

The Royal Swedish Academy of Sciences has decided to award the

**1998 Bank of Sweden Prize in Economic Sciences
in Memory of Alfred Nobel**

to Professor **Amartya Sen**, Trinity College, Cambridge, U.K.

for his contributions to welfare economics.

Collective decisions are made in every society. They reflect different forms and degrees of democracy and equality, while contributing to a more or less even distribution of a society's welfare. An inquiry into collective decisions—and social choice in general—raises a number of fundamental questions: Is there a fair and theoretically sound way of aggregating individual preferences into values for society as a whole? Does the majority principle work in practice? How should the results of collective decisions be measured and evaluated? What kinds of decisions are consistent with different schools of moral philosophy? A systematic analysis of issues such as these is precisely what concerns the theory of social choice. It examines fundamental problems related to the design of decision rules in a democratic society. The theory also has important applications: How should income inequality be measured in a society? Can the distribution of welfare be compared among different societies? What determines whether or not poverty has been mitigated?

By answering such questions, Amartya Sen has made extensive contributions to the development and application of social choice theory. His work has been a source of inspiration to many other researchers. He has also been highly instrumental in restoring an ethical dimension to economics and related disciplines. Some of Sen's studies have initiated a new and rewarding

scientific approach; in other instances he has elaborated on established fields of research. His contributions range from purely axiomatic theory of social choice, over analysis and definition of welfare indexes, to empirical studies of famine.

Despite its breadth, Sen's scholarly production is well integrated. His analysis of welfare indexes is closely linked to his contributions to the theory of social choice, while his empirical studies are based on the ideas he developed in his work on welfare measurement. Different aspects of the distribution problem are almost always at the forefront. Many of Sen's analyses focus on poverty. In particular, his empirical studies in development economics have enhanced our understanding of the mechanisms underlying famine.

Until recently, Amartya Sen held professorships in both economics and philosophy at Harvard University. As of 1998, he is Master at Trinity College in Cambridge, England. He was born in Bengal, India in 1933. After completing his early academic education in India, he continued his studies in Cambridge, England and received his doctorate there in 1959. Sen has been professor at the University of Delhi, 1963-71, the London School of Economics, 1971-77, All Souls College in Oxford, 1977-88 and Harvard University, 1989-97. He has been awarded some 20 honorary doctorates and has presided over leading scientific associations, such as the American Economic Association, the Econometric Society and the International Economic Association. His scholarly publications include a dozen books and approximately 200 articles in scientific journals. Some of his work belongs solely to the economics sphere, although a significant share combines economics

and philosophy. Sen has also been a frequent participant in the economic policy debate, particularly regarding the problems of developing countries, population and related issues.

The theory of social choice and Sen's contributions to it are described in Section 1 below. Section 2 addresses Sen's work in welfare measurement and some of the welfare indexes he has proposed. Sen's studies in development economics, particularly his empirical analyses of famine, are outlined in Section 3. A summary is offered in Section 4.

1 The Theory of Social Choice

Social choice theory analyzes the relation between individual preferences and collective decisions. Fundamental issues are whether various decisions in society respect individual preferences and whether different social states can be ranked fairly, or evaluated in some other way. When there is general agreement, the choices made by society are usually uncontroversial; the challenge arises when different interests have to be aggregated into decisions which affect everyone.¹

Majority rule is probably the most common method of making collective decisions in a democracy. A long time ago, this rule was found to have deficiencies, in addition to the fact that it may allow a majority to suppress a minority. In some situations, so-called intransitivities arise under pair-wise voting; that is, a majority may prefer alternative x to another alternative y ,

¹That even unanimity can come into conflict with individual rights is pointed out in Sen (1970b).

whereas a (second) majority prefers y to a third alternative z ; meanwhile, a (third) majority prefers z to x . In other situations, it may pay off for individuals to vote strategically; that is, not always vote for their own best alternative. These types of problems motivated economics laureate Kenneth Arrow to undertake a systematic study of potential rules for aggregating individual preferences into preferences for society as a whole, in an attempt to find workable mechanisms for collective decision-making. Majority rule is then only one of many possible alternatives.

