in 1967, the second in 1970, and it has now been decided to issue these reports every four years. The reports were requested because "Until now the United Nations approach to development . . . has not been balanced by adequate attention to questions of social policy *per se* or to the social aspects of economic policy".[3]

In the United States a Presidential Message to Congress in 1966 announced the intention of collecting and producing social indicators to "chart our progress". A Panel on Social Indicators was set up in the autumn of 1966 and *Toward a Social Report* (U.S. 1969) was published in 1969.[4] In the same year a National Goals Research Staff responsible for collecting and watching indicators of the quality of life was set up as part of the White House staff, and suggestions have been made for the creation of a Committee of Social Advisers to the President along the lines of the Committee of Economic Advisers.[5] The OECD too has adopted a programme to develop a set of social indicators covering 24 areas of social concern.[6]

There are real problems, however, in making concrete some of the desires expressed in these developments. Some would like to see social indicators used to form what Juster (1971) has called a "happiness index". But the different indicators cannot be combined in an objective manner to form an overall index. There is no acceptable weighting system which might be used akin to the use of prices in the national income accounts. It is well known that these prices reflect in part the distribution of income and to that extent are not objectively determined weights, but they do seem to be sufficiently acceptable to render the national income statistics useful and meaningful index numbers. The same cannot be said about social indicators. At the present stage there are two main problems for the investigator in this field.

First are the limitations of the statistics themselves. They are often produced as the by-product of government administration, and surveys have usually been limited to periodic censuses. A major difficulty is to obtain statistics which are comparable either between countries at the same date or for the same country between different points of time. This problem should be less important in the future. Some countries are actively trying to rectify the situation; for example, the

[2]There is a good discussion of these subjective studies in Olson (1973), chapter 3.

[3]United Nations (1971) p. xii.

[4]As an outgrowth of this, the Office of Management and Budget published a statistical compilation entitled *Social Indicators* in 1973.

[5]A Bill to this effect was introduced by Senator Mondale in 1967.

[6]*OECD Observer*, No. 64, June 1973.

United Kingdom now produces an annual publication, called *Social Trends*, and the OECD programme referred to above will bear fruit in the future. It should, though, be clearly stated at the outset that because of these difficulties the data employed in this study were far from ideal for the purpose. And the lack of appropriate data has led to the use of statistics that are really input measures rather than indicators of output. For example, instead of a measure of the quality of education we have used figures on public expenditure on education and on the numbers of students.[7] These problems should be borne in mind by the reader when evaluating the results which are described below.

The second problem though is what to do with the data once they have been collected. It would be hard to improve on Professor Moser's explanation of the problem:

"Social statistics are deficient not only in coverage, but in methods of analysis and interpretation. There is a generally felt need for standardised and universally agreed ways of analysing the present large and confusing array of descriptive data so as to arrive at a new set of derived quantities (indicators) which are somehow comprehensively representative of the state of society. Further, there is the hope that this derived set of quantities will be a relatively small set . . .". (United Kingdom C.S.O. 1970, p. 10).

One of the aims of this paper is to see what statistical justification there is for representing the different "primary" variables by a small number of derived or "secondary" indicators.[8] The most obvious statistical tool to employ is principal components analysis. Essentially this is a method for finding that linear combination, or weighted average, of the variables which explains the largest proportion of their variance. This combination, or first principal component, consists of a number for each observation (in our case two for each country) calculated to capture as much of the variation in the individual indicators as possible. In section 3 we shall present the results of applying principal components analysis to the data, and compare the results with those obtained by using another method of calculating a social index for each country. It cannot be emphasised too strongly that this paper is merely a statistical exploration of the possibilities of, and the difficulties entailed in, constructing an aggregate index of social performance. The theoretical difficulties involved in constructing such an index are well-known and obvious, but there still remains the possibility that with a reasonable degree of correlation between the indicators a useful index could be formed. In the present state of knowledge an examination of these issues may be of some value. Shonfield (1972, p. x) has expressed the view that many in the field "would be ready to settle for the moment, in default of satisfactory social theory, for clear evidence of correlations between social phenomena."

The indexes developed here are not presented as theoretical alternatives to the measures of economic welfare constructed from national income figures suggested by Nordhaus and Tobin. Nor are they proposed as definitive indexes of social welfare. Rather they are to be seen as summary statistical measures of a variety of different social indicators. It would be impossible to express the concept

[7]Although the number of children who pursue full-time higher education may be a desirable goal in itself.

[8]For a discussion of the use of "primary" and "secondary" indicators see King (1972).

of social welfare in terms of a set of indicators for which we have data and which could be combined by a unique set of weights. The choice of weights depends on individual preferences, and for social indicators there are no market prices which could be observed and used as weights.[9] The task of this paper is to see if anything may be learned from an attempt to construct summary statistical measures of the individual indicators.

In the final section we shall look at the relationship between changes in these indexes of social performance and the rate of economic growth. This is the closest we can get, in this empirical study, to examining the relationship between economic welfare and total welfare.

2. The Data

Statistics on seventeen indicators were collected for twenty countries for each of the two years 1951 and 1969. The most time-consuming task in the analysis was the preparation of the data matrix of forty observations on the seventeen indicators. Table 1 lists the countries and the indicators included in this study.

