Journal of Econometrics 50 (1991) 7–13. North-Holland

On the measurement of welfare

Jan Tinbergen
Erasmus University, Rotterdam, The Netherlands

The author believes in the measurability of welfare (also called satisfaction or utility). Measurements have been made in the United States (Jorgenson and collaborators), France (Allais), and the Netherlands (Van Praag and collaborators). The Israeli sociologists Levy and Guttman have shown that numerous noneconomic variables are among the determinants of welfare. The determinants are numerous; the author proposes a list of about fifty. Various mathematical functions have been proposed, of which the logarithm of the determinants shows the highest correlation with welfare, as measured.

1. Is measurement possible?

Among economists no unanimity prevails on the question whether welfare (considered identical, in this article, to utility or satisfaction) is measurable. For quite some time economists did not explicitly deal with that question, but wrote about utility as if it were measurable. Vilfredo Pareto took up the question explicitly and showed that the usual theories of economic behavior (demand and supply theories, for instance) only need ordinal knowledge of welfare, and not a comparison between individual degrees of satisfaction. This attitude appeals to many economists still. Although economic policy choices do require such comparisons, these are considered not to be part of economic science, but rather part of ethics or politics.

In the last two or three decades the number of economists disagreeing with Pareto is increasing again. Several attempts at measurement or at developing methods of possible measurement have been made. The procedure can be described by the assumption that utility is the same function of a number of 'determinants' or 'components' for all individuals or households but with *parameters* characterizing the individual (or the household) considered which *differ* among individuals. The function has a shape expressed by some mathematical function in which *coefficients* appear that are the same for all individuals (or households).

Economists in favor of welfare measurement are called cardinalists. Their justification may be that economists are better experts than ethical experts or politicians when it comes to understand the economic consequences of interpersonal comparisons. Other justifications are possible as well, as we shall see.

To begin with I briefly describe the measurements made and I describe them for three national groups of economists which until recently worked somewhat in isolation – an isolation that meanwhile has been broken. *Empirical* work was done by an American, a Dutch, and a French group. The British economists did not intend to do empirical work, but rather to contribute to the methodological discussion. In a brief note [Tinbergen (1985a)] I mentioned the names of several economists involved and in another note [Tinbergen (1987)] I added the French economist Maurice Allais. In the present article two noneconomists will be added from whom we can learn.

I group the American economists involved around Dale W. Jorgenson. He and his co-authors [cf. Christensen, Jorgenson, and Lau (1975), Jorgenson, Slesnick, and Stoker (1980), Jorgenson and Slesnick (1983, 1986)] use a *translog utility function*, that is one where the *log* utility is a *quadratic function* of the logs of the determinants (components) and the latter are three or five consumption goods or services. The number of parameters to characterize the groups of consumers is also five: family size, age of head, region of residence, race, and type of residence. They introduce restrictions on preferences not used by ordinalists which may be considered the price they pay to justify their being cardinalists. The restrictions used are *exact aggregation* of individual demand to total demand and the *integrability* of demand functions – rather formal criteria.

The multiple correlation coefficients obtained are not impressive; this may be due to the neglection of a number of noneconomic determinants, used by sociogists and other noneconomists and to be discussed below.

The Dutch economists will be grouped around Van Praag [cf. Van Praag (1971), Van Praag and Kapteyn (1973)]. They use one determinant, income, and test a large number of utility functions [cf. Van Herwaarden and Kapteyn (1981)], although they prefer the *cumulated lognormal function*, for reasons of convenience in a number of applications. The function preferred by the present author is *linear in the logs of the determinants* x_i used by him, plus unity:

$$\omega = \sum_i \alpha_i \ln(x_i + 1), \tag{1}$$

The advantage of this relationship is that it shows *falling marginal utilities*,

namely:

$$\partial\omega/\partial x_i = \alpha_i/(x_i + 1). \tag{2}$$

Moreover, the logarithmic shape appeared to give the *best fit* of all functions tested. It has a lower limit if we consider $x_i \geq 0$; it is true that it has *no upper limit*, but the necessity of such an upper limit is debatable.

The general restriction implied is that the qualifications used to carry out the measurement procedure of the satisfaction experienced (excellent, good, satisfactory, bad, etc.) have the *same meaning* to the persons compared. This restriction can be accepted since in discussion on the policy resulting from the use of welfare measurements the *same words are also used* either to accept or to reject the policy. The restriction is more acceptable for local than for world-wide policies, of course: the concept of a 'good income' means something different to an American and a Pakistani metal worker.