Arrow's approach provides a logically stringent framework—which became generally accepted among economists—for analyzing the ways in which individual preferences can be aggregated. The formal model for collective decisions is derived from a set N of individuals i , each of whom has preferences R_i over a set X of social *alternatives*, or *states*. One writes xR_iy whenever individual i weakly prefers alternative x to alternative y , allowing for indifference between the two alternatives. Formally, an individual's preferences R_i thus constitute a binary relation on the set X .

The social choice problem is to find an *aggregation rule*, or *decision rule*, f , that assigns a preference relation R over X for any collection of individual preferences R_i over X

$$R = f(R_1, R_2, \dots).$$

The resulting preferences R are interpreted as *social preferences* over the states in X .

Such aggregation can be performed in many different ways, depending on requirements imposed, both on the resulting social preferences and on the aggregation rule itself. The point of reference for such analyses is Ar-

row's (1951) impossibility theorem. This theorem states that, if the set N of individuals is finite, and the set X is finite and contains at least three alternatives, then there exists no aggregation rule f that fulfills the following five conditions (axioms):

A1: The resulting social preferences R over X are transitive and complete.

A2: The resulting social preferences R are compatible with the Pareto criterion.

A3: The resulting social preferences over any two alternatives are independent of the individual preferences over all other alternatives.

A4: The aggregation rule f is nondictatorial.

A5: The aggregation rule f is defined for all individual preferences over X that are complete and transitive.

According to conditions *A1* and *A5*, social or individual preferences are *complete* if, for any pair of alternatives x and y , either x is weakly preferred to y or y is weakly preferred to x (or both). Such preferences are *transitive* if alternative z is weakly preferred to alternative x whenever z is weakly preferred to some alternative y that itself is weakly preferred to x ; imposing condition *A1* thus rules out situations as the intransitivity of majority rule described above. *The Pareto criterion* ranks one alternative x (weakly) above another alternative y if all individuals (weakly) prefer x to y . As regards the *independence* condition *A3*: if $R = f(R_1, R_2, \dots)$ prefers x to y , then so does $R' = f(R'_1, R'_2, \dots)$, for any individual preferences R'_i that agree with R_i

concerning alternatives x and y ; that is, a social ranking of x above y obtained from f is unaffected if individuals change their preferences but retain their ranking between x and y . An aggregation rule f is *nondictatorial* if there is no individual i such that xRy whenever xR_iy ; that is, no individual always decides the preferences of society.

Arrow's surprising and fundamental result indicated severe limitations on the outcomes that can be achieved through collective decision-making. The result seemed to be an insurmountable obstacle to progress in the normative branch of economics for two decades. How could individual preferences be aggregated into collective decisions, and how could different social states be evaluated and compared in a satisfactory way? In the late 1960s, Sen's research initiated a new outlook on social choice theory. He continued to make vital contributions in the 1970s and 1980s. In some instances, Sen opened up new fields of research; in others, he elaborated on existing theory. His monograph *Collective Choice and Social Welfare* (1970a) had a far-reaching impact and inspired many researchers to renew their interest in basic welfare issues. The style of the book, interspersing formally and philosophically oriented chapters, provided a new dimension for the economic analysis of normative problems.

1.1 Possible Solutions to the Social Choice Problem

Arrow's theorem demonstrates that no collective decision rule can fulfill all five conditions simultaneously. But there are decision rules which fulfill any four of the five conditions. For instance, pair-wise majority voting defines an aggregation rule f that satisfies conditions *A2-A5*. However, as indicated

above, the resulting social preferences need not be transitive (*A1* is violated).

One way of achieving consistency is to reduce the domain of the decision rule, i.e., by not allowing all transitive and complete individual preference relations as in condition *A5*. A well-known restriction on individual preferences is to allow only so-called single-peaked preferences (Black, 1948).² In his article, “A Possibility Theorem on Majority Decisions”, Sen (1966; also Chapter 10 in *Collective Choice and Social Welfare*) introduced a condition on individual preferences, so-called *value restriction*. This condition encompassed all of the conditions, including single-peakedness, previously proposed in the literature to ensure that majority rule will be transitive under pair-wise voting (cf. Footnote 2). In principle, value restriction implies that for every set of three alternatives, either all individuals agree that one of the alternatives is not best, or that it is not second best, or that it is not worst. Later on, in collaboration with Prasanta Pattanaik, Sen found necessary and sufficient conditions for ensuring that decisions can always be made under majority rule; see Pattanaik and Sen (1969).