TABLE 1

Countries and Indicators

Countries	Indicators
1. Austria	1. Gross Reproduction Rate
2. Belgium	2. Population Density
3. Denmark	3. Dependency Ratio
4. Finland	4. Illegitimacy Rate
5. France	5. Public Expenditure on Education as % of GNP
6. W. Germany	6. Students per 100,000 population
7. Ireland	7. % Students Female
8. Italy	8. Hospital Beds per 1,000 population
9. Netherlands	9. Doctors per 10,000 population
10. Norway	10. Protein Consumption per person per day
11. Portugal	11. Infant Mortality Rate
12. Spain	12. Late Foetal Death Rate
13. Sweden	13. Stomach Ulcer Death Rate
14. Switzerland	14. Suicide Rate
15. U.K.	15. Motor Accident Death Rate
16. Canada	16. Telephones per 100 pop.
17. U.S.A.	17. Radio Receivers per 1,000 population
18. Japan	
19. Australia	
20. New Zealand	

The criterion for choice of countries was that they be market economies and have achieved a certain minimum stage of economic development. The arguments about the effect of economic growth on social welfare relate largely to developed

[9]Even with the sort of monetary measures of economic welfare proposed by Nordhaus and Tobin, the weights used to combine different physical outputs depend on value judgements about the distribution of income.

countries. It would be an interesting exercise to extend the analysis to developing countries but a major stumbling block here would be to produce data for each of two particular years.[10]

The choice of indicators was dictated largely by the availability of data and in particular the requirement that indicators be constructed for two bench-mark years. This was necessary in order to be able to examine changes over time. The indicators also had to be potential candidates for inclusion in a measure of welfare, either in their own right or as proxies for other variables for which no data were available. Within these confines indicators were chosen to try to measure (i) externalities not captured in the national income figures, and (ii) broader aspects of social development such as trends in health, education, and demographic variables. There are few statistics for the first group mainly because no comparative data are available for the environment. This is a matter to which we shall return in the last section. Some of the indicators, however, do represent the effects of externalities. The education, communications and health variables affect everybody to the extent that an educated and healthy population is more productive and we prefer contact with educated and healthy people. There are also more direct effects. The value of a telephone, for example, is not independent of the consumption of telephones by others. The more of one's friends who own telephones the more useful such an apparatus is.

The other indicators measure wider social trends. Detailed descriptions of the indicators are given in the appendix; here we discuss more general points. First are the demographic indicators. The reasons for including population density, the dependency ratio, and the illegitimacy rate are all fairly obvious.[11] The inclusion of the gross reproduction rate, however, needs explanation. The gross reproduction rate is used as a measure of the underlying trend of population growth. It shows the limiting rate of population growth which would eventually occur if the fertility rates at a given time were maintained and the mortality of women of child-bearing age and below were zero. It is a convenient method of summarising, for comparative purposes, the age-specific fertility rates of women, and, unlike the crude birth rate, is not affected by the age distribution of the population. The net reproduction rate which takes account of mortality rates among women could not be used as it is not available for some of the countries in our sample, and for other countries is based on out-of-date life tables. For those countries for which both rates were available the differences between the rates were small.

Our justification for including some measure of population growth is contained in an argument put forward by Nordhaus and Tobin (*op. cit.*). They pointed out that the higher the growth rate of population the higher is the proportion of GNP which must be devoted to investment merely to maintain the level of capital per man. This investment does not increase consumption per head but is effectively a cost of population growth. Thus the proportion of GNP which

[10]This is illustrated by the excellent study of Adelman and Morris (1965) who applied factor analysis to a set of social and political variables for 74 developing countries. Their data were drawn from a variety of years, whereas a more accurate dating is required to analyse changes over time.

[11]These three indicators are regarded as being, *ceteris paribus*, social "bads", although for the illegitimacy rate this is becoming increasingly unrealistic.

can be devoted to sustainable consumption is inversely related to the rate of population growth.[12]

The inclusion of population density is open to the usual objections about the appropriate definition of land area although the ranking of countries, as opposed to the absolute figures, is unlikely to be sensitive to this. The dependency ratio (defined as the ratio of the population under 15 years of age and over 64, to the numbers aged 15–64) varies widely between countries. For instance, in 1969 Japan had only 45 "dependents" per 100 of "working age" compared with Ireland's figure of 74. This reflects differences in population growth rates. For the countries in our sample there was quite a strong positive correlation between the gross reproduction rate and the dependency ratio.[13]

The education and health indicators are fairly straightforward. Public expenditure on education reflects the proportion of national resources devoted to education although for the U.S., U.K., and Finland, the omission of private expenditure is important. The figures for the number of students are for those in some form of higher education, and the percentage of students who are female is included to take some account of the position of women. In Finland 49 percent of students in 1969 were women, a much higher proportion than in any other country. Next came France (44 percent), U.S. and Portugal (40 percent, although Portugal had fewer students than any other country), Canada (39 percent), and the U.K. (38 percent). At the other end of the spectrum only 22 percent of students in Switzerland were women, and in Spain the figure was 24 percent.

The statistics on hospital beds and doctors reflect the provision of medical services, and protein consumption is considered because, unlike carbohydrates, there is no upper limit beyond which consumption is harmful. Ideally we would like to use statistics on the outputs of the health services, such as the expectation at birth of a healthy life rather than figures of the inputs into the health system. But this kind of information is not available and we have to fall back on the indicators listed in Table 1. The mortality rates attempt to capture differences in health care and the incidence of disease, although mortality rates, as opposed to statistics on illnesses, have obvious limitations. Two of these are differences between countries in the classification of cause of death and differences in classification over time in the official statistics. On these grounds the death rate from stomach ulcers was chosen as providing a reasonable basis for comparison. It is regarded by some as partly the product of an affluent and competitive society, and partly the result of general strain and stress. Late foetal deaths are a concept usually described as stillbirths. Because of difficulties arising in allocating some deaths between infant mortality and stillbirths, we have chosen to consider both rates. The variation in infant mortality rates is striking, from a low of 11.7 (infant deaths per 1,000 live births) in Sweden to a high of 56.8 in Portugal. The death rate from motor accidents is included because more than most causes of death it strikes unexpectedly, and hits young people and those with dependents. It does not measure driving or safety standards because no account is taken of the number of miles travelled. Rather, it measures the general incidence of mortality from road

[12]The benefits of population growth, such as the exploitation of economies of scale, will be captured by the national income statistics.

