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DEPARTMENT OF ECONOMICS

RESEARCH MEMORANDUM

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AN EXERCISE IN WELFARE ECONOMICS (II)

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Abstract

The present research memorandum reviews on and evaluates the many efforts of establishing collective preferences. The first section is devoted to a broad discussion of the a priori as well as the ex post approaches. The a priori concept clearly appears to be second to the ex post one. The latter starts from the implicit preferences idea and recognises that planning behavior involves constrained optimisation conditional on expectations of the future while constraints and the information set are relatively well understood. Moreover, it takes into account policy decisions do not follow simple repeated optimalisations. Two alternative determination models for implicit preference structures are highlighted in the second section. It is argued that the (D)eterministic (S)tatic (I)mplicit (D)etermination model takes care of results not being influenced anymore by the a priori functional form of the preference function. Also the problems of the second order conditions for an optimum have been overcome now by the use of the concept of the relative preference elasticity. The second alternative of the 'Interactive Respecification' model seems to reconstruct by a pseudo-simulation of a given policy choice the characteristics of planning behavior and the underlying preference structure in more detail compared with the D.S.I.D-model approach. Nevertheless, the present paper concludes that the former way of doing may deliver reasons perhaps why the D.S.I.D.-approach has to be preferred, especially if the attention is merely turned to test stability through time of relative preference elasticities rather than to simulate the planning behavior in itself.

An Exercise in Welfare Economics (II)

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Section I.B. Two alternative determination models for preference structures

An Exercise in Welfare Economics (II)

Introduction: 'Problems of quantitative determination of an optimal economic policy'

This paper is intended to be a global overview how in literature on welfare economics research workers tried to get rid of solving problems which fall within the realm of welfare economics; the latter being defined as that branch of economic science which aims at evaluating the social desirability of alternative economic states. We define an economic state as a particular arrangement of economic activities, implying a well-defined use of the resources available to the economy. States of the economy may differ in many respects, e.g. in the structure and the functioning of the economy, but we can always say that each state is characterized by a different allocation of resources and a different distribution of the rewards for economic activity.

In order to make it possible to transform one state of the economy into another, policy measures have to be available for changing an existing and undesirable situation. However, before being able to take these measures the policy decision making unit of an economy will need an instrument in order to analyze when and what decisions are to be taken so as to ultimately bring about the desired situation.

In the literature, various tools, i.e. policy decision models, have been developed. Two of them are the flexible target and the policy simulation models. The synthesis of these two models resulting in the possibility for the policy decision unit of ultimately arriving at an optimal control of a national economy should be emphasized[1)]. The flexible target-policy simulation model fits exactly into the framework of systems of quantitative economic planning postulated by the mere part of research workers in that field and this can be presented in the following schematic way:

(I.a) There is a set A of feasible actions for the policy decision making unit, the elements of which are denoted by the action vector $\underline{a}$. An action results in a state $\underline{s}$, i.e. $\underline{s}$ is a set of functions $\underline{s} = \underline{f}(\underline{a})$ of the action taken. The set of possible states of the economy $\underline{S}$ is generated by $\underline{s} = \underline{f}(\underline{a})$ when $\underline{a}$ varies over the set A.

The policy decision making unit has to decide on what action to take according to some 'social' preferences concerning $\underline{S}$. Decision making on what action to take in accordance with some social preferences concerning alternative states of the economy can be performed by maximizing a social welfare function: $w = w(\underline{s})$ subject to side conditions describing the functioning of the economy under given policy measures $\underline{s} = \underline{f}(\underline{a})$. The social welfare function may be defined as describing a ranking of society's welfare, a function of the satisfaction levels of individuals composing society; its form depends on value judgements about the possible economic states of all the individuals of a society (e.g. a country). In a truly national economy it is the policy decision making unit, which undertakes the decision making with regard to social welfare maximization. Such a unit may consist of one or more representatives of the whole group of individuals of a country. Because each individual representative not only maximizes the welfare of individuals, but also wants to assure his own political survival, a social welfare function of the policy decision making group is likely to be a preference function which has become partly independent of the preferences (value judgements) of all other individuals in a country.

