LIFE EXPECTANCY AS AN INTEGRATING CONCEPT IN SOCIAL AND DEMOGRAPHIC ANALYSIS AND PLANNING[1]

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This paper considers the need for a more integrated system of social and demographic statistics than SSDS and discusses the advantages of building it on the concept of life expectancy. The system would include a network of additive tables which would (as SNA does for economic variables) bring together leading social variables in a way that would permit the effects of exogenous changes to be quantified and compared. The author proposes as the base of such a system a table giving the expected duration of various life states (education, employment, retirement, etc.). This would be supplemented by a family of social co-efficients and fixed-weight index numbers that slot into it, allowing inter-temporal and international comparisons. The system would facilitate analysis of inequalities (regional, ethnic, etc.) and social change, and government planning of such change. It would also provide a framework for the development of national systems of social statistics.

During the past few years, there has been a search for an integrated system of social and demographic statistics which could provide a framework for the increasingly important social aspects of planning and thus supplement national income accounting. This search can be seen, in fact, as an attempt to do for statistics in the social field what the system of national accounts[2] has done for economic statistics. That system has made it possible for us to trace the connections between output, consumption and investment, factor incomes, public finance, foreign trade, etc. Its additive possibilities make it feasible to pose policy choices in terms of their respective quantitative effects (at least in the short run and in global terms), e.g. between policies yielding increments in private consumption and public. Practically all official economic indicators can be housed in it—index numbers of industrial production, retail sales, export volume, etc. So monitoring the consequences of policies is straightforward. With its comprehensiveness and enforced consistency, national income accounting has stimulated an enormous proliferation of economic statistics, and facilitated both academic research and government policy making. In fact, one could say that it has been a major influence in the development of economics and in strengthening this discipline relative to the other social sciences.

Clearly a coherent statistical system can have a great impact.[3] An important attempt at the systemisation of social statistics is "Towards a System of Social and

[1]An earlier draft of this paper was first presented to a conference on statistical policy at the Institute of Development Studies in the summer of 1975. I am grateful for comments from Ms Nancy Baster, Mr John Blacker, Professor A. K. Sen and Professor Richard Stone.

[2]"System of National Accounts" (United Nations, 1968), or SNA.

[3]This impact is not necessarily always beneficial: the promotion of the SNA has led in many countries to the production of accounts of very poor quality, which are arranged in ways not really convenient, in the local context, for either analysis or policy, especially when long-term structural changes are on the agenda.

Demographic Statistics" (United Nations, 1975), by Richard Stone (who was of course also one of the principal architects of the SNA). The SSDS, as it is known for short, encompasses a wide range of statistical material, and although suggestions are made for the standardisation of definitions, to call the end-product a "system" is stretching the meaning of the word somewhat.[4]

"Social and demographic statistics" cover such a heterogeneous field that the search for a completely comprehensive system is perhaps a vain one. Nevertheless, the advantages of systemisation would be so great that it is worth considering whether a stronger and more integrated framework than SSDS could be constructed for at least part of this field. One really needs for social analysis and the social aspects of planning what the SNA provides for economic statistics:

(i) A system of tables that bring together leading variables in a way that permits the effects of exogenous changes, including changes in policies, to be quantified and compared *ex ante* or *ex post* in relation to specified objectives.

(ii) A family of coefficients and index numbers that slot into this framework permitting intertemporal (and international) comparisons.

Although the SSDS does not really meet these needs, Richard Stone's work provides a clue on how to do so. I shall follow this clue here and suggest a set of tables and an associated family of social indicators. These could be developed into a core system within the SSDS.

In "Towards an SSDS" (5.37–5.42), Stone discusses the "decomposition of life expectancies" into the length of time someone can expect to spend in school, to be economically active, etc. He has, in fact, done this elsewhere for what he calls the "active sequence", by using social matrices to follow a cohort through a

TABLE 1

THE EXPECTATION OF LIFE AT BIRTH AND THE MAIN COMPONENTS OF THE ACTIVE SEQUENCE: ENGLAND AND WALES, MALES, 1965–66

	(Years)
Pre-school	4.5
School	11.4
Further education	1.0
Economic activity	47.2
Home and retirement	6.8
Total life expectancy	71.0

Source: "The fundamental matrix of the active sequence", by Richard Stone in *Input–output Techniques*, ed. A. Brady and A. F. Carter (North Holland, 1972). The estimates reproduced here are those "partially adjusted" to achieve consistency—the total expectation of life is slightly higher than the Registrar–General's figure for the same year, 68.5.