[13]See Table 6 below.

accidents and, to the extent that this depends upon the number of vehicles, such mortality may be a penalty of an affluent society. The number of telephones and radio receivers represent the ease of communications and access to news and information respectively.

The indicators for which we do not have information, at least on any meaningful basis, are legion, and some of the problems should be pointed out. We have already mentioned the lack of statistics on the environment. To these we must add data on the distribution of income, crime, public expenditure on leisure and the arts, and many other indicators. Some were omitted because it was impossible to obtain figures for two years, e.g. the average expectation of life and the number of households with basic sanitary and other facilities. Some were omitted because the figures were not available for a sufficiently large number of countries, e.g. industrial accident rates and average hours worked. Finally, some were omitted because the indicators permitted no clear interpretation, e.g. the average age of marriage, and the divorce rate which depends critically on the legal provision for dissolution of marriage. Many more indicators than have been mentioned above were considered and rejected as being unsuitable for one reason or another.[14]

The list of seventeen indicators used in this study may seem woefully inadequate, but it does in fact contain all the information available from official published statistics meeting the criteria mentioned above.[15] Given that the aim of the exercise is to look at changes over time for a reasonable sample of countries, there is little alternative to noting the difficulties and pressing on with the analysis.

3. The Statistical Analysis

Faced with the task of constructing summary statistical measures of a set of social variables, it would seem sensible to begin by using a simple method. Among the least demanding statistics are measures of association using ranks, and so we might rank all the countries for each indicator in turn for a particular year. Countries are then given scores ranging from one to 20 for each indicator. (This implicitly assumes that countries are distributed uniformly along the axes of the indicator space.) If we aggregate these scores over the indicators we obtain an overall ranking score (ORS) for every country. We are, however, required to decide whether a given indicator should have a positive or a negative weight so that the "best" country is given a score of 20, rather than one. Nevertheless the ORS is a useful starting point and its construction places few demands on the accuracy of the data.

Table 2 gives the ORS for each country in 1951 and 1969, giving positive weight to indicators 5 through 10, 16 and 17, and negative weight to the remainder. Since the scores are based on rankings they reflect the *relative* position of each country and not some absolute measure of social performance. A decline in a country's ORS between 1951 and 1969 means that its relative position has declined but its absolute position may well have increased. It is worth remarking

[14]In particular, the murder rate was omitted because the available data included deaths from wars thus distorting the figures for 1951 and 1969, especially in the case of the U.S.

[15]The criterion of comparability of published statistics was given a high priority.

TABLE 2

OVERALL RANKING SCORES

	1951	1969
Austria	175.5	127.5
Belgium	154	158.5
Denmark	184.5	194.5
Finland	194	241
France	171	178.5
W. Germany	152.5	157
Ireland	173.5	156
Italy	157.5	182
Netherlands	191.5	184.5
Norway	235	207.5
Portugal	66.5	94
Spain	132	127.5
Sweden	202.5	224.5
Switzerland	209.5	184
U.K.	186	172
Canada	220.5	232
U.S.	221.5	205.5
Japan	114	174.5
Australia	210.5	176
New Zealand	218	193

Maximum possible score 340
Minimum possible score 17

that the scores do correspond, in a rough and ready sort of way, to what one might expect. The North American and Scandinavian countries perform well, and Portugal, Spain and Japan lag behind—in the case of Portugal way behind.[16]

This approach has two disadvantages. First, the ORS takes no account of the value of any indicator, merely the rankings. Large differences between countries are regarded as equivalent to small differences, and so much of the information present in the data is ignored. Secondly, the indicators are given equal weight in the determination of the index. A more sophisticated technique might help to overcome these difficulties.

As we commented in section 1 an appropriate statistical tool for analysing variables about whose interrelationship we have few *a priori* beliefs is principal components analysis. This idea originated in the work of Pearson (1901) and Spearman (1904), and the method was fully developed in Hotelling's classic paper (1933). Stone (1947) provided the first application to economic data and since

[16]Two other studies should be mentioned at this point. The *Economist* (December 25, 1971, and January 22, 1972) published two league tables of countries in terms of various social and economic indicators. The first article used the ranking score method for nine countries and a small number of indicators. The second article extended the number of countries to 14, and changed the basis of calculating a country's score. The mixture of economic and social indicators makes comparison with our results difficult. Another study which calculated ranking scores for European countries using some rather dubious data was published in *Vision* (July/August 1973). The top five countries in this ranking were the Netherlands, Denmark, Sweden, Norway, and the U.K. In our study the leading European countries were Finland, Sweden, Norway, Denmark, and the Netherlands.

then it has been used by many others to analyse economic and other phenomena. The approach is essentially inductive rather than deductive. We have forty observations (two for each of twenty countries) on 17 variables arranged in a 40×17 matrix, and we ask the question, is it possible to find a proxy variable which captures a significant proportion of the variance of these variables? Principal components analysis finds that linear combination of the 17 variables which accounts for the highest proportion of the overall variance. This is done by minimising the sum of squares of the discrepancies between the actual values of the variables and the approximate values implied by the proxy variable. This combination is called the first principal component. Second and higher order components are chosen to minimise the residual variance after all previous principal components have played their part, and are constructed so as to be orthogonal to each other.[17] Thus the contribution which any one component makes to explaining the overall variance is independent of the contribution of any other component.