Instead of limiting the domain of the aggregation rule, existence of such a rule can be achieved by reducing the requirements on the resulting social preferences. Under axiom *A1*, these preferences are required to be complete and transitive. But in order to make collective decisions in a finite set

²A preference relation R in a set X of alternatives is *single-peaked* if X is an ordered set, with ordering \leq , and there is a best alternative x^* , according to R , such that xRy if $y \leq x \leq x^*$ or $x^* \leq x \leq y$. The implications of single-peakedness for pair-wise majority voting were first studied by Black (1948). In order to eliminate the possibility of intransitivity under majority rule, Inada (1964) identified two conditions other than single-peakedness, while Ward (1965) generalized Black’s conditions.

X of alternatives, the requirement of transitivity can be reduced to quasi-transitivity. If condition $A1$ is modified so that it allows quasi-transitivity, it becomes consistent with the other conditions (A2-A5).³ This result may be found in Sen (1969) and in Chapter 5 of *Collective Choice and Social Welfare* (1970a).

1.2 A Sphere of Individual Rights

If the independence axiom $A3$ is omitted, there are again aggregation rules which fulfill the remaining conditions. In this class of rules, Sen examined the scope for nondictatorial aggregation rules by replacing axiom $A4$ with the following requirement on individual rights:⁴

$A4'$: There exist at least two individuals, i and j , and two pairs of alternatives, (x_i, y_i) and (x_j, y_j) , such that individual i (j) always decides the social ranking between x_i and y_i (between x_j and y_j).

This condition implies $A4$, since it requires that each of at least two individuals alone decide what should be preferred for society as a whole in at least some dimension of choice. Obviously, this requirement of individual rights represents only one of many possible ways of strengthening the nondictatorial condition, although it may be regarded as an absolute minimum of individual rights. If there are two individuals in an economy, each of whom

³Preferences are *quasi-transitive* if alternative z is strictly preferred to alternative x whenever z is strictly preferred to some alternative y that is strictly preferred to x . The strict preference ordering P induced by a weak preference ordering R is defined by xPy if xRy and not yRx .

⁴Sen referred to condition $A4'$ as “minimal liberalism.”

owns something, then the condition is fulfilled according to every reasonable definition of property rights. Sen (1970b) showed that the set of possible decision-making rules is still empty when the independence axiom $A3$ has been dropped, and the nondictatorial condition $A4$ has been replaced by $A4'$.

In an ethical context, Sen's result demonstrates the difficulty in finding decision rules that fulfill apparently reasonable requirements in a democracy committed to combining individual influence in the decision-making process with efficiency and respect for individual rights. His contribution initiated a scientific analysis among both economists and philosophers; the issue was whether the requirement of an individual sphere of rights can be consistent with a collective decision rule. Much of this analysis has relied on the significance of the prerequisites for individual rights ($A4'$) as compared to the requirement of compatibility with the Pareto criterion ($A2$); other possibilities for achieving consistency have also been discussed. Sen's analysis has generated a literature in economic theory, e.g. Gibbard (1974) and Suzumura (1978), as well as a philosophical analysis of rights, e.g. Nozick (1974) and Dworkin (1978).

1.3 Invariance Analysis

Many applications are severely limited by adopting the five axioms in Arrow's impossibility theorem. If social preferences are to serve as a basis for evaluating the distribution of welfare in society, the five axioms produce a stalemate. Indeed, it is assumed in $A5$ that individuals can only rank alternatives, without any comparability among different individuals, i.e., no type

of cardinal information is used and all types of interpersonal comparisons of welfare are excluded. This condition admittedly allows for very general individual preferences and avoids the difficult question of whether different individuals' evaluations of social states can really be compared. But the condition also precludes saying anything worthwhile about inequality. In order to make any progress on this issue, the generality of the assumption about individual preferences has to be relaxed in some reasonable way.

