AN EMPIRICAL ESTIMATE OF THE RELATION BETWEEN TWO MEASURES OF ECONOMIC WELFARE*

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The main objective of this paper is to explore and quantify the difference between two measures of comparative economic welfare: (a) the more or less conventional measure of per capita national income, and (b) the capitalized value of expected future income per capita. The paper begins with a brief summary of the argument in favor of the present value of expected future income per capita as a measure of economic welfare. This is followed by an examination of the empirical relationship of the ratio of the suggested alternative measure to per capita income and an analysis of the variables used to compute the present value of expected income per capita. The main conclusion drawn from the calculations is that very substantial differences occur in the measurement of relative economic well-being depending on which measure is used. A final section discusses the implications of this finding for international comparisons of economic welfare.

Simon Kuznets argues, in his pioneering work on national income, that national income in spite of its conceptual and empirical problems is the best measure available of economic welfare.[1] Adequate documentation of the conventional acceptance of his proposition is most easily found in the comparisons of economic welfare among countries. These comparisons all employ one of a number of closely related concepts and measures of per capita national income. More recently, Burton Weisbrod suggested an alternative measure of comparative economic welfare—the capitalized value of expected future income per capita.[2] Weisbrod argued the relative merits of this measure, and then compared per capita income with the computed expected income for four cities in the United States. Rankings of these cities by both measures of economic welfare were identical, but the variation in welfare among the cities, measured by per capita income, was reduced when the measure of present value of future income per capita was used.

Unfortunately, Weisbrod's presentation did not clarify or adequately quantify the influence of the variables he used in computing alternative measures of economic welfare. The differences he obtained between the "present value of future income per capita" measure and the presently used "per capita income" measure remain largely unexplored. The main objective of this paper is to explore and quantify these differences. The paper begins with a brief summary of Weisbrod's argument favoring the present value of expected future income per

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[1]For a concise statement of this proposition see his "National Income and Economic Welfare" in Simon Kuznets, *Economic Change*, New York, 1953, pp. 192–215.

[2]Burton A. Weisbrod, "An Expected-Income Measure of Economic Welfare," *The Journal of Political Economy*, 70 (August 1962), pp. 355–367.

capita as a measure of economic welfare. This precedes an examination of the empirical relationship of the ratio of the suggested alternative measure to per capita income and an analysis of the variables used to compute the present value of expected income per capita. A final section discusses the implications of the relationship between the two measures for international comparisons of economic welfare.

I. The Alternative Measure

If the present value of expected future income for an average person at age n is defined as:

$$V_n = \sum_{a=n}^{\infty} \frac{[(e_a E_a + O_a) S_n^a]}{(1+r)^{a-n}}, \tag{1}$$

where E_a is the mean expected earnings of employed persons at age a, e_a is the expected probability of being employed at age a, O_a is the mean expected income other than earnings at age a, S_n^a is the expected probability of surviving from age n to age a, and r is the rate of discount, then the capitalized value of expected future income per capita can be defined as:

$$V = \sum_{n=0}^{\infty} V_n P_n \tag{2}$$

where P_n is the proportion of the total population of age n. It is this value of V which Weisbrod argues is superior to income per capita, Y, as a measure of economic welfare. The desirable property of V, not shared by Y, is that V plausibly accounts for both present and future conditions affecting one's economic welfare. In particular it accounts for: (a) expected earnings in the future; (b) expected employment in the future, and (c) life expectancy.

The measure V will differ from the measure Y in a comparison of countries not only because of values of the three factors just listed, but also because of different age distributions of the populations. Both V and Y are the results of weighting by P_n two different distributions—an age-wealth distribution V_n and an age-income distribution Y_n. The effect on the ratio V/Y of varying these four factors, within their respective and *realistic* ranges among countries, will be explored below.

II. An Empirical Relationship

Two simplifying assumptions are made to overcome difficulties stemming from data which are desired but unavailable, and unbridgeable differences in concept and measurement in female population data among countries. These assumptions are:

(a) Income other than earnings, O_a, is assumed negligible thereby yielding mean expected earnings, E_a, of employed persons which represent all mean expected income, Y_a, of employed persons.

(b) Computations are performed only on the male population of a country.