A common procedure in cases such as ours where the variables have no common unit of measurement is to standardise the variables by expressing them as deviations from the means and dividing by the standard deviations, and we have adopted this convention here.[18] The values of the first principal component are given in Table 3. These consist of a score for each country in both 1951 and 1969, which for a given country is a weighted sum of its performance in terms of the standardised indicators. Since the first principal component has been normalised above average values are positive and below average negative. Two features stand out from Table 3. First, every country improved its score between 1951 and 1969, although there were substantial differences in the magnitude of the improvement. Second, as with the ORS the North American countries score highly and Portugal, Spain and Japan have low scores.

The extent to which the first principal component is a useful index number depends on the proportion of the overall variance which it accounts for and the weights implicit in the calculation of the first component. Table 4 gives the weights for each indicator which are used to calculate the first principal component in order to maximise the variance accounted for. Of the seventeen indicators four have weights of the opposite sign to that imposed *a priori* in the calculation of the overall ranking score. Positive weights are given to the dependency ratio, the illegitimacy rate, the suicide rate, and the death rate from motor accidents. As far as the first three are concerned this is of little consequence because they comprise three of the four smallest weights. For road deaths, however, the matter is more important and the positive weight undoubtedly helps to inflate the scores for the U.S., Canada, Austria, Germany and Australia. This reflects the positive correlation between road accident deaths and those other indicators which are given a

[17]If we have n observations on K variables arranged in an $n \times K$ matrix X then the normalised principal components are the eigenvectors of XX'. The first principal component is the eigenvector corresponding to the largest eigenvalue, the second to the next largest and so on. There exist r principal components where r is the rank of X; normally $r = K$.

[18]The results are not invariant to this transformation. The justification for so transforming the data is that since we are finding a weighted average of the individual series, an indicator which happened to be measured in small units, and so took on large values, would tend to dominate the result.

TABLE 3

FIRST PRINCIPAL COMPONENT

	1951	1969
1. Austria	−0.101	0.113
2. Belgium	−0.185	0.068
3. Denmark	−0.038	0.168
4. Finland	−0.069	0.177
5. France	−0.097	0.131
6. W. Germany	−0.126	0.089
7. Ireland	−0.128	0.025
8. Italy	−0.213	0.039
9. Netherlands	−0.123	0.075
10. Norway	−0.061	0.094
11. Portugal	−0.334	−0.148
12. Spain	−0.295	−0.094
13. Sweden	−0.030	0.222
14. Switzerland	−0.021	0.105
15. U.K.	−0.108	0.053
16. Canada	−0.001	0.305
17. U.S.	+0.096	0.384
18. Japan	−0.328	0.004
19. Australia	−0.014	0.153
20. New Zealand	+0.016	0.196

TABLE 4

Indicator	Weight
1. Gross Reproduction Rate	−0.68
2. Population Density	−1.78
3. Dependency Ratio	1.47
4. Illegitimacy	1.63
5. Education Expenditure	4.55
6. Students/pop.	5.12
7. Female Students	3.77
8. Hospital Beds	2.99
9. Doctors	3.62
10. Protein Consumption	3.68
11. Infant Mortality	−5.17
12. Foetal Deaths	−5.55
13. Ulcer Deaths	−2.99
14. Suicides	1.26
15. Road Accidents	4.53
16. Telephones/pop.	5.56
17. Radios/pop.	4.61

positive weight, and supports our previous contention that road deaths are a symptom of an advanced society.[19]

The second criterion for judging the usefulness of the first principal component is the extent to which it captures the variation of the basic indicators. The proportion of the variance of each indicator accounted for by the first and second

[19]Of the seventeen indicators five are negatively, and twelve are positively, correlated with the level of gross national product *per capita*. Only the four indicators mentioned in the text have correlations with GNP of the "wrong" sign.

principal components is shown in Table 5. From the last row of Table 5 we see that the first principal component accounts for 36 percent of the overall variance, and the first and second components together account for just over one half of the variance. As one would expect from the column of weights in Table 4 these proportions vary between indicators. The first principal component accounts for much of the variation in the educational, health and communications variables, while accounting for little of the variance of the demographic indicators. The latter is captured by the second principal component.[20]

TABLE 5

Indicator	Proportion of variance accounted for by: First Component	Second Component	Rest
1. Gross Reproduction Rate	0.01	0.78	0.21
2. Population Density	0.08	0.16	0.76
3. Dependency Ratio	0.05	0.55	0.40
4. Illegitimacy	0.07	0.12	0.81
5. Education Expenditure	0.52	0.04	0.44
6. Students/pop.	0.66	0.01	0.33
7. Female Students	0.36	0.05	0.59
8. Hospital Beds	0.22	0.01	0.77
9. Doctors	0.33	0.08	0.59
10. Protein Consumption	0.34	0.16	0.50
11. Infant Mortality	0.67	0.00	0.33
12. Foetal Mortality	0.77	0.01	0.22
13. Ulcer Deaths	0.22	0.03	0.75
14. Suicides	0.04	0.54	0.42
15. Road Accidents	0.51	0.00	0.49
16. Telephones/pop.	0.77	0.01	0.22
17. Radios/pop.	0.53	0.00	0.47
Overall	0.36	0.15	0.49

The figure of 36 percent for the proportion of the overall variance explained by the first principal component is rather low, and affords little prospect of being able to construct index numbers of social progress which would be reasonably robust.[21,22] It reflects a low degree of correlation between the individual indicators, as witnessed by the correlation coefficients in Table 6. Of the off-diagonal elements only four are greater than 0.75 in absolute value, those showing strong positive correlations between the gross reproduction rate and the dependency ratio, the infant mortality rate and the late foetal death rate, the student ratio and telephone ownership, and lastly between the student ratio and the ownership of radios. The last two reflect the common influence of some third variable, probably economic, but the first two correlations are more interesting. The relationship

[20]The fact that the demographic indicators as a group are represented by the second component was also discovered by Berry (1960) in a study of 95 developing countries.