Is more information about individual utility scales compatible with the existence of a collective decision rule and nondictatorial social preferences? Sen introduced his analysis of this question in Chapters 7-8 of *Collective Choice and Social Welfare* and Sen (1970c). He thereby initiated a new direction for the analysis of social choice, where conceivable social preferences—and existing ethical principles—were characterized precisely in terms of both the information contained in individual utility scales and the potential for interpersonal comparisons of utility. A *utility function* u_i for an individual i with preferences R_i over the set X of social states is a real-valued function defined on X such that $u_i(x) \geq u_i(y)$ if and only if xR_iy , i.e., the utility level in state x is at least as high as in state y if and only if individual i weakly prefers x to y . Based on such individual utility functions one can define utilitarian social preferences R , by comparing the sums of individual utility in the different social states:

$$xRy \quad \text{if and only if} \quad \sum_i u_i(x) \geq \sum_i u_i(y) .$$

Clearly this utilitarian principle defines transitive and complete social preferences R over X . These preferences are also Pareto compatible, fulfill the independence condition, and imply a nondictatorial rule. In other words, ax-

ioms $A1-A4$ are met. In contrast to the analysis described earlier, however, it is now presumed that a particular individual utility function u_i can be used for each individual i . But there are infinitely many utility functions u_i all of which represent each preference relation R_i . If $g_i : \mathbb{R} \rightarrow \mathbb{R}$ is a strictly increasing function, then the composition $v_i(x) = (g_i \circ u_i)(x) = g_i(u_i(x))$ also defines a utility function for the same individual preferences R_i . Such a change in the utility scale may change the utilitarian social preferences R given above. Axiom $A5$ is no longer met, since it requires that social preferences R be a function of individual preferences R_i only. By contrast, the above utilitarian social preferences presume that individual *utility differences* are interpersonally comparable: for any pair of social states x and y , we need to compare one individual's utility gain $u_i(x) - u_i(y)$ with another individual's utility loss, $u_j(x) - u_j(y)$.

According to Rawls' (1971) well-known principle, two social states should be compared only with reference to the individual who is worst off in each state:

$$xRy \quad \text{if and only if} \quad \min_i u_i(x) \geq \min_i u_i(y) .$$

This obviously requires individual *utility levels* to be interpersonally comparable.

The approach, where different assumptions about information and comparability are fully analyzed using different types of so-called invariance axioms, may be described formally as follows. It is required that

$$R = f(u_1, u_2, \dots) = f(g_1 \circ u_1, g_2 \circ u_2, \dots)$$

for a suitable class of strictly increasing functions, $g_i : \mathbb{R} \rightarrow \mathbb{R}$. These trans-

formations reflect the information about, and interpersonal comparability of, individual utilities in a given situation. Under condition *A5*, where individual utilities are ordinal and not interpersonally comparable, the second equality above is required to hold for all strictly increasing real functions g_i . Interpersonally comparable ordinal utility scales require all g_i to be equal—the prerequisite for applying Rawls’ maximin principle. Utilitarianism with cardinal utilities and interpersonally comparable differences in utility can be expressed as the requirement that g_i can only take the form $g_i(t) = a_i + bt$, where a_i, b and t are real numbers, and b is positive.

A possible change in Arrow’s conditions would be to use cardinal—instead of only ordinal—information in individual preferences, i.e., let g_i take the form $g_i(t) = a_i + b_i t$, where a_i, b_i and t are real numbers, and b_i is positive. Sen showed that this limitation on the domain of the decision rule does not eliminate the inconsistency between conditions. This new impossibility theorem is found in Chapter 8 of *Collective Choice and Social Welfare*.

Sen (1970c) does not a priori presuppose interpersonal comparability of differences in utility. However, he does ask whether the possibility of generating more or less complete social preferences depends on the degree of interpersonal comparability. Two extremes are noncomparability (g_i arbitrary, strictly increasing functions) or full comparability (g_i of the form $g_i(t) = a + bt$). Sen analyzes the consequences of these two extremes as well as a number of possibilities in-between. Noncomparability leads to social preferences given by the Pareto criterion, whereas full comparability leads to complete social preferences given by the utilitarian criterion.

