1. Introduction

1.1 WELFARE; ORGANIZATION OF THE BOOK

In this chapter the main concepts, some of their relevant features and a survey of the models to be developed will be dealt with. In addition, some pioneers in our subject – individuals as well as institutions – and the main data sources will be listed. This is comparable to the list of *dramatis personae* of a play.

The central concept of economic science is welfare. We shall consider the terms 'satisfaction' or 'utility' as identical to welfare. Human beings, individually and in groups, aim at maximizing their welfare within the set of restrictions imposed on them. Restrictions are imposed on them by nature as well as by man-made institutions. Natural restrictions may be the natural environment (for example climate) as well as the personal characteristics of an individual (her or his needs and capabilities). Restrictions by man-made institutions are the individual's rights and duties (for example, old-age pension and payment of taxes or bus fares). Welfare and restrictions both show a large number of components. Welfare has many determinants such as food, clothing and satisfaction from or irritation by work. Restrictions are numerous since human nature, as well as modern society, is complicated.

In macro-economic models the complicated character of both welfare and the restrictions is almost hidden by the use of complicated macro-economic concepts for welfare's determinants (for instance, total consumer expenditure) and for restrictions (for instance, national income plus foreign assistance as the restriction on all expenditures). In Sections 1.4 to 1.6 inclusive welfare functions will be specified, that is, how welfare depends on its determinants.

With their aid a number of different problems will be formulated which constitute aspects of the subject of this book. This subject may be briefly described as how to maximize world security and equity and was dealt with by Dietrich Fischer and the present author in our book *Warfare and Welfare* (Fischer and Tinbergen, 1987) in a non-mathematical way. As an illustration, only three models of a mathematical character were discussed, but the general argument was verbally presented. It is the purpose of the

present book to extend and, hopefully, to reinforce the foundations of the 1987 book by the discussion of a large number of models. A survey of these models will be given in Section 1.7. The formulation and treatment of the models constitutes the main part of the book, set out in Chapters 2 to 7. Chapter 8 brings together the main conclusions attained with the aid of the ten groups of models studied, most of them containing several alternative specifications. Section 1.8 of the present chapter (Appendix I) informs the reader on the history of world modelling. Section 1.9 (Appendix II) lists the sources of data.

1.2 SECURITY

In our 1987 book Professor Fischer and I argued that security policy affects welfare, the conventional objective of socio-economic policy, to such an extent that the two policies had better be integrated. This is particularly true as a consequence of the existence of nuclear weapons, but it can also be argued to be a consequence of what was called 'total war' in the Second World War and even of the tremendous human suffering already experienced in the First World War. The integration of security policy and conventional economic policy implied that the aim of such a generalized economic policy becomes 'welfare in security' or 'generalized welfare'.

The concept of security, we stated, is important in its own right, but on superficial inspection, underdeveloped nevertheless. Textbooks of international law such as Röling's (Röling, 1985) or the Report of the Palme Commission (Palme *et al.*, 1982, 1986) are not clear about its nature, and a generally accepted definition and a method to measure security does not yet exist. The attempt presented in this book does not reflect a generally accepted definition but just an attempt submitted. It weakly reflects some of Röling's suggestions. The empirical research suggested in *Warfare and Welfare* has not started yet. The approach followed in this book is that security's determinants or components are considered to be military expenditures and expenditures on some non-military goods, services or information. Both categories may be subdivided into numerous components, but the only subdivision made in this book is into defensive and offensive military expenditures. Examples of security-relevant non-military expenditures are supplies of grain or of high technology for peaceful uses. An important aspect of security expenditures is how decisions on them are made: by sovereign nations or in various forms of co-operation or co-ordination between sovereign nations.