[21]The figure of 36 percent is not dissimilar to that found by Firestone (1972) in an application of principal components analysis to 28 social and demographic indicators for five regions in Canada. In this study he found that the first principal component accounted for 49 percent of the overall variance.

[22]When evaluating the contribution of any indicator to explaining the overall variance it should be remembered that the components are orthogonal, and so their contributions are independent.

TABLE 6

CORRELATION COEFFICIENTS OF THE INDICATORS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Gross Reproduction Rate	1	−0.283	0.764	−0.262	−0.199	0.023	0.069	−0.115	−0.245	0.146	0.066	0.159	0.103	−0.524	0.005	−0.146	−0.112
2. Population Density		1	−0.246	−0.368	0.016	−0.196	−0.280	−0.332	0.059	−0.438	0.060	0.109	0.246	0.068	−0.028	−0.266	−0.181
3. Dependency Ratio			1	−0.020	0.199	0.315	0.183	−0.105	0.088	0.271	−0.171	−0.149	0.061	−0.358	0.208	0.136	0.151
4. Illegitimacy Rate				1	0.250	0.210	0.171	0.101	0.197	0.017	0.092	−0.095	0.026	0.449	0.135	0.315	0.159
5. Public Expenditure on Education as % of GNP					1	0.651	0.421	0.226	0.425	0.101	−0.627	−0.649	−0.077	0.233	0.415	0.661	0.474
6. Students per 100,000 pop.						1	0.496	0.108	0.410	0.297	−0.524	−0.538	−0.294	−0.001	0.587	0.794	0.829
7. % Students Female							1	0.320	0.072	0.400	−0.407	−0.401	−0.337	−0.028	0.460	0.374	0.395
8. Hospital Beds per 1,000 pop.								1	0.208	0.466	−0.477	−0.472	−0.123	0.254	0.242	0.346	0.145
9. Doctors per 10,000 pop.									1	0.135	−0.371	−0.555	−0.201	0.200	0.550	0.479	0.361
10. Protein Consumption per person per day										1	−0.566	−0.563	−0.587	−0.071	0.290	0.366	0.303
11. Infant Mortality Rate											1	0.904	0.349	−0.126	−0.496	−0.696	−0.450
12. Late Foetal Death Rate												1	0.498	−0.254	−0.563	−0.718	−0.466
13. Stomach Ulcer Death Rate													1	0.158	−0.281	−0.314	−0.273
14. Suicide Rate														1	0.177	0.192	0.095
15. Motor Accident Death Rate															1	0.592	0.502
16. Telephones per 100 pop.																1	0.711
17. Radio Receivers per 1,000 pop.																	1

between the gross reproduction rate and the dependency ratio is essentially *long-run* and the fact that such a connection has shown up in our cross-section correlations testifies to the relative stability of the demographic indicators. The infant mortality rate and the foetal death rate were both included to allow for the possibility that deaths attributed to one category in country A would be classified under the other in country B. If this practice were important it would induce a negative correlation between the two indicators. In fact the two are very strongly positively correlated (with a correlation coefficient of 0.904) and it appears that differences in health care between countries and over time swamp any effect due to different methods of classifying infant deaths.

Although the first principal component only accounts for 36 percent of the overall variance it may still have some value as an index number. Its value will depend on how sensitive are the conclusions about the ranking of countries by their social score to methods of calculating such scores. If an alternative method of calculating a social score for each country gives very different conclusions the results are much more ambiguous than if they agree. We now have two index numbers for each country, a first principal component (FPC) and an overall ranking score (ORS). A good test of the robustness of our results is to compare these two indexes.

The FPC and the ORS scores may be compared by ranking the countries by the two index numbers and seeing if the rankings are similar. In Table 7 we have presented the rankings by both indexes for the two years. An inspection of the table reveals a close similarity in the orderings. A more rigorous test of the degree

TABLE 7

COUNTRY RANKINGS BY SOCIAL SCORE

	1951		1969	
	FPC	ORS	FPC	ORS
U.S.	1	2	1	5
New Zealand	2	4	4	7
Canada	3	3	2	2
Australia	4	5	7	12
Switzerland	5	6	10	9
Sweden	6	7	3	3
Denmark	7	11	6	6
Norway	8	1	11	4
Finland	9	8	5	1
France	10	14	8	11
Austria	11	12	9	18.5
U.K.	12	10	15	14
Netherlands	13	9	13	8
W. Germany	14	17	12	16
Ireland	15	13	17	17
Belgium	16	16	14	15
Italy	17	15	16	10
Spain	18	18	19	18.5
Japan	19	19	18	13
Portugal	20	20	20	20

of similarity is provided by calculating Kendall's Rank Correlation Coefficient (τ), adjusted for tied rankings, which is shown below.[23]

	1951	1969
τ	0.77	0.56

In both years the rankings given by the two methods are highly correlated and the values of τ are significantly different from zero at the 1 percent level.[24] The fact that the same broad picture is painted by both methods is reassuring.