[4]See my review note in *The Economic Journal*, September 1976, pp. 595–598.

sequence of "states", being diminished as it progresses in two ways: by mortality, or by movement into a subsequent state.[5] Table 1 shows his results.

A point to note about this table is that it brings together various important social statistics from different fields. The total expectation of life at birth is of course itself a significant indicator in the field of health, reflecting nutrition, medical services, etc. The expected number of years at school can be compared with the legal requirement at that time (10 years) and with similar figures for other years, throwing light on the utilisation of the educational system. The period in "further education" has an obvious significance, as does that in "economic activity".

(i) *A System of Additive Tables*

Table 1, however, is not sufficiently detailed to accommodate many areas of social concern. "Economic activity" in particular is a very broad category. One could in principle show, for example, how many of those years a new-born child could expect to spend unemployed, granted the unemployment rates of the year concerned. We could further decompose the "active sequence" to something like Table 2. A table like this would show how long a period the average person would expect to spend in undesirable states such as incapacitation, prison, unemployment or unpensioned retirement, if current (or recent) experience remained unchanged. To sum these periods and show the expected total time to be spent in *any* of the undesirable states would provide a single welfare index that would have some meaning, though one should bear in mind that the expectation is static,

TABLE 2

DUMMY TABLE FOR SOCIAL ANALYSIS AND PLANNING

The Expectation of Life at Birth and its Components States*	(Years)
Pre-school	
Primary school	
Secondary school	
Absence from school	
Technical college, etc.	
University	
Incapacitation	
Prison	
Unemployment	
Employment	
Economically inactive	
Unpensioned	
Pensioned	
Total life expectancy	

*These states have of course to be defined so that they are mutually exclusive and between them cover the whole life span.

[5]The theory of multiple decrement tables, with some examples and further references, is discussed in *The Methods and Materials of Demography*, by H. B. Shryock and Associates, (U.S. Bureau of the Census, 1973), Vol. II, pp. 455–457.

referring to a "stationary population". This table would be a way of bringing together a number of social statistics in an additive framework, as, for example, a national expenditure table does for economic variables, and of showing some connections between them. For example, an increase in the number of university students adds to the expected time that a child born today will spend at a university and thus reduces his or her expectation of unemployment.

This frame need not be confined to static analysis. It could contain columns for two different years to enable progress to be measured, or for the base-year and end-year of a plan, showing how much a plan would change the average time in various states. This could also be articulated at places with economic planning, both directly (the expected time in employment in various occupations or industries would need to be consistent with plans for output) and indirectly (through government capital and current spending on the social services to achieve the target values of the social variables).

The table need not be confined to national averages. Separate columns for males and females would obviously be needed. Other divisions could of course be used, according to national structure and political concern, e.g. for each race. It would also be possible to show separate figures for each area (e.g. urban/rural or by province or region), or for each socio-economic class, though these would raise problems of interpretation because of migration and social mobility.

Other life sequences can also be presented in the same way. One possibility would be a table of the marital sequence (Table 3). Each of the states shown could

TABLE 3

DUMMY TABLE FOR SOCIAL AND DEMOGRAPHIC ANALYSIS

The Expectation of Life at Birth and its Main Demographic Components: Male and Female

States	Males	Females	Both sexes
	(Years)		
Unmarried			
Married			
Divorced			
Widowed			
Total life expectancy			

be broken down according to the number of dependent children, and the "married" state could be sub-divided into first, second, third, etc., marriages. Expected life patterns of health, housing, etc., could also be constructed.

Of course, since states like unemployment are intermittent, the total unemployment of the average lifetime could not be easily estimated from social matrices, and to base a system on such matrices would inhibit its development. But Stone's matrices are not essential for decomposing a life sequence. This could be done using age-specific rates for the states concerned. $\mathring{X}$, the at-birth expected duration in a certain state X, such as unemployment, can be expressed as the sum of the products of the at-birth expectation of life during the $(n + 1)$th year, ${}_n\mathring{E}$, and the incidence of that state in that year, ${}_nx$.