Therefore, the term 'social preference function', or just preference function of the policy decision making unit, is to be preferred to that of 'social welfare function'. Besides that, the name of collective preference function occurs in the literature. It indicates the close relation between this p.f. of the policy decision making unit and the collectivity of the individual preference functions of the members of the unit. Such a collective preference function may be considered to be a function denoting a kind of compromise arrived at by the policy makers with regard to the individual preference orderings on the possible states of the economy. They accept this collective preference function as being the function on which optimal joint decision making about actions and their resulting states of the economy can be achieved by means of quantitative optimization techniques. If the policy decision making unit does not consist of democratically elected members representing the whole group of a democracy, but only of one non-democratically elected person, we are dealing with

the case of a dictatorship. Here optimal decision making will be based on the individual preference function of the dictator.
In reality, when computing an optimal economic policy by means of quantitative optimization techniques, the collective preference function or the dictatorial p.f. are supposed to be single valued objective functions which are maximized subject to some functional (economic) side conditions. The objective function consists of all the target variables possibly with some of the instrument variables of economic policy. Research workers often postulate that the vector $\underline{s}$ of economic states in the mentioned social welfare function may be translated into terms of all the policy target- and instrumentvariables, so $w = w(\underline{s})$ will be transformed into the preference function:

$$\omega = \omega(\underline{y},\underline{z}) \tag{I.b}$$

where $\underline{y}$ and $\underline{z}$ are the vectors of the policy target and instrument variables respectively. Preference function (I.b) is to be maximized subject to the side conditions of an economy which may be described by a macroeconomic model, expressing the functional relations between the different variables of the economy, i.e. the relation $\underline{s} = \underline{f}(\underline{a})$ will be transformed into the macro economic model:

$$\underline{f}(\underline{y};\ \underline{v};\ \underline{z};\ \underline{x};\ \underline{y}_-;\ \underline{v}_-;\ \underline{e}) = \underline{0} \tag{I.c}$$

where $\underline{y}$ and $\underline{z}$ have already been defined; $\underline{v}$ and $\underline{x}$ denote irrelevant endogenous resp. uncontrollable (exogenous) variables; $\underline{y}_-$ and $\underline{v}_-$ denote lagged endogenous variables and $\underline{0}$ is the null-vector. $\underline{e}$ stands for the vector of constant terms.

We shall often use the terms 'preference function' and 'individual preference function', to denote the collective preference function of a policy decision making unit and the preference function of one individual policy decision maker respectively.

Summing up we can say that optimal policy management by means of quantitative optimization techniques needs quantitative knowledge of the preference function and of the economic side conditions. Besides, an appropriate quantitative optimization technique must be available. In spite of the fact that econometrics and operations research have succeeded in a satisfactory way in developing econometric models and optimization techniques, it still appears difficult to arrive at numerically determined preference functions.[2)]

As said already one of the main aims of the present paper is to give a global overview of literature we studied during the last decade when we off and on made efforts in explaining social preference functions e.g. for Belgium, France and the Netherlands and looking for important characteristics of the preference structure underlying such functions.[3)]

The results of such theoretical and empirical investigation may give a better insight into the preference behaviour of the postulated quantitative policy decision making units in these countries. It can tell us, among other things, whether the relative preferences of a decision making unit are constant over time or not; the answer to this question is important in view of the aim to arrive ultimately at the possibility of checking whether the implicitly pursued aims correspond to the ones that have been stated, too, and over which time period they have been active.

Section I.A. General Background

Par. I.A.1. Economic Policy Management

Since the nineteenth century economics has dealt with the problem of understanding the functioning of the economic system in order to discover by what kind of policies it could be steered in certain directions.

The main objectives of national economic policy were and still are equal distribution of increasing wealth. However, up to the second world war, the tasks of economic policy were mainly thought of as the creation of an institutional framework which provided the best environment for the operation of market forces, and not as the study of the effects of direct manipulations of those forces.