1.3 OPTIMAL WELFARE IN SECURITY; SECURITY AND DEVELOPMENT AID; 'WORLDS' DISTINGUISHED; WORLD DECISION-MAKING STRUCTURE

The aim of the policies or of the political institutions to be discussed is 'optimal' welfare in security, that is, its maximum value possible within the framework of the restrictions imposed on the decision makers. Some possible restrictions were mentioned in Section 1.1. Aims have to be attained by using the means chosen by the decision makers. Means are phenomena controlled by the latter, such as the set of institutions of the socio-economic order. An essential difference exists between the Western world and the Eastern, communist-ruled world. Another terminology calls them market economies and centrally planned economies. Quantitative means, such as taxes or subsidies, will be called instruments. Military and non-military expenditures are examples already mentioned. Non-military expenditures for security aims may be called security assistance or aid, comparable with development aid as a policy instrument in development co-operation. Security assistance is an instrument used by countries of the First World (W1) in their relationship with the Second (communist-ruled) World (W2), whereas development assistance is used by Wl in its relation with the Third World (W3). In a large number of our models the world as a whole is subdivided in this highly 'macro' way. The world as a whole is also sometimes subdivided even more simply: W1 and W2 are considered 'developed', W3 'underdeveloped' (or 'developing'). An alternative subdivision is in 'market economies' (Wl + W3) and 'centrally planned' (W2). A clear case of doubt, to be discussed, is where China (with one quarter of the world population) has to be located. There are several more doubtful cases, such as Vietnam or Portugal. Whenever in a model the maximization of some variable (mostly welfare-in-security) or some other target is aimed at, a decision-making structure is implied that enables the policy makers concerned to implement that target. We shall call this aspect the 'world decision-making structure'. The structure at stake may be the existence of treaties between sovereign nations, by the existence of supranational authorities for a limited area (such as the European Community) or for the world at large. Its competence may cover a few or a large number of fields of activity, and so on.

This structure is dealt with extensively in Dietrich Fischer's and my book *Warfare and Welfare* (op. cit.). Here the emphasis is on the quantitative aspect of the decisions; and the decision-making structure is, as a

rule, implicitly related to the targets set and the values of the instrument variables found (if the value is nil, no decision-making institution is needed).

1.4 WELFARE FUNCTIONS; DIMINISHING MARGINAL UTILITY

To begin with, the analysis is made in the simplest way possible, that is, using the smallest number of actors necessary to deal with our problems. This requires at least one actor each for the First, Second and Third Worlds. Each of these actors' roles is based on his welfare-in-security, and is dealt with in the same way as individual actors in micro-economic theory. Later (Chapters 5 and 6), a larger number of actors, down to single nations, will be introduced.

Our assumption is that the welfare function characterizes the human race, and hence is the same for all human beings. It depends on human properties, such as intelligence, and therefore schooling, however. These act as parameters. For lack of data we neglect these aspects in the most macro chapters (1 to 4 inclusive). A better specification is offered in Section 6.3.

Welfare-in-security (or generalized welfare, or just utility, used as synonyms) is assumed to be measurable, following recent trends in economic science (cf. Tinbergen, 1985 and 1987). A functional relationship is assumed between utility ω and its determinants. Two main types of utility functions are used. Both satisfy the 'law of diminishing marginal utility'. If there is only one determinant, expenditure e, one type used is:

$$\omega = \ln (e + 1) \tag{1.41}$$

The corresponding marginal utility is

$$\frac{\partial \omega}{\partial e} = \frac{1}{e + 1} \tag{1.42}$$

and this is falling for rising values of e. For $e = 0$ utility, $\omega = 0$ and for rising values of e utility rises without any limit. Van Praag and his school opted for a lognormal utility function, which does not show diminishing marginal utility. Van Herwaarden and Kapteyn (1981) presented an empirical comparison of the shape of welfare functions and concluded that 'the logarithmic function performs slightly, though significantly, better' than

the lognormal and eleven other shapes. The determinant used by these authors is income. Our first determinant will be total expenditure on non-military goods and services, which is closely connected with income.

In the models in this book at least one more determinant will often be introduced, for instance, military expenditure a. Then it is assumed that welfare is:

$$\omega = \ln (y + 1) + \alpha \ln (a + 1) \tag{1.43}$$

where y is non-military spending and a is military expenditure. Evidently α is a measure of the relative preference for military expenditure.

1.5 SATIATION

The logarithmic utility function assumes that an increase in expenditure will always result in increased generalized welfare. It reflects the often-defended view that human needs have no limit. This is not correct in the case of the need for individual goods or services. It is common experience that such need shows satiation and even oversatiation. It is less clear whether this also applies to total expenditure, since the number of goods and services has increased without limit and is invented by technological research and sold with the aid of advertizing. For good reasons this imposition of the purchase of ever-increasing numbers of goods is sometimes described as the creation of 'artificial' needs. The limits of real, as compared with artificial, needs are unclear. As an ethical principle the assumption of satiation for total expenditures deserves support in a world where very many individuals suffer from too low incomes even to satisfy their basic needs. Therefore, we are going to study the consequences of utility functions showing satiation and oversatiation as an alternative to the utility functions mentioned in Section 1.4. This seems to make sense, in particular with regard to military expenditure: the existence of the tremendous overkill capacity of today's arsenals is a convincing argument in favour of this assumption. For general expenditure it seems not very realistic.