These assumptions are shown later in footnote 15 to be of no great consequence. Given the assumptions, equation (1) reduces to:

$$V_n = \sum_{a=n}^{\infty} \frac{e_a Y_a S_n{}^a}{(1+r)^{a-n}} \tag{3}$$

Given Y_a (Y_n) for a number of countries, the implied per capita income is:

$$Y = \sum_{n=0} e_n Y_n P_n \tag{4}$$

where the values of e_n and Y_n now refer to current values rather than to expected future values as in equation (3). The ratio of V/Y is given by the division of equation (2) by equation (4).

For the moment we assume that the expected future values in equation (3) are the current values.[3] Now, given current values of the four age-functions e_n, Y_n, $S_n{}^a$, and P_n for a number of countries, it becomes possible to calculate values of V/Y, and express these as functions of the parameters determining e_n, Y_n, $S_n{}^a$, and P_n. An attempt was made to solve the problem analytically by fitting analytic functions to data of e_a, Y_n, $S_n{}^a$, and P_n. The attempt failed because of the complexity of some of the fitted functions.

Age-Income Functions, Y_n

Earnings figures specified by age for different countries are rarely found. An intensive search of the statistics for different countries uncovered a few usable sets covering the range of income per capita observed in the modern world.[4] Four patterns were finally chosen, which represent most of the existing range. These earnings profiles are for males in India, France, Japan, and the United States. The data on India were obtained from Harberger and represent earnings of primary school graduates in Hyderabad.[5] The data for France are annual wage and salaries of full-time male workers classified by nine different age groups.[6] The data for Japan represent earnings of the employed by age.[7] The data for the United States are earnings of high school graduates for ages between 18 and 64.[8] Earnings figures prior to age 18 are estimated from age-specific income figures of the U.S. population. Yearly figures for Japan, France and the United States are obtained by linear interpolation of the basic data.[9]

[3]A later section of this paper relaxes the important assumption that mean expected income of employed persons at age a can be approximate with Y_n values.

[4]A thorough search of age-income profiles by the library staff of the International Labour Office, Geneva, is acknowledged with gratitude.

[5]Arnold C. Harberger, "Investment in Men Versus Investment in Machines: The Case of India," in C. Arnold Anderson, and Mary Jean Bowman, eds., *Education and Economic Development*, Chicago 1965, p. 24. The data clearly are very rough estimates constructed by assumption in the light of knowledge of other societies, and subject to reasonable consistency with education-income data not broken down by age.

[6]*Etudes et Conjoncture*, No. 11, November 1965, Table XIX B, p. 62.

[7]Bureau of Statistics, Office of Prime Minister, 1962 *Employment Status Survey*, Vol. 1, Table I-1, p. 2; Table I-23, pp. 132–141.

[8]Herman P. Miller, *Present Value of Estimated Lifetime Earnings*, Technical Paper No. 16, Bureau of the Census, Table 1, p. 9.

[9]The processing of the basic data was performed competently by Frank Goldberg.

Employment Participation Rates, e_a

The employment participation rate of the male population can be thought of as the product of the labor force participation rate and the employment rate of those in the labor force. Basic data on labor force participation rate were obtained from a United Nations Report.[10] In this report, average age-specific activity rates for males in 72 countries are classified into three groups, according to the degree of industrialization (as measured by the per cent of active males engaged in agriculture and related activities): (a) industrialized countries; (b) semi-industrialized countries; and (c) agricultural countries. We multiply these three sets of labor force participation rates by one minus "typical" age-specific unemployment rates[11] yielding three sets of e_a. The individual values for each year are derived from a linear interpolation of the grouped data. These three sets of employment participation rates over the life of an average person represent the range of variation in these rates among most countries, and are used in the following computations.

Survival Probabilities, S_n^a

On the basis of life-table mortality rates by sex and age for many countries at different periods, the Department of Social Affairs of the United Nations has constructed model life-tables representing the entire range of mortality experience found in the world. Of the forty models constructed for males, five were chosen to represent five different expectations of life at birth (models No. 1, 10, 20, 30, and 40).[12] These age-specific mortality rates are converted, by standard demographic methods, to probabilities of survival at birth to any age, a, from which the expected probability of surviving from age n to age a, S_n^a in equation (3) is easily inferred. The five sets of S_n^a cover the range of expectation of life at birth from 18 years to 70 years, and are characterized either by these expectations, or by the inverse of these expectations (multiplied by 1,000)—the death rate per thousand in a stationary population.