Thus

$$\mathring{X} = \sum({}_n\mathring{E} \cdot {}_nx). \tag{1}$$

The first factor, at-birth expectation of life during any particular year, can be taken from a life table. Such a table is available in almost every country: it may be slightly out-of-date, but the incidence of mortality is so stable that this will rarely matter much.

The practical question is whether it is possible to estimate the age-specific incidences. Ages are usually available in the basic source of social statistics. Where these are not collected and tabulated nationally, it is within the bounds of possibility to do so. One should not underestimate the difficulties of reconciling data from different sources and using them to construct a comprehensive system of this kind,[6] but it ought to be feasible in most important social fields in countries with well-developed statistical systems.

A more fundamental problem arises because concepts like "unemployed", "retired", etc., have different meanings from country to country (and even in the same country over a period of time). It would not be appropriate to go into such difficulties here, but two points can be made. In the first place this problem arises in any statistical system, especially in the social field. Secondly, provided no basic changes occur in the socio-economic structure, intertemporal comparisons will not be meaningless: the problem would arise primarily in international comparisons, which would not be the main purpose of such a system.

But both the need for statistical detail and the requirements of conceptual precision suggest that the system would be more appropriate for industrial countries, including the Soviet Union and Eastern Europe. However, in most other countries, it could be considered, because of its flexibility, at least a frame for the development of social statistics, as the SNA is for economic statistics.

It is obvious that this framework can absorb a good many types of statistical material. Mortality rates fit it easily because of the use of life tables. It readily accommodates both longitudinal surveys and data from time budgets. The former could be used to study associations between states; the latter would enable time periods to be analysed in greater detail. When we say that some male was in employment for a certain number of years, we mean that this was typically the way he spent normal working hours. In addition, of course, he slept, did domestic chores, travelled to and from work, enjoyed leisure, etc. Table 2 above could in principle be expressed in hours, instead of years, and show periods spent on activities outside the normal hours of school and adult work.

It is possible to accommodate also some other types of data, by expressing them as life expectancies. Expected lifetime earnings can be discounted (as is done in deriving measures for the benefits of education) and compared for different sexes and races. Occurrences such as accidents or arrests or having one's house burgled cannot be expressed as durations, but could be shown as the number

[6]Because of the inadequate tabulation of ages, Richard Stone had to classify the school population by years enrolled, which gave rise to considerable problems of adjustment, but would not have caused great inaccuracy, because the age of school entry is legally specified in England and Wales.

expected in a lifetime, and thus related to durations (e.g. of unemployment) in research into life patterns. Subjective data, such as those showing degree of satisfaction, in response to survey questionnaires, could in principle be similarly converted. To express some types of data in this way would, however, be rather artificial, and statistics on structural characteristics (for example, ownership of land and other property, or the stock of social capital) would not fit into the system at all. (The attempt to accommodate structural data weakens SSDS).

The suitability of the system for particular countries also raises political issues. Any quantitative framework for analysis and planning implies a political philosophy.[7] The basic assumption behind official use of the system proposed here would be that the length and pattern of life of a human being is in some degree the responsibility of the government of the country where he or she lives. The preparation of variants showing data separately for different races, for example, would carry a tacit assumption that if some section of the population was significantly worse off than the national average in some respect, this would justify special corrective policies. A social development plan based on such a system would convey the powerful message that the official intention was to achieve specific improvements in the quality of life. The usefulness of the system to an official statistical office depends therefore largely on the strength of government commitment to solving social problems.

However, we must not fall into the common trap of assuming that statistics are only produced for governments. The composition of the human lifespan is also a proper object of analysis by academic social scientists. It is true that many social concerns are excluded from Table 2 and could not be covered by any system because they do not lend themselves to measurement—for example, participation in decision-making. In addition, some important social experiences, although in a degree measurable, could not easily be expressed in life expectancies—for example, corruption, police brutality and bureaucratic power—even if data on them were available. In countries where the legitimacy of the government is in question a social critic might consider it a weakness of this statistical framework that it focussed attention on the social service aspects of state-individual relations. However, the fact that it provides an articulated frame for so many types of socially relevant data, which could be broken down to fit particular social models, would make it of some use for most researchers, including those with a fundamentally critical philosophy.