The invariance analysis that Sen introduced has turned out to be highly

useful in the theory of social choice. The theory now provides many axiomatic characterizations of social preferences, with respect to available information on individual utilities. Arrow's axioms *A1-A3* and *A5* imply that social preferences have to be identical with those of one individual in the economy. However, if condition *A5* is modified by replacing ordinal, interpersonally noncomparable individual preferences with ordinal, interpersonally comparable preferences, the class of possible social preferences is extended. It will then consist of all social preferences which coincide with the individual preferences of the individual i_p who has the p^{th} highest utility in every utility profile $(u_1(x), u_2(x), \dots)$, where p is an arbitrary but predetermined number. If $p = n$, the number of individuals, then Rawls' maximin principle is obtained. If $p = n/2$, the median voter's preferences will determine the outcome. The class of possible social preferences is extended further when more information about, and comparability between, individual utility scales is used.⁵

2 Indexes of Welfare and Inequality

The construction of theoretically sound indexes to measure differences in income and welfare in society is an important application of the theory of social choice. In fact, there is an equivalence between inequality indexes and a certain class of social welfare functions (which represent social preferences). A specific index can be evaluated on the basis of those axioms—and

⁵A large number of researchers have later contributed important results. See, for example, Blackorby (1975), Fine (1975), Hammond (1976,1977), Gevers (1976), Deschamps and Gevers (1978), Maskin (1978), and Roberts (1980a,b).

the invariance axiom in particular—which characterize corresponding social preferences.

In order for social preferences, R , to be fully represented by a social welfare function, w , condition $A1$ has to be fulfilled, i.e., the preferences have to be transitive and complete. Formally, social preferences R over X are represented by a social welfare function w , whenever for all $x, y \in X$, xRy exactly when $w(x) \geq w(y)$. When aggregating individual preferences into a social welfare function for measuring differences in welfare, it seems self-evident to require Pareto compatibility ($A2$), independence ($A3$) and nondictatorship ($A4$).

This leaves only $A5$ to be modified. The invariance analysis introduced by Sen deals explicitly with the consequences of alternative information and comparability axioms and thus offers a natural systematization. When condition $A5$ is weakened, while retaining $A1$ - $A4$, a large class of collective decision rules and corresponding social preferences can be used to construct welfare indexes. Axioms regarding distribution can then be formulated within this class. For instance, $A1$ - $A4$ are fulfilled by preferences defined according to

$$xRy \quad \text{if and only if} \quad \sum_i u_i^q(x) \geq \sum_i u_i^q(y) ,$$

where all utility values are nonnegative and the power q is positive. Condition $A5$ does not hold, however, although the preferences are invariant to proportional changes in a common utility scale; i.e., it does not matter whether utility is measured in dollars, cents or pounds.⁶ For every value of

⁶In the notation of Section 1, the requirement is that each function g_i should be of the form $g_i(t) = bt$ for some $b > 0$.

the parameter q , social preferences are obtained which can be used as welfare indicators. If the objective is to take distributional requirements into account, for example that the welfare of society should increase by a transfer from the "richer" to the "poorer", then q has to be less than one ($q = 1$ gives utilitarian preferences).

Welfare indicators are often expressed as a comprehensive index rather than as a social welfare function. The relation is as follows. Assume that there are n individuals, and that society's preferences R over X are represented by a welfare function $W(u_1(x), \dots, u_n(x))$. An inequality index J corresponding to R can be defined according to

$$J(u_1(x), \dots, u_n(x)) = \frac{e(u_1(x), \dots, u_n(x))}{\hat{u}(x)},$$

where $\hat{u}(x) = \sum_i u_i(x)/n$ is the average individual utility level in the economy and $e(u_1(x), \dots, u_n(x))$ is the utility level which, if it were the utility level of all individuals, would yield the same welfare level $W(u_1(x), \dots, u_n(x))$ as the original utility profile. Conversely, for a given value of the index J , the above equation can be used to "back out" the corresponding welfare value $e(u_1(x), \dots, u_n(x))$, thereby constructing social preferences from an inequality index.

The precursors in the theoretical development of inequality indexes were Kolm (1969), Atkinson (1970) and Sen (1973). To examine the theory, let y denote the income distribution, where y_i is the income of individual i , and let $L_y : [0, 1] \rightarrow [0, 1]$ be the associated *Lorenz curve*, i.e., for any t between zero and one, $L_y(t)$ is the share of total income, $\sum y_i$, attributed to the share of size t of the population that has the lowest incomes. Then $L_y(t)$ is never higher than t , with equality only if all individuals have the same income.