The French economist who engaged in measuring welfare is Maurice Allais [cf. Allais (1984)]. He uses one component, the '*psychological assets*', and prefers the functional shape of *linearity in its logs*. He only claims this shape for the *main interval* of the variable and admits that deviations occur at the extremes. At the upper extreme he finds the phenomenon of *satiety* (an asymptote).

Not only economists engaged in the measurement of welfare, however. Being an economist I don't feel able to discuss at any length what noneconomists contributed to our insight. One example will suffice to show how important a study of those contributions is. In two data sets Levy and Guttman (1975) show that some twenty components, of which a few only (two or three) are economic determinants, are able to explain about 2/3 of the variance in 'happiness' (their word for utility), so $\bar{R}^2 \sim 0.67$, of which only 0.13 is explained by economic components! The number of observations (interviews) was > 1800 in two investigations. The low values of $\bar{R}^2$ reported by Jorgenson and Slesnick are explained by this evidence. This justifies our discussion, in the next section of this article, of the components (or determinants) of utility.

With the preceding summary I think to have shown that measuring welfare or utility has become a respectable activity, comparable to similar processes and developments in other sciences. Clear examples can be found in physics, where initially qualitative characteristics were followed by very satisfactory quantitative measurements. In the theory of heat qualifications such as hot, warm, lukewarm, and cold were replaced by temperature. In the theory of light qualitative characteristics such as red, orange, yellow, green, blue, and purple were replaced by wave lengths. In the theory of sound and music also wave lengths became the quantitative characteristics of low and high sounds.

2. Components of welfare or satisfaction

Feelings of satisfaction, called happiness by Levy and Guttman, clearly can be described more carefully by a subdivision into many categories or components of such feelings. This may first be illustrated by some examples only. There are purely individual feelings such as being hungry or cold which may be affected by eating (consumption of food) or heating (use of more fuel by the heating system). These examples may be called *materialist*, in contrast with *mental* or *spiritual* satisfaction attained by listening to music or looking at paintings. These examples show how many components contribute to human satisfaction. If more precision is aimed at, it is important to establish a list of them and to express, by subdivision of that list, whether categories and subcategories can be distinguished.

In my 1985 note [Tinbergen (1985b)] I already argued that satisfaction is not only derived from *consumption* (as suggested by the work of the American and British group), but also from *learning* and from *productive activities*. In my 1987 note I present some extremely simple examples of how satisfaction from working and from schooling may depend on other variables. I did not add any new measurement research but only mentioned some possible sources of data.

In the present essay I am not going to add new research results either, but two contributions to its elaboration. First, I think there still is another main category of components of welfare, namely the welfare derived from *international security*. This category has become very important as a consequence of the development of military technology, in particular (but not only) nuclear weapons (Alfvén rightly prefers the word 'annihilators'). The impact of these recently developed annihilators on human welfare is so strong that the size of their stocks and of their production can no longer be disregarded by economists.

My second contribution will be an attempt at categorizing in more detail the components of welfare. Categorization requires two checks on its acceptability. The welfare of components must result in *total* welfare and *no duplication* or overlapping of components must occur. The satisfaction we discuss is satisfaction of needs. If we categorize needs into *individual* and *social* needs, social needs stands for all nonindividual needs. If individual needs refer to needs only of the individual considered and we split off food needs, the other components must add up to all nonfood individual needs, and so on.

In table 1 more than fifty components are proposed. So far only a small number of them have been measured, but the methods used by Van Praag and his collaborators as well as by Levy and Guttman, and public opinion polls, show how most of the components may indeed be measured. This list is *submitted for discussion*. It is possible that some categories are disregarded,

Table 1

Components of satisfaction from consumption needs, formal learning, productive activity, leisure, and security.

I. *Consumption needs*

I.A. Individual consumption needs, material
- I.A.1. Not being hungry (food)
- 2. Not being thirsty (drinks)
- 3. Not being cold (clothing, heating)
- 4. Physical exercise (walking, swimming)
- 5. Other health components

I.B. Individual consumption needs, spiritual
- I.B.1. Faith
- 2. Music
- 3. Other arts
- 4. Curiosity for facts, nearby
- 5. Curiosity for facts, far away
- 6. Curiosity for other knowledge
- 7. Curiosity for understanding

I.C. Relations to other individuals (social)
- I.C.1. To partner, sexual happiness
- 2. To partner, other happiness
- 3. To other family members
- 4. To other relatives
- 5. To other friends (or foes)
- 6. To job colleagues (solidarity)
- 7. To job assistants (responsibility)
- 8. To job relations (participation)
- 9. To other countrymen (justice, freedom, patriotism)
- 10. To other individuals (personal security)

II. *Formal learning*

II.1–10 Consecutive years of obligatory schooling
II.11 etc. Consecutive years of voluntary schooling