Population Age Distributions, P_n

One of the most striking results of demographic studies is that the age composition of a population is profoundly affected by the level of fertility, and almost not at all by the level of mortality. For all practical purposes the age distribution of a population is wholly determined by the level of fertility.[13] A simple intuitive explanation of this phenomenon is that whenever women have many children, the population is young; whenever they have few, the population is

[10]United Nations, *Demographic Aspects of Manpower*, Report 1: "Sex and Age Patterns of Participation in Economic Activity," New York, 1962.

[11]For industrialized countries "typical" age-specific unemployment rates are those of the United States in 1953. The variation in age is reduced for the second group, and no variation is allowed for the third.

[12]United Nations, *Age and Sex Patterns of Mortality*, Population Studies No. 22, New York, 1955, Table 7, pp. 18–19.

[13]For a brief demonstration of this point see George W. Barclay, *Techniques of Population Analysis*, New York, 1958, pp. 227–230. For a more technical and detailed demonstration see Ansley J. Coale, "The Effect of Changes in Mortality and Fertility on Age Composition," *The Milbank Memorial Fund Quarterly*, 34 (January 1956), pp. 79–114.

old. It is possible therefore to construct from the five sets of survival probabilities, previously discussed, the equilibrium population age distribution observed with a given fertility rate irrespective of the death rate. From a survival function, the age distribution of a stationary population (birth rate equal to death rate at some given level) can be computed. Since this age distribution (or a very good approximation of it) remains undisturbed if the death rate is allowed to vary, it can represent the particular fertility level initially chosen. Thus, the five sets of age distributions obtained from the five survival functions can be characterized by a single respective parameter—the birth rate per thousand.

Results of the Computations

With four age-income functions, three employment participation functions, five survival functions, five population age distributions, and four discount rates (0.04, 0.06, 0.08, and 0.10) it was possible to compute 1200 V/Y ratios with all possible combinations of the variables.[14] An initial examination of the results led to two conclusions:

(1) The value of V/Y is not sensitive to the variations in the age-income characteristics covered in the sample of countries.

(2) The value of V/Y is, for practical purposes, insensitive to the variations in the employment participation rates describing typical patterns of such rates.[15]

The calculated values of V/Y are, on the other hand, sensitive to variations in the survival function, the population age distribution, and the discount rate. In order to summarize this sensitivity, average calculated values of V/Y (averages for Japan, France, and the U.S.A.) at employment participation rates appropriate for industrialized countries were regressed on B, the birth rate implied in the age distribution, D, the death rate implied in the survival functions, and r, the discount rate. The following fit was obtained:

$$\log V/Y = 0.3475 + \underset{(0.0072)}{0.2505}\ \log B - \underset{(0.0072)}{0.2737}\ \log D - \underset{(0.0101)}{0.7164}\ \log r, \tag{5}$$

with $R^2 = 0.988$ and a standard error of the estimate in log terms of 0.01506 (or in percentage terms of 3.53 per cent), which can be expressed as:

$$V/Y = 0.2256\, B^{0.250}\, D^{-0.274}\, r^{-0.716}.^{16} \tag{6}$$

[14]The programming and supervision of the computations were performed very competently by research assistants Jesse W. Boehler and Bennis J. Callaghan, whose work is acknowledged with gratitude.

[15]An important consequence of these empirical findings is that the two simplifying assumptions made at the beginning of this section [(1) income other than earnings negligible and (2) treatment of the male population alone] are now perfectly satisfactory. This is so: (a) since any income other than earnings would change, only slightly, the pattern of the age-income profiles of the different countries, and therefore imperceptibly the V/Y ratios; and (b) as long as age distributions and survival rates of the female portion of the population are not significantly different from those of the male population, the resulting V/Y ratios for the total population will not significantly differ from those of the male population.

[16]This equation is useful precisely because it is virtually pre-determined, and is interpreted only as a summary of certain calculations. It is not a regression analysis in the usual sense of testing a hypothesis.