(ii) *A Family of New Social Indicators Slotting into the System*

Let us turn to the uses of the system for those monitoring social progress (e.g. towards plan targets) or for social scientists carrying out dynamic analyses.

It is awkward that the great battery of existing social statistics, such as rates of school enrolment, cannot be related directly to the durations in Tables 1 or 2. This link could, however, be forged. It would be possible to construct a family of

[7]"The Political Economy of National Accounting" by Dudley Seers in *Essays in Honour of Hans Singer* (Macmillan, 1976). The SNA was developed to meet the needs of Keynesian economics, especially global demand analysis and management, at the root of which lies a liberal view of the role of the state.

indicators that would form part of this system, and permit changes in components of life expectancy to be analysed.

One crude way of doing this would be to treat each component as a fraction of the total life expectancy. Thus dividing equation (1) by $\sum_n \mathring{E}$ we get

$$\mathring{X}/\sum_n \mathring{E} = \sum({}_n\mathring{E} \cdot {}_n x)/\sum_n \mathring{E}. \tag{2}$$

The right-hand side of equation (2) can be looked on as an average of age-specific rates, each weighted by the expectation of life for the various ages. An indicator of this kind would not, however, be very meaningful: applied to school enrolment, for example, it would cover adult ages, for which of course the enrolment rates are zero. A more useful index could be constructed by confining both the numerator and the denominator to the school attendance years—say 5 to 15. The indicator for school enrolment (s) between these ages becomes:–

$${}_5\sum_{15}({}_n\mathring{E} \cdot {}_n s)/{}_5\sum_{15} \cdot {}_n\mathring{E}. \tag{2A}$$

This will not be very different from what is the conventional rate of enrolment, obtained by simply dividing all those enrolled during the ages of compulsory school attendance by the total in those ages. The coefficient proposed simply has artificial weights—in effect the survivors at each age in a stationary population,[8] instead of the actual population at that age.

Other social coefficients can be built up in the same way. We can partition the average life expectation at birth, $\mathring{E}$, into segments of a type ${}_m\mathring{E}_n$, the expectation (at birth) of life between the mth and the nth birthdays, and then divide each of these in turn into whatever compartments we want.

Table 1 ignores such age ranges, but we could rearrange that table or Table 2, by breaking the expectation of life into age groups which are analytically useful, the most significant probably being pre-school (say 0–5), school (5–15), working (15–60) and retirement (60–D), with D standing for death.[9]

The decomposition of life expectancy at birth could then proceed as in Table 4. This would immediately yield more interesting indicators. The expectation of surviving the first year is of course an indicator of intrinsic importance, reflecting infant mortality. In addition, rearrangement of these statistics yields other basic socio-economic ratios and data, for example:

Child mortality indicator	$4 - {}_1\mathring{E}_5$
School enrolment rate	${}_5\mathring{S}_{15} \div {}_5\mathring{E}_{15}$
Labour force participation rate	$({}_{15}\mathring{M}_{60} + {}_{15}\mathring{U}_{60}) \div {}_{15}\mathring{E}_{60}$
Unemployment rate	${}_{15}\mathring{U}_{60} \div ({}_{15}\mathring{M}_{60} + {}_{15}\mathring{U}_{60})$
Dependency indicator	$({}_0\mathring{E}_5 + {}_5\mathring{E}_{15} + {}_{60}\mathring{N}_D) \div ({}_{15}\mathring{M}_{60} + {}_{60}\mathring{M}_D)$.

[8]The average at-birth expectation of life in a year is the same as the average fraction of a birth cohort surviving in that year.

[9]There is one doubtful implication for social policy which should be mentioned. The segmentation of the life span suggests that some activities are only appropriate to certain age groups. While this is certainly broadly true, the current tendency, especially in education, is to pay less attention to such conventions. A table of this kind would need to be interpreted with this in mind and perhaps eventually modified.