Nowadays all main political forces as well as the general public in the capitalist economies accept the idea that governmental policy decision making units can and should assume responsibility for the 'management' of these economies. Management is generally considered to be successful when it achieves at least the simultaneous attainment of the following six objectives:

1. Full employment
2. A sound balance of payments
3. A sufficient rate of growth of the economy.
4. A reasonable distribution of incomes.
5. Price stability.
6. Protection of the environment.

Especially Keynes has stimulated the process of thinking about the tasks of economic policy[4)]. He showed how the economy could be managed so as to secure the full utilization of resources, in particular full employment of labour, mainly by governmental actions in the fiscal and monetary field without any radical change in the institutional framework of a market economy.

However, merely accepting the idea of the possibility of managing the national economy does not solve all the problems of this aspect of welfare economics. In the years after the second world war there was little understanding of the difficulties which arose in attempting to achieve all objectives of economic policy simultaneously, or, if they were not achieved or came into open conflict with one another, of the ways in which government policy was to be conducted. Kaldor[5)] concludes that in the language of present-day econometrics, the failure of postwar governments to pursue policies consistent with their declared objectives, could be primarily due to an insufficient orchestration of instruments i.e. to not having sufficient separate policy instruments at hand to secure the simultaneous attainment of the various objectives. Formally speaking, the basic cause of the failures of economic policy management was the attempt to achieve too much with too little understanding of the full implications of the principles of economic policy management.

In recent years this understanding has increased; for the managers of national economic policy i.e. those who make the decisions with regard to

and are engaged in practical welfare economics have increasingly come to feel a need for criteria with which to evaluate the effects of alternative economic policies on the behaviour of an economic system.
Econometric literature on economic policy management indicates various ways of analyzing those effects and in doing so it makes use of macroeconometric models whether or not with explicitely stated preference functions of the policy management unit.

Par. I.A.2. Models of economic policy management[6)]

Four main models for computing policy vectors, including an analysis of their effects on the behaviour of an economic system can be distinguished.
1. The fixed target policy model.
2. The flexible target policy model.
3. The mixed fixed-flexible target policy model.
4. The policy simulation model.

Each model has been derived from a given econometric model of the economy of the country in question, embodied in a set of simultaneous equations, linear or non-linear. If such a model is assumed to be linear and deterministic, it shows the following structural form:

$$A\underline{y}_t + B\underline{v}_t + C\underline{z}_t + D\underline{x}_t + \sum_p A_p\underline{y}_{t-p} + \sum_p B_p\underline{v}_{t-p} + \underline{e} = \underline{0} \qquad \text{(I.A.2.a)}$$

where:

$\underline{y}_t$ is an Jxl vector of target variables.
$\underline{v}_t$ is an Ixl vector of irrelevant endogenous variables.
$\underline{z}_t$ is an Kxl vector of policy instrument variables.
$\underline{x}_t$ is an Lxl vector of non-controlled exogenous variables.
$\underline{y}_{t-p}$ is an Jxl vector of lagged target variables (p=1,.....,P).
$\underline{v}_{t-p}$ is an Ixl vector of lagged irrelevant endogenous variables (p=1,....,P).
$\underline{e}$ is an Nxl vector of the constant terms.
A is an NxJ coefficient matrix corresponding the vector $\underline{y}_t$.
B is an NxI coefficient matrix corresponding to the vector $\underline{v}_t$.
C is an NxK coefficient matrix corresponding to the vector $\underline{z}_t$.

D	is an NxL coefficient matrix corresponding to the vector $\underline{x}_t$.
A_p	is the NxJ coefficient matrix corresponding to the vector $\underline{y}_{t-p}$ (p=1,....,P).
B_p	is the NxI coefficient matrix corresponding to the vector $\underline{v}_{t-p}$ (p=1,....,P).
$\underline{0}$	is the Nx1 null vector.
t	denotes year t (t=1,....,T).
T	denotes the horizon over which the economic evolution of a certain economy is described or computed.