An Illustrative Example

To illustrate the use of equation (6) in determining differences that might be involved in measuring economic welfare by Y instead of by V, we assume, at first, a conservative discount rate of 8 percent. Equation (6) then reduces to:

$$V/Y = 13.590\, B^{0.250}\, D^{-0.274}. \tag{7}$$

Using age distribution and survival rates for three different countries named "India," "Mexico," and "Sweden" we observe the ratios V/Y as computed from equation (7) and recorded below.[17]

Country	B	D	V/Y
"India"	40	40	12.48
"Mexico"	40	10	18.23
"Sweden"	10	10	12.88

Since present international comparisons of relative economic welfare are made using Y, per capita earnings or income, rather than V, the ratio V/Y indicates the extent to which comparisons in Y underestimate or overestimate relative position in terms of V. Thus one can employ the ratio V/Y as a multiplicant of Y values and determine what the "bias" is in not having compared economic welfare as measured by V. Returning to the above table, it is clear that when comparing "India" and "Sweden" not much "bias" is introduced by using Y values since the V/Y ratios for these countries are almost identical. The implication is that had the comparison been made with V values, "India" and "Sweden" would have retained the same relative positions they maintain in the conventional comparisons with Y values. On the other hand, when comparing either one of these countries with "Mexico" the economic welfare of "Mexico" is underestimated by almost 50 percent by using Y values (46 percent when comparing "Mexico" with "India") since the V/Y ratio for "Mexico" is that much larger.

III. The Effect of Expected Growth

In the previous section it was assumed that expected values of age-income profiles for any country could be approximated with their current values. The assumption is unsatisfactory and especially unsatisfactory in the present world where the per-capita-income-growth experience of nations is so different. An alternative, and probably more realistic, manner of treating expected income values is to infer the expected values of the age-income profile from the growth experience of the specified country in its last decade or two.

With the simple assumption that income, at all ages grows at the average rate of growth of the recent past, it is possible to closely approximate the

[17]The quotation marks around these countries indicate that the selected data *roughly* apply to them, and that the countries are representative of three types we wish to emphasize.

difference introduced in measuring economic welfare with *current* per capita income rather than with the per capita present value of *expected* further income. The method consists of computing the V/Y values at a discount rate equal to a chosen initial discount rate minus the average growth rate forecast for the country.

As an illustration of the order of magnitude of the difference, we again consider the previous example, but assume now that per-capita-income-growth expectations, g, for the three countries are: "India" 0 percent, "Mexico" 3 percent, "Sweden" 2 percent. Below we list the resulting V/Y values corresponding to the assumption made in the previous example.

Country	B	D	G	V/Y
			%	
"India"	40	40	0	12.48
"Mexico"	40	10	3	25.53
"Sweden"	10	10	2	15.83

It is clear when comparing the values of V/Y with those of the previous table that considerable additional "bias" is introduced when the expected growth of income is not considered in the computations. Thus, a comparison of per capita income of "Mexico" with "India" would involve now an underestimate of the economic welfare of "Mexico" of 105 percent (rather than the 46 percent noted earlier). Stated differently, the difference due *only* to growth differences in this example is 40 percent [(25.53 – 18.23)/18.23).]

IV. Concluding Remarks

The conclusion drawn from the above calculations is that *substantial* differences occur in the measurement of relative economic well-being of countries depending on whether it is measured by V or Y. Whether these differences can properly be called a bias depends on whether one is willing to accept the premise (briefly justified at the beginning of the paper, and in more detail by Weisbrod) that economic welfare can be more adequately measured by V.

The major conceptual difficulty with the measure V[18] lies in its dependence on the discount rate. Not only is it necessary to choose a discount rate,[19] but it is possible to conceive of cases in which different rates are chosen for different countries, thus reflecting different rates of time preferences. Then the problems involved in making intercountry welfare comparisons may become very difficult. Clearly, this is not an especially good reason for dismissing the comparative values of V for those of Y.

[18]The additional apparent limitation of V to currently living members of the population, including those of pre-working age, is not any more arbitrary than the limitation of Y to currently living *and* earning members of the population.

[19]The effect of the choice of discount rate on the size of the "bias" is rather interesting. Had we chosen to use a lower discount rate in the first example, the "bias" would have been of exactly the same size in *relative* terms. This conclusion follows from the dependence of V/Y on the discount rate specified in equation (6), which is a reasonable approximation of the defining relation for the range of discount rates considered.