We are now in a position to consider the question of the nature of the relationship between changes in the social index numbers and economic growth. Table 8 contains the relevant information. The first two columns show the change in the two social scores for each country, and the third column shows the average annual rate of growth of real *per capita* gross domestic product between 1951 and 1969. Gross domestic product seems to be the most appropriate measure of economic growth in this context. The rank orderings corresponding to Table 8 are

TABLE 8

GROWTH AND SOCIAL PROGRESS

	Change in FPC	Change in ORS	Annual Average Growth Rate of Real *per capita* GDP (percent)
Austria	0.214	−48	4.8
Belgium	0.253	4.5	3.0
Denmark	0.206	10	3.2
Finland	0.246	47	3.4
France	0.228	7.5	3.9
W. Germany	0.215	5.5	5.1
Ireland	0.153	−17.5	2.5
Italy	0.252	24.5	4.5
Netherlands	0.198	−7	3.6
Norway	0.155	−27.5	3.2
Portugal	0.186	27.5	4.4
Spain	0.201	−4.5	6.2
Sweden	0.252	22	3.2
Switzerland	0.126	−25.5	2.6
U.K.	0.161	−14	2.1
Canada	0.306	11.5	2.5
U.S.	0.288	−16	2.3
Japan	0.332	60.5	7.8
Australia	0.167	−34.5	2.5
New Zealand	0.180	−25	1.6

shown in Table 9. We have seen that the rankings of countries by the FPC and ORS scores are similar. The next question to ask is can the same be said about the rankings by the change in score? For the rankings of change in the FPC and of change in the ORS scores the rank correlation coefficient τ is 0.46 and is significantly different from zero at the 1 percent level. Thus the two measures of

[23]The definition of τ adjusted for tied rankings is given in Kendall (1948) p. 26.

[24]The tests for significance employ a correction for continuity and allow for tied rankings; see Kendall (1948) p. 43.

TABLE 9

COUNTRY RANKINGS

	Growth Rate	Increase in	
		FPC	ORS
Japan	1	1	1
Spain	2	12	11
W. Germany	3	9	9
Austria	4	10	20
Italy	5	5.5	4
Portugal	6	14	3
France	7	8	8
Netherlands	8	13	12
Finland	9	7	2
Denmark	11	11	7
Norway	11	18	18
Sweden	11	5.5	5
Belgium	13	4	10
Switzerland	14	20	17
Canada	16	2	6
Ireland	16	19	15
Australia	16	16	19
U.S.	18	3	14
U.K.	19	17	13
New Zealand	20	15	16

social change are in reasonably close agreement with one another, and we can use them as a statistical basis for a comparison of economic and social development.

Is economic growth positively or negatively associated with social progress, or is no relationship discernible? This is the question which was posed at the beginning of this paper and we may now see what light our statistics throw on the issue. We shall use two kinds of tests for this purpose, rank correlation tests and regression analysis. The former places fewer demands on the statistics whereas the latter uses more of the information in the data but requires stronger assumptions about the nature of the error structure of the assumed model.

From Table 9 we may calculate rank correlation coefficients for the association between economic growth and each of the two estimates of the change in social score. These are shown below

	$\triangle$FPC	$\triangle$ORS
τ	0.17	0.30

Both values of τ are positive indicating a positive correlation between economic growth and social development. This correlation, however, is rather weak. Using the change in the values of the first principal component we find the value of τ is insignificant, and when the change in the overall ranking score is used τ is significantly different from zero only at the 7.5 percent level. If we look at the rankings we see that for the first principal component the U.S. and Canada are markedly out of line with other countries, and in part, but only in part, this reflects the positive weight given to road accident deaths. A more important factor is the difference in method of construction of the two scores. For the ORS a country

which is ranked highest gains nothing by scoring significantly higher than the next country, whereas the FPC takes account of the magnitude of the difference. This problem is particularly acute in the case of the U.S. and Canada since in those indicators in which they score well, such as the numbers of students, telephones and radio receivers, they tend to perform very much better than the countries below them.

For this reason the rank correlation coefficients were recalculated omitting the values for the U.S. and Canada.

excl. U.S., Canada	△FPC	△ORS
τ	0.35	0.34

For the remaining eighteen countries there is a positive association between growth and change in social score which for the first principal component is significant at the 5 percent level, and for the overall ranking score at the 6 percent level. The omission of the U.S. and Canada does little to improve the correlation with the change in the overall ranking score, but does noticeably improve the performance of the change in the first principal component, thus confirming the hypothesis that it is the FPC scores for the U.S. and Canada which are obscuring the underlying relationship.

Measures of association using ranks do not utilise all the information contained in the data, and so we shall now examine a simple regression model. We test the hypothesis that the change in social score is dependent on the rate of economic growth. For the first principal component score the formal model is

$$\text{(A)} \qquad \triangle\text{FPC} = a + bg + \varepsilon$$

where g is the percentage rate of growth and the disturbance term, ε, is assumed to be independently normally distributed with constant variance. Note that the use of a regression model requires assumptions about the distribution of the error term. The change in the overall ranking score reflects the change in a country's relative position and so a more appropriate model is

$$\text{(B)} \qquad \triangle\text{ORS} = \alpha + \beta(g - \bar{g}) + v$$

where $\bar{g}$ is the mean growth rate of the sample and we make the same assumptions about the distribution of v as we did about ε. If we accept the hypothesis then we might have certain *a priori* beliefs about the values of the parameters of the two models. The signs of b and β will indicate the nature of the association between growth and social change and in the light of the rank correlation results we might expect them to be positive. The value of a be positive reflecting the improvement in provision of social services over time which will occur even without economic growth. The value of α, however, will be zero because changes in the relative positions of countries reflect differences in their growth rates. The results of fitting the two models to all countries are shown below with standard errors in brackets.