III. *Productive activity*

- III.1. Difference between required and actual schooling
- 2. Difference between required and actual degree of leadership
- 3. Difference between required and actual other qualities
- 4. Learning on job
- 5. Creativity
- 6. Pride on performance

IV. *Leisure*

- IV.1. Hobbies
- 2. Holidays

V. *Security* (national)

- V.1. Arms stock of nation, nonnuclear, defensive
- 2. Arms stock of nation, nonnuclear, offensive
- 3. Arms stock of nation, nuclear, defensive
- 4. Arms stock of nation, nuclear, offensive
- 5–8. Arms stock of allies (4 types)
- 9–12. Arms stock of potential opponents (4 types)
- 13. Nonmilitary instruments of international security

even if they clearly have an impact on welfare (utility, satisfaction, or happiness), because they cannot be affected by socio-economic policy. They may be relevant to other policies or to the activities of others than politicians (for instance, psychiatrists or other medical experts).

3. The concept of (inter)national security

Security is a state of mind with regard to one's country in relation to other nations and it refers to all future.

A first implication is that the many time units (for instance years) into which the future can be subdivided may have a different weight in the security concept. A simpler concept may contain a few, possibly large, time units only, whereas a more precise concept may contain more, possibly smaller, time units.

A second implication is that the impact of determinants is not certain, but can only have some probability.

The relation to other nations mainly refers to the country's *sovereignty*, that is, that its government mainly depends on the preferences of its own citizens. Sovereignty need not only exist with respect to all the country's activities; the country may be a member of an alliance and voluntarily subscribe to the objectives of such an alliance.

The preceding statements lead to a definition of security as a person's estimate of the *probability of her or his country's sovereignty in the coming decade*. This, then, is the simplest version and attempts at measuring security may be interviews among a sample of citizens. During the interview questions may be raised by the interviewee that suggest refinements. One type of refinement was mentioned before: estimating the probability of sovereignty for two successive decades or five successive five-year periods.

Other more complicated versions may be derived from more precise definitions of sovereignty such as sovereignty in polluting the atmosphere or the rivers. Interviews may be extended to asking what types of sovereignty are anticipated by the interviewee to be reduced within the framework of European integration, or of new treaties to be concluded with the Warsaw Pact nations.

A clear distinction must be kept in mind between what we so far defined as components or determinants of security and another concept to be called means or instruments of a security policy. The latter are other variables appearing in a model of some economies which can be deliberately applied by a government to change security. These instruments may be military instruments, such as stocks of weapons of various kinds or nonmilitary instruments such as the supply of grain by the United States to the Soviet Union, or the supply of high tech goods for peaceful ends. The discussion of these instruments or means belongs to the construction of a model, for

instance in order to identify an optimal policy. This is not part of the subject of this paper.

References

Allais, M., 1984, Determination of cardinal utility according to an intrinsic invariant model, Excerpt from: Recent developments in the foundations of utility and risk theory (D. Reidel Publishing Co., Dordrecht (Netherlands)).

Christensen, L.R., D.W. Jorgenson, and L.J. Lau, 1975, Transcendental logarithmic utility functions, American Economic Review 65, 367–383.

Jorgenson, D.W. and D.T. Slesnick, 1983, Inequality in the distribution of individual welfare, Discussion paper no. 987, June (Harvard Institute of Economic Research, Cambridge, MA).

Jorgenson, D.W. and D.T. Slesnick, 1986, The measurement of social welfare, Discussion paper no. 1226, April (Harvard Institute of Economic Research, Cambridge, MA).

Jorgenson, D.W., L.J. Lau, and T.M. Stoker, 1980, Welfare comparison under exact aggregation, American Economic Review 70, 268–272.

Levy, S. and L. Guttman, 1975, On the multivariate structure of well-being, Social Indicators Research 2, 361–388.

Tinbergen, J., 1985a, Production, income and welfare (Wheatsheaf Books, Brighton).

Tinbergen, J., 1985b, Measurability of utility (or welfare), De Economist 133, 411–414.

Tinbergen, J., 1987, Measuring welfare of productive consumers, De Economist 135, 231–236.

Van Herwaarden, F. and A. Kapteyn, 1981, Empirical comparison of the shape of welfare functions, European Economic Review 15, 261–286.

Van Praag, B.M.S., 1971, The welfare function of income in Belgium: An empirical investigation, European Economic Review 2, 337–369.

Van Praag, B.M.S. and A. Kapteyn, 1973, Further evidence on the individual welfare function of income: An empirical investigation in the Netherlands, European Economic Review 4, 33–62.