The Lorenz curve is related to the preferences of society in Atkinson (1970) and Dasgupta, Sen and Starrett (1973). The latter derived the following important result: Let $u_i(y_i)$ be the utility that individual i obtains when his or her income is y_i , and let $w(y_1, \dots, y_n)$ denote the associated social welfare level, $W(u_1(y_1), \dots, u_n(y_1))$. If the Lorenz curve for some income distribution y in all income intervals lies above the Lorenz curve for another distribution y' , then y is preferable to y' according to a large class of social welfare functions (and vice versa). The class of social welfare functions in question refers to those for which the corresponding function w is so-called S-concave.⁷ More exactly: If y and y' are income distributions with the same total income, $\sum_i y_i = \sum_i y'_i$, then $L_y(t) \leq L_{y'}(t)$ for all t if and only if $w(y_1, \dots, y_n) \leq w(y'_1, \dots, y'_n)$ for all S-concave functions w .

As poverty indexes can be regarded as a special class of inequality indexes, they can also be derived from axioms concerning social preferences. Since data on individual welfare in poor countries can be more or less uncertain, informational assumptions are crucial in determining the degree to which distributions in different countries can be compared.

A common poverty index is constructed by computing the share of the population H whose incomes are below an exogenously given poverty line. But the theoretical basis for such an index is unclear. Moreover, the measure ignores the distribution of income among the poor. In order to eliminate this

⁷The function w is *S-concave* if $w(y) \leq w(By)$ for all income vectors $y = (y_1, \dots, y_n)$ and doubly stochastic matrixes B , i.e., matrixes with non-negative entries and with all row and column sums equal to one.

drawback, Sen (1976b) derived the poverty index

$$P = [I + (1 - I)G] H ,$$

where G is the Gini coefficient (measuring the degree of income inequality) and I is a measure (between 0 and 1) of the distribution of income, both computed for the share of the population below the poverty line.⁸ In his analysis, Sen refers to the informational assumptions and the invariance analysis outlined above. This enabled him to point out the practical circumstances under which the poverty index and even the Gini coefficient can and should be applied.

Sen's poverty index P has been used in numerous applications.⁹ Even those in favor of alternative poverty indices have often based their arguments on Sen's analysis. When deriving his index, Sen postulated five axioms. Three of them have been used by most other researchers, who have subsequently proposed alternative poverty indexes.

Another example of this research orientation is Sen's article entitled "Real National Income" (1976c). Here, he again uses an axiomatic approach to analyze the foundations of the concept of national income and the potential for using it in relevant comparisons among different countries. His objective is to clarify the extent to which distributional indicators can be incorporated into the concept of national income. The specific alternative proposed in

⁸More precisely, $I = \frac{1}{qx^o} (\sum_{i \in F} z_i)$, where x^o is the income that defines the poverty line, F is the group of individuals whose income falls below the poverty line, q is the number of individuals in this category, and $z_i = x^o - x$ is the difference between the poverty line and i 's income.

⁹See, for example, the references in Sen (1982, pp. 33-34).

this article for making comparisons among countries is to use the measure $(1 - G)y$, where y is income per capita and G the Gini coefficient.

Sen's analyses of the possibilities of formulating a welfare index which can be used in interpersonal comparisons have received considerable attention. The need for this type of index is obvious, particularly in the context of justice. Rawls' maximin principle, for example, is contingent on whether or not the prerequisite of interpersonal comparability is fulfilled. Arrow's impossibility theorem is "solved" if interpersonal comparisons of utility can be carried out. In his monograph, *Commodities and Capabilities* (1985), Sen emphasized that what creates welfare is not goods as such, but the activity for which they are acquired. This idea is reminiscent of the so-called Lancaster approach, where goods are defined as multidimensional objects in terms of their characteristics. The similarity to Lancaster's ideas is only formal, however. According to Sen, goods create "functional opportunities" for individuals; the set of such functional opportunities can then be used to define an individual's actual opportunities—or "capabilities".