$$\triangle\text{FPC} = \underset{(0.030)}{0.164} + \underset{(0.008)}{0.014}\, g \qquad R^2 = 0.16$$

$$\triangle\text{ORS} = \underset{(5.508)}{0.050} + \underset{(3.753)}{8.991}\,(g - \bar{g}) \qquad R^2 = 0.24$$

For both models the coefficients of the growth rate term are positive thus confirming the rank correlation results. Once again though the correlation is weak. The values of R^2 are low and only for the ORS model is the coefficient of the growth rate term significantly different from zero at the 5 percent level. The estimates of a and α, however, do agree with our *a priori* expectations, a being significantly positive while α is almost zero.

As before both models were re-estimated omitting the U.S. and Canada.

excl. U.S. and Canada

$$\triangle FPC = 0.128 + 0.021\, g \qquad R^2 = 0.43$$
$$(0.025)\ (0.006)$$

$$\triangle ORS = 0.306 + 9.518\,(g - \bar{g}) \qquad R^2 = 0.26$$
$$(6.012)\ (4.046)$$

For the change in the FPC the fit is much improved and the regression coefficients are significantly different from zero at the 1 percent level. The results for the change in the ORS are almost unchanged and the coefficient of the growth rate term is significantly different from zero at the 5 percent level.

Thus we cannot reject the hypothesis that the change in social score is positively correlated with the rate of economic growth. We can, however, reject the hypothesis of a negative association. In the light of this we might expect to find a similar relationship between the level of GNP and the absolute value of the social score.[25] The countries were ranked by GNP/head for both 1951 and 1969 and the following table reports the rank correlation coefficients of this ranking and each of the two rankings by social score.

	1951	1969
FPC	0.75	0.66
ORS	0.67	0.50

All the entries in this table are significant at the 1 percent level, although it is noticeable that the correlations are less strong in 1969 than in 1951. One interpretation of this finding is that the relationship between economic and social performance is much stronger at low levels of national income, and that as GNP rises the correlation between economic and social change becomes weaker.

4. Conclusions

What does all this add up to? We may summarise our statistical findings as follows:

(1) The degree of correlation between the indicators was low (the first principal component explained only 36 percent of the overall variance) and this means that it is difficult to construct an acceptable index number which reflects movements in relevant social variables.

(2) Despite this, our two index numbers, the FPC and ORS, although constructed in very different ways, agreed quite closely on the ranking of the countries in the sample.

[25]Gross national product was used here as no data on the levels of gross domestic product were easily available.

(3) There was a strong positive relationship between the social score and the level of GNP *per capita.*

(4) There was a weaker but still positive association between the change in a country's social score and its rate of economic growth.

To the extent that the indicators used in this study are representative, the hypothesis that social development and economic growth are negatively associated is rejected, and there is some evidence of a positive relationship between the two, which is a much stronger result. This brings us to the question of the indicators which we could not include. The most important are the environmental indicators on which no data are available. Two points can be made here. First, environmental damage and pollution are essentially localised phenomena and it is hard to see what nation-wide indicators of the environment would mean.[26] Secondly, they are examples of externalities which are not caused by economic growth *per se* but result from a defect of the pricing system in that we treat as free things which are not really free. Pollution would exist even in a stationary economy. It is nevertheless true that if the output of pollutants is related to the level of production then a high growth rate increases the welfare loss from the externality. In this case it is important to correct the defects in the price system (we may echo Beckerman's call (1972) for the development of environmental indicators to provide the necessary information), and if this is done it cannot be concluded that economic growth and environmental damage go hand in hand.

It would perhaps be fitting to conclude with three major reservations. First, it is necessary to consider the implications of the fact that for some areas (for example, education and health) the indicators we have used measure inputs rather than outputs. And it is quite possible that the inputs are more closely correlated with the level of national income than are the outputs, in which case some of the observed correlation would be spurious. Secondly, the hypothesis that economic growth is positively related to social development was tested using only the data which could be obtained for the entire sample of twenty countries. It would be possible to extend the test to other indicators by reducing the number of countries in the sample, and obviously further information could be gained in this way.

Finally, the indexes used to test the relationship between changes in GDP and changes in social indicators are summary statistical measures, not true measures of social welfare. Social indicators are most needed in those areas where market prices cannot be used to weight outputs together, either because markets do not exist (public goods), or because of significant externalities. So any index of social welfare must incorporate a set of weights which will express the value judgements of the individual compiling the index. To calculate the ORS index indicators were given equal weights with the sign imposed *a priori*, and for the FPC index the weights were chosen to maximise the proportion of the variance of the indicators captured by the index. It would, therefore, be misleading to claim that the results reported here are in any sense the most preferred test of the relationship between economic growth and social welfare. Rather they are intended to be suggestive, and to provide evidence for the debate on this important issue.

[26]On the other hand if a high proportion of the population live in cities then localised phenomena may affect the majority of the population.

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APPENDIX: NOTES ON STATISTICS

Social Indicators

1. Gross Reproduction Rate. This is defined as the average number of live daughters that would be born per woman in a group of women, all of whom survive to the end of the potentially reproductive period of life and bear daughters at each age in accordance with the rates prevailing among women of various ages in the area and during the period concerned. The second benchmark year is 1968 and data for this were obtained from [6], 1969, and for the earlier year from [6] 1954 and 1965.