1.6 A PARABOLIC WELFARE FUNCTION

The simplest mathematical shape of a utility function that combines decreasing marginal utility with the existence of satiation and oversatiation is a parabolic utility function:

$$\omega = \omega_0 - \frac{\omega_0}{y_0^2}(y - y_0)^2 + \alpha\omega_0 - \frac{\alpha\omega_0}{a_0^2}(a - a_0)^2 \qquad (1.61)$$

In it two determinants have been assumed to occur: non-military (y) and military (a) expenditure. In the case of one determinant we have two parameters y_0 and ω_0 where y_0 is the value of y for which ω is a maximum and ω_0 the maximum value of ω. For $y > y_0$ utility decreases; so y_0 is the satiation value and beyond y_0 there is oversatiation. For $y = 2y_0, \omega = 0$. For national averages y will be below y_0 even for wealthy countries, at least according to public opinion in these countries. Another question is whether inhabitants of poor countries think so too. To them, rich countries' y may surpass what poor countries' public opinion thinks about y_0. This question may be an interesting subject for inquiries by public opinion polls. For the elaboration of world co-operation policies such information might be relevant. Whereas social policy rightly emphasizes the usefulness of information on a minimum income needed to satisfy basic needs, a world social policy may have to study also which values of y_0, the 'satiation income level', are necessary to guarantee a world-wide minimum income.

For the study of arms-control policies information on a_0 is relevant. Values of a_0 are different, of course, under different regimes of international security policy. Under an optimal world security regime, present values of a are definitely larger than a_0. A utility function may contain a logarithmic term for y and a parabolic term for a, such as:

$$\omega = \ln(y + 1) + \omega_0 - \frac{\omega_0}{a_0^2}(a - a_0)^2 \qquad (1.62)$$

1.7 SURVEY OF MODELS USED

As announced, the main part of this book consists of a considerable number of studies of an optimal welfare-in-security policy or order, based on a series of macro-economic models. With their aid either the complete problem of the world's security and development or its main components, a security policy and a development policy, are analyzed. These analyses may be grouped according to their main characteristics. One characteristic

is whether the model used is *static or dynamic*. The larger part (Chapters 2 to 6 inclusive) is based on static models in the sense of Frisch's definition (Frisch, 1929). Static models are not restricted to stationary (constant) values of the variables considered. The variables may change over time, because some exogenous variables of the model show movements, usually monotonous, but occasionally cyclical. The relevant cycles as a rule are long cycles and not juglars or kitchins (cycles with periods of up to about ten years). Chapter 7 deals with some dynamic models in Frisch's sense. In such models at least one variable's value must occur for different time units. The movements of the variables' values are endogenous: they may show movements even if all exogenous variables are stationary. Endogenous movements may be cyclical, but need not be.

A second main characteristic of the models used consists of the *number and the nature of the geographical units considered*, mentioned briefly in Section 1.3. All models are macro-models, but some are 'less macro' than others. Chapters 2, 3 and 4 respectively deal with 2, 3 and 4 geographical units or 'worlds'. Among the worlds considered are the areas known as the First (W1), the Second (W2) and the Third (W3) World. W1 consists of the developed market economies, but sometimes members of NATO only. W2 consists of the developed communist-ruled countries and so practically coincides with the members of the Warsaw Pact, except when China is included (W2', Section 3.1). W3 consists of the underdeveloped market economies, including the newly industrialized countries (NICs). In Section 3.2, however, China is included, because it is a centrally-planned country. Because of its size China is called the Fourth World (W4) in Chapter 4.

So much for the 'very macro' models studied. Chapters 5 and 6 are reserved for two 'less macro' models, both consisting of twenty worlds. The first of these are not twenty geographical areas, but twenty groups of individuals (or households). Ten live in W1 and are the 'deciles' (one-tenth each) of the population, arranged according to income. The first decile is the poorest tenth, the tenth decile constitutes the richest ten per cent. The other ten groups are the deciles in W3.

The second twenty-worlds model does consist of twenty geographical areas in the world's market economies, W1 + W3. Each has a population of about 5 per cent of the total population. Six are developed and fourteen underdeveloped. These data are available thanks to work done by Kravis *et al* (1982).

1.8 APPENDIX I: PIONEERS IN WORLD MODELS

Economic models as a tool for formulating policy proposals have been built and used for half a century, and the jubilee was celebrated in 1987 by a congress held in Amsterdam. The year 1987 also marked the 125th birthday of the Netherlands Economic Association (cf. Knoester, 1987).