In accordance with this view, income is significant because of the opportunities it creates. But actual opportunities also depend on a number of other factors, such as health; these factors should also be taken into account when measuring welfare. Alternative welfare indicators, such as the UN's *Human Development Index*, are constructed precisely in this spirit.

Sen's concept of fairness presupposes that actual opportunities should be as equal as possible for all individuals; greater resources should be allotted to individuals who, for one reason or another, require them in order to achieve the same capability. This resembles the (egalitarian) view held by Rawls, who

wanted to maximize the welfare of the worst off in society. Obviously, such a criterion cannot be applied in practice without an interpersonally comparable welfare index. Rawls (1971) mentions an index of “primary goods”, but does not offer any suggestions for solving the index problem. Sen’s work, however, provides guidelines for dealing with these matters.

3 Development Economics

The contributions of Amartya Sen described so far belong to the realm of theory and analytical methods—even if his formulations of welfare indexes do have direct applications. But Sen has also done applied research, primarily in development economics. In fact, almost all of Sen’s works are devoted to development economics, as they are often concerned with the welfare of the poorest people in society. In his very first articles, written in the late 1950s and early 1960s, he analyzed the choice of appropriate production technology in developing countries.

Later on, Sen carried out empirical studies emanating from his theoretical results on social choice and welfare measurement. This work is reported in a number of books and essays. Perhaps his best-known empirical study is *Poverty and Famines: An Essay on Entitlement and Deprivation* (1981). Here, the primary objective was to understand the background and causes of famine. This book was followed by discussions of ways to prevent famine, or limit its effects once it has occurred. These considerations are summarized in a book coauthored with Jean Drèze; see Drèze and Sen (1989).

In *Poverty and Famines*, Sen challenges the common view that a drastic

decline in the supply of food is necessarily the most significant explanation for famine. But he does not claim to be the first to perceive that numerous other factors can cause famine in large groups of a population; nor does he maintain that a shortage of food cannot trigger famine. According to Sen, the conception which prevailed when the book was published, known as FAD (food availability decline), cannot explain phenomena observed during many famines, such as: (i) famine has occurred in years when the supply of food per capita was not lower than during previous years without famine; (ii) food prices increased considerably in some years, although the supply of food was not lower as compared to previous years; (iii) in all cases of famine, large groups have not suffered starvation; and (iv) in some case, food has been exported from famine-stricken areas.

Sen shows that a profound understanding of famine has to be based on the factors which affect the actual opportunities of different groups in society. Starvation occurs when the actual opportunities available to groups of people do not include sufficient access to food, and there are many social and economic factors which limit such opportunities. For example, part of his explanation for the Bangladesh famine of 1974 is that flooding throughout the country that year significantly raised food prices, while the work opportunities for agricultural workers declined drastically as one of the crops could not be harvested. Due to these factors, the real incomes of agricultural workers declined so much that this group was disproportionately stricken by starvation.

In *Poverty and Famine*, Sen established a new approach to the problems of starvation and famine. There is general agreement as to the outstanding

significance of the book, even though some of its details have been disputed. A few critics have questioned the empirical foundations for Sen's results regarding the causes of famine. Indeed, data on food supply in a developing country stricken by famine are notorious for causing measurement problems. But such criticism nevertheless seems misdirected. In particular, Sen's insights into the causes of famine are highly valuable, regardless of whether some of the empirical results might be unreliable.

Poverty and Famine examines extremely important problems and is undoubtedly a key contribution to development economics. With its emphasis on distributional issues, poverty and starvation, the book reflects the recurring theme in Amartya Sen's research.

4 Summary

Amartya Sen has made several key contributions to the research on fundamental problems in welfare economics. His contributions range from purely axiomatic theory, over definitions of welfare indices, to empirical studies of famine. They are unified by a general interest in distributional issues and a particular interest in the most impoverished members of society. Sen has clarified the conditions which permit aggregation of individual preferences into collective decisions, as well as the conditions which permit rules for social choice to be consistent with a sphere of individual rights. He has also analyzed the importance of available information about different individuals' welfare in collective decision-making. Thereby he has improved the theoretical foundations for comparing different distributions of welfare in society and

defined new, more satisfactory poverty indexes. In empirical studies, Sen's applications of his theoretical approach have enhanced our understanding of the economic mechanisms underlying starvation and poverty.

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