2. Population Density; defined as de facto population (present in area) per square kilometre. Source [5], various issues.

3. Dependency Ratio; defined as the ratio of the population under 15 years of age and over 64, to the numbers aged 15–64. Sources [1] and [4].

4. Illegitimacy Rate; number of illegitimate live births per 100 total live births. Data for Spain exclude live-born infants dying within 24 hours of birth, and for France exclude infants dying before registration of birth. Figures for the second year are for 1968. Source [6] 1959 and 1969.

5. Public expenditure on education as a percentage of GNP, both measured at current market prices. This includes expenditure on public and subsidised private education financed by all levels of government. The figure for Sweden in the earlier year is as a percentage of GNP at factor cost. For other countries figures for the earlier year are for 1950 and expenditure is expressed as a percentage of national income. Sources: [2] and [8].

6. Number of students in higher education per 100,000 inhabitants. Students are defined as those eligible to sit for examination and to receive degrees or diplomas at degree-granting and non-degree-granting institutions of higher education of all types, such as universities, higher technical schools, teacher-training colleges, theological schools etc., both public and private. The figures for W. Germany do not include engineering schools (Ingenieurschulen), or post-graduate teacher training. For the second benchmark year data for 1968 were used. Sources: [2] and [8].

7. Female students as a percentage of the total student body. Student is as defined above. Sources: [2] and [8].

8. Number of hospital beds per 1,000 population. "Hospitals" include all medical establishments, both public and private, with beds (including mental hospitals). The figures were calculated from data on the number of hospital beds and population figures in [5] 1952, 1953, 1970.

9. Number of doctors per 10,000 population. "Doctors" include those in public and private institutions plus private practitioners provided they have some type of official legitimation. Sources: [5] 1952, 1953, 1970.

10. Protein consumption measured in grammes of protein per person per day. These figures were taken from various issues of [5] and were prepared by governments in collaboration with the FAO and OECD.

11. Infant Mortality Rate; defined as the number of deaths of infants under 1 year of age per 1,000 live births. The data exclude still-births which are included in statistics of foetal deaths. Source [6], various issues.

12. Late foetal death ratio; defined as the number of late foetal deaths (those of at least 28 weeks gestation) per 1,000 live births in the same year. The 1951 figure for New Zealand is for the European population only. No data for Ireland are available for the period before 1966, and so an estimate for 1951 was constructed by a linear extrapolation of the change between 1966 and 1969. This was very close to an alternative estimate made by multiplying the 1969 ratio of the Irish to the U.K. figure by the 1951 U.K. foetal death rate. Sources:[6] 1954, 1957, 1962, 1967 and 1970.

13–15. Death Rates from various causes. For 18 of the countries in our sample the cause of death in 1951 was classified according to the 1948 Revision of the Abbreviated List of 50 Causes for Tabulation of Mortality of the International Statistical Classification of Diseases, Injuries and Causes of Death. The two exceptions, Austria and Spain, follow the 1938 Revision of the Abridged International List. For 1969 cause of death was classified according to the 1955 Revision of the Abbreviated List, except for the following countries which adopted the 1965 Revision: Austria, France, Ireland, Netherlands, U.K., Canada, U.S., Japan, Australia and New Zealand. For the causes of death we have considered the differences in coverage due to the different classifications are

negligible. All death rates are expressed as numbers per 100,000 population. It was not always possible to obtain figures for 1969 and so 1968, or sometimes 1967, figures were used instead. Sources: [6] 1953, 1954, 1955, 1957, 1967, 1968 and 1970.

16. Number of telephones in use per 100 population. For 1951 the total number of telephones has been divided by the mid-year estimates of population, both given in [5], 1953. The figures for 1969 calculated on the same basis are given in Table 158 of [5], 1970.

17. Number of radio receivers per 1,000 population, on December 31 of the year in question. The data are for the number of licences issued except for the following countries where the figures refer to the estimated number of receivers in use: Spain (1969), Canada (1951 and 1969), U.S. (1951 and 1969), Japan (1969). Source [5].

Economic Indicators

Average annual growth rate of *per capita* gross domestic product at factor cost; obtained by weighting together the growth rates for 1950–60 ([5] 1969, Tables 179 and 180) with those for 1960–69 ([5] 1970, Tables 181 and 182, and 1971, Tables 182 and 183) by the number of years. Data for Japan refer to the growth rate of gross national product at constant market prices. GNP *per capita* in U.S. dollars; for 1951 data for fifteen of the countries were found in [3]. For the other five data on GNP were obtained from [7], were deflated by population figures from [5] and converted by the exchange rates given in [5]. For Spain the exchange rate used was the "controlled free" rate. Data for 1969 were found in [5], 1971 Table 186.

Statistical Sources

[1] OECD, *Manpower Statistics 1950–62*, Paris 1963.
[2] OECD, *Development of Higher Education 1950–67*, Paris 1970.
[3] OECD, *National Accounts of O.E.C.D. Countries 1950–68*, Paris 1970.
[4] OECD, *Labour Force Statistics 1959–70*, Paris 1972.
[5] United Nations, *Statistical Yearbook*, issues for 1952, 53, 54, 55, 56, 61, 68, 69, 70, 71.
[6] United Nations, *Demographic Yearbook*, issues for 1953, 54, 55, 57, 59, 65, 67, 68, 69, 70.
[7] United Nations, *Statistics of National Income and Expenditure*, Statistical Papers, Series H, No. 10, New York 1957.
[8] UNESCO, *Statistical Yearbook 1970*, Paris 1971.