TABLE 4

DUMMY FRAMEWORK FOR SOCIAL AND DEMOGRAPHIC INDICATORS

The Expectation of Life at Birth and its Components by Age Groups (Years)

Ages	State	Expectancy of time in that state	Segment of life expectancy
0–5	Infancy	$_{0}\mathring{E}_{1}$	$_{0}\mathring{E}_{5}$
	Pre-school childhood	$_{1}\mathring{E}_{5}$	
5–15	Enrolled in school	$_{5}\mathring{S}_{15}$	$_{5}\mathring{E}_{15}$
	Other	$_{5}\mathring{O}_{15}$	
15–60	Studying, full-time	$_{15}\mathring{S}_{60}$	$_{15}\mathring{E}_{60}$
	Employment	$_{15}\mathring{M}_{60}$	
	Unemployment	$_{15}\mathring{U}_{60}$	
	Not studying or economically active	$_{15}\mathring{N}_{60}$	
60–D	Employment	$_{60}\mathring{M}_{D}$	$_{60}\mathring{E}_{D}$
	Retirement	$_{60}\mathring{N}_{D}$	
0–D			$_{0}\mathring{E}_{D}$

These rates are not quite the same as their conventional counterparts because, as pointed out above, they would be weighted by the numbers in a stationary population. Such age-standardised indicators may well, however, for many purposes be somewhat more useful than simple averages, weighted implicitly by the current age structure, because they are unaffected by temporary fluctuations in this structure, due, for example, to the postwar "baby boom". The advantages are particularly obvious when the state concerned is associated with age, e.g. participation in the labour force.[10] Such indicators would enable the influence of age on social conditions to be eliminated, so that other influences could be analysed directly.

We could take a step further and use the same life table for each year of a time series to construct an index number. This would show what changes have taken place in, for example, school enrolment *apart from those due to variations in fertility and mortality*. This makes a virtue of necessity, because life tables are not available every year, nor is the most recent usually very up to date.

Using $\mathring{E}_b$ to show expectation of life in a base year, and $\mathring{E}_t$ in the year concerned, then an index for school enrolment weighted by a base-year stationary population[11] would be

$$_{5}\sum_{15}(\mathring{E}_b \cdot s_t) \div {}_{5}\sum_{15}(\mathring{E}_b \cdot s_b).$$

A family of socially significant index numbers of this type could be generated with consistent weighting systems for all sequences, analogous to the family of price-weighted series used in economic analysis. Thus we could show what changes in

[10]Unemployment is also more common among young adults, but a Keynesian would no doubt argue that total national unemployment is determined by the level of global demand, not by the age structure, which simply influences the way in which the total is distributed.

[11]"Stationary population" is of course used in the technical, not the popular, sense.

the marital composition of the population would have occurred (or would occur) in the absence of fluctuations in age structure, by expressing expected durations of marriage, divorce, etc., as proportions of the life expectation of those aged over 15, and weighting throughout by the same stationary population. This can be done with any state for which age-specific data are or could be available, e.g. imprisonment, incapacitation, pensioned retirement, illiteracy, morbidity, etc. Such index numbers could be used to monitor progress to social targets such as the elimination of illiteracy.

Similar comparisons could be made between parts of a population. Age-weighted indices can be worked out separately for each sex, region, race, social class, etc. using a national life table for all groups. They would show what the rates of school enrolment or unemployment, for example, would be in white and black parts of a population *if the age structures were the same.*[12]

To sum up, the integrating potential of this system is clear, and it would act as a powerful stimulus to the development of social statistics and research, as well as providing a much-needed core to the SSDS and facilitating social planning. Indicators of the type described would be unfamiliar, but the acceptance of weighted economic indicators by the public has made it easier to introduce other weighted indices, and in any case the system would be useful even if indicators were not developed along the lines suggested.

The resource costs of such a system, however, would be considerable, and in some countries it could only be a long-term goal. These benefits and costs could only be established by research, preferably by a national statistical office.

[12] Analogous points arise if we use this system for international comparisons. Even indicators weighted by either country's stationary population would be useful and in fact might for some purposes be slightly preferable to normal ones (because they would eliminate the consequences of differences in age composition). But it would be in principle possible to improve such analyses by applying an international standardised life table.