It took some time for the model-building profession to devote itself to models with a wider scope. Increasing interdependency of the world's nations made international policies ever more important and this was reflected in a growing series of economic models of the world at large. Probably the first such model was built by J. J. Polak (1953). Another early world model was J. L. Mosak's, used for United Nations' tasks, and in particular for the United Nations Development Planning Committee, created in 1966. At that time the model existed already; unfortunately it was never published. In 1970 the Department of Applied Economics of the Brussels Free University published another world model (Duprez and Kirschen, 1970). In 1976 another Belgian economist J. Waelbroeck edited a collection of national models that had been used by the so-called Project Link (Waelbroeck, 1976). In 1977 W. Leontief and collaborators produced a series of alternative world models (Leontief *et al.*, 1977) in order to forecast the world economy's situation around the year 2000. Important work has also been done in the Science Centre, Berlin, by Professor K.W. Deutsch (cf. Deutsch, 1984) and collaborators.

1.9 APPENDIX II: SOURCES OF PRINCIPAL DATA

The importance of econometric models is to enable theories on the subject studied to be tested with the aid of statistical data. Clearly, much depends on the quality of the statistics used. In the present study extensive use has been made of two publications by Professor I.B. Kravis and his collaborators resulting from a thorough study made under the auspices of the World Bank (Kravis *et al.*, 1978, 1982).

The 1978 article shows *per capita* real incomes (GDP) for more than 100 countries. Real incomes means that the incomes are expressed in (1975) US dollars buying-power, on the basis of very extensive and careful price comparisons. The 1982 publication is the official report on the subject to the World Bank and contains some estimates for the communist countries in addition. The 1978 article also shows a distribution of real incomes over seven geographical areas, used for our twenty-worlds model.

Another source of great importance is Ruth Leger Sivard's annual publication *World Military and Social Expenditures*, of which we selected the 10th anniversary (1985) edition. It contains 1982 figures, in US dollars, for 142 countries, of GNP, military expenditures, population and several other items. One complication is that for non-USA countries the amounts of GNP and military expenditures are expressed in dollars with the aid of exchange rates and not, as Kravis's figures,of purchasing power parities.

A third important source of data were some of E. F. Denison's studies on the components of economic growth in the USA, a number of European countries and Japan, which contain estimates of growth consequent on technological development.

REFERENCES

Denison, E. F. (1967), *Why Growth Rates Differ* (Brookings Institution, Washington, D.C.).

Denison, E. F. (1974), *Accounting for United States Economic Growth* (Brookings Institution, Washington, D.C.).

Deutsch, K. W. (1984), 'Zur Bedeutung von Weltmodellen – Verstehen lernen wie sich die Welt verändert [On the importance of world models – to learn and understand why the world changes]', *WZB-Mitteilungen*, no. 25 (1084), Science Centre Berlin pp. 12–15.

Duprez, C. and E. S. Kirschen (eds) (1970), *Megistos, A World Income and Trade Model for 1975* (North-Holland, Amsterdam and London; American Elsevier, New York).

Fischer, D. and J. Tinbergen (1987), *Warfare and Welfare* (Wheatsheaf Books, Brighton).

Frisch, R. (1929), Statikk og dynamikk i den økonomiske teori [Statics and dynamics in economic theory]', *Nationaløkonomisk Tidsskrift*, pp. 229–72.

Knoester, A., (ed.) (1987), *Lessen uit het verleden* [Lessons from the Past] (H. E. Stenfert Kroese B.V. Leiden, Antwerpen).

Kravis, I. B. *et al.* (1978), 'Real GDP *Per Capita* for More than One Hundred Countries', *Economic Journal*, vol. 88 no. 350, pp. 215–42.

Kravis, I. B. *et al.* (1982), *World Product and Income. International Comparison of Real Gross Product* (Johns Hopkins University Press, Baltimore and London, for the World Bank).

Leger Sivard, Ruth (1985), *World Military and Social Expenditures* (World Priorities, Washington, D.C.)

Leontief, W. *et al.* (1977), *The Future of the World Economy, A United Nations Study* (Oxford University Press, New York).

Palme, O. *et al.* (1982, 1986), *Common Security. A Blueprint for Survival*, by the Independent Commission on Disarmament and Security Issues (Simon and Schuster, New York (1982) and Delhi (1986)).

Polak. J. J. (1953), *An International Economic System* (University of Chicago Press, Chicago, and George Allen and Unwin, London).

Röling, B. V. A. (1985), *Volkenrecht en Vrede* [International Law and Peace] (Kluwer, Deventer).

Tinbergen, J. (1985), 'Measurability of Utility (or Welfare)', *De Economist*, vol. 133, pp 411–14.

Tinbergen, J. (1987), 'Measuring Welfare of Productive Consumers', *De Economist*, vol. 135, pp. 231–6.

Van Herwaarden, F. G. and A. Kapteyn (1981), 'Empirical Comparison of the Shape of Welfare Functions', *European Economic Review*, vol. 15 pp. 261–86.

Waelbroeck, J. L. (ed.)(1976), *The Models of Project Link* (North Holland, Amsterdam, New York and Oxford).