System (I.A.2.a) is assumed to be a complete model i.e. the number of equations (N) equals the number of endogenous variables (J + I). The elements of $\underline{y}_t$ and $\underline{v}_t$ are the endogenous variables of model (I.A.2.a) whereas the elements of $\underline{z}_t$, $\underline{x}_t$, $\underline{y}_{t-p}$ and $\underline{v}_{t-p}$ are exogenous at a given time t.

The four main models of economic policy management will be reviewed in brief.

Par. I.A.2.1: <u>The Fixed Target Policy Model</u>

Setting up this policy model assumes that instruments of economic policy could be applied to reach targets for which certain fixed values are specified by the policy decision making unit of a national economy.
For the given values of all the exogenous variables without $\underline{z}_t$, i.e $\underline{x}_t$, $\underline{y}_{t-p}$ and $\underline{v}_{t-p}$ in system (I.A.2.a), the equations of this econometric model are solved simultaneously for the set of values of the policy instruments $\underline{z}_t$ and those of the irrelevant endogenous variables $\underline{v}_t$ that are consistent with the fixed-valued target variables $\underline{y}_t$.
In analyzing and solving the problems in the framework of the fixed target policy approach we may distinguish:

(1) <u>The analytical problem</u> of expressing the target variables $\underline{y}_t$ in terms of the instruments $\underline{z}_t$ and the non-controllable variables $\underline{x}_t$ and $\underline{y}_{t-p}$, for the solution of which the variables $\underline{v}_t$ and $\underline{v}_{t-p}$ should be eliminated.

Literature[7)] gives the necessary conditions for arriving ultimately at the solution of the 'analytical problem' consisting of the so-called 'reduced form' of model (I.A.2.a). Transforming the original matrices and vectors of system (I.A.2.a), one obtains:

$$\underline{y}_t = S\underline{z}_t + T\underline{u}_t \qquad \text{(I.A.2.1.a)}$$

where:

$\underline{y}_t$ is the Jx1 vector of target variables in system (I.A.2.a).

$\underline{z}_t$ is the Kx1 vector of instruments.

$\underline{u}_t$ is an (L+P+1) x 1 vector of the non-controllable variables taking into account a constant term derived from the standard operations on the vector $\underline{e}$ of system (I.A.2.a). (All elements of this vector $\underline{u}_t$ are predetermined).

S is a JxK coefficient matrix.

T is a Jx (L+P+1) coefficient matrix.

(2) <u>The political problem</u> of expressing the instruments $\underline{z}_t$ in terms of the target variables $\underline{y}_t$ and the vector $\underline{u}_t$ in system (I.A.2.1.a); so we may derive:

$$\underline{z}_t = S^{-1}\underline{y}_t - S^{-1}.T.\underline{u}_t, \qquad \text{(I.A.2.1.b)}$$

assuming matrix S is non-singular.

Par. I.A.2.2. <u>The Flexible Target Policy Model</u>

To derive this policy model from system (I.A.2.a) one has to assume the existence of a preference function ω of (I.b). For the time being we shall describe ω as being a single-valued objective function, corresponding to a weighted average of the flexible targets and instruments of the national economy in year t.
Supposing a quadratic mathematical form we can write for (I.b):

$$\omega_t = \tfrac{1}{2}\underline{y}_t^* P\underline{y}_t + \tfrac{1}{2}\underline{z}_t^* Q\underline{z}_t \qquad \text{(I.A.2.2.a)}$$

where:

P and Q represent diagonal matrices with only J and K coefficients on their main diagonals which correspond to the vectors $\underline{y}_t$ respectively $\underline{z}_t$.
The problem of the policy decision making unit consists in finding the values of $\underline{y}_t$ and $\underline{z}_t$ that will maximize ω_t of (I.A.2.2.a) subject to the constraints imposed by the econometric model (I.A.2.a) for predetermined values of $\underline{x}_t$, $\underline{y}_{t-p}$ and $\underline{v}_{t-p}$. We may derive the necessary conditions arriving ultimately at the solution of the flexible target model, using the classical solution technique for maximizing a function ω_t of (I.A.2.2.a) subject to the constraints of system (I.A.2.a). Using the results obtained in I.A.2.1 our problem consists of maximizing ω_t of (I.A.2.2.a) subject to the linear constraints of (I.A.2.1.a).
Applying the classical solution technique and performing certain standard matrix operations we get the following optimal policy instrument vector:

$$\underline{z}_t = - [Q+S^{*}PS]^{-1}S.^{*}P.T.\underline{u}_t \qquad \text{(I.A.2.2.b)}$$

provided the second order conditions are met in the optimum i.e. $Q+S^{*}PS$ is negative (semi-)definite.

Par. I.A.2.3. <u>The Fixed-Flexible Target Policy Model</u>

Here the policy decision making unit is dealing with minimizing an objective function the arguments of which are the deviations of the realised values of the target- and instrument variables from their fixed 'ideal' values.
This approach implies an intermediate form between the approaches of the fixed and the flexible target policy models described in I.A.2.1 and I.A.2.2.

Suppose the objective function which has to be minimized has the following mathematical form:

$$\omega_t = \left[\underline{y}_t - \underline{y}_t^{d}\right]^{*} P\left[\underline{y}_t - \underline{y}_t^{d}\right] + \left[\underline{z}_t - \underline{z}_t^{d}\right]^{*} Q\left[\underline{z}_t - \underline{z}_t^{d}\right] \qquad \text{(I.A.2.3.a)}$$

where:

$\underline{y}_t^d$ is the Jx1 vector of the target variables of which the 'desired ideal' values are fixed by the policy decision making unit for a certain year t.

$\underline{z}_t^d$ is the Kx1 vector of the instrument variables of which the 'desired ideal' values are fixed by deriving them from the relations between $\underline{z}_t^d$ and $\underline{y}_t^d$ (see systems (I.A.2.1.a) and (I.A.2.1.b)).

Minimizing ω_t of (I.A.2.3.a) subject to system (I.A.2.a) will produce the same result as maximizing the following objective function

$$\omega_t' = -\left[\underline{y}_t - \underline{y}_t^d\right]^* P\left[\underline{y}_t - \underline{y}_t^d\right] - \left[\underline{z}_t - \underline{z}_t^d\right]^* Q\left[\underline{z}_t - \underline{z}_t^d\right]$$

(I.A.2.3.b)

subject to the same constraints as in system (I.A.2.a).

Making use again of the reduced form of model (I.A.2.a) i.e. taking into account of the side conditions expressed by the linear system (I.A.2.1.a), the classical optimization technique yields the following optimal $\underline{z}_t$ vector:

$$\underline{z}_t^0 = -[Q+S^*PS]^{-1}.S^*P\underline{y}_t^d + [Q+S^*PS]^{-1}.Q\underline{z}_t^d - [S^*PS+Q]^{-1}S^*PT\underline{u}_t$$

(I.A.2.3.c)

where:

$\underline{z}_t^0$ is the optimal Kx1 instrument vector which maximizes ω_t' of (I.A.2.3.b) subject to the linear constraints of (I.A.2.1.a) and minimizes ω_t of (I.A.2.3.a) subject to the same linear constraints.

Par. I.A.2.4. The Policy Simulation Model

The policy simulation approach requires no prior knowledge neither of the preference function nor of the policy decision making unit.
By means of simulation one solves the set of simultaneous equations of system (I.A.2.a) for the target variables $\underline{y}_t$ and the irrelevant endogenous variables $\underline{v}_t$ in terms of $\underline{x}_t$, $\underline{y}_{t-p}$, $\underline{v}_{t-p}$ and $\underline{z}_t$. One may generate the time-paths of $\underline{y}_t$ and $\underline{v}_t$ for as long a period (horizon) as one wishes. The time-path of $\underline{y}_t$ i.e. the vector consisting of calculated values of the target variables for each year t is of course the object of the special interest of the policy decision making unit.
In using it for policy simulation, we may transform system (I.A.2.a) in the following 'normalized' form:

$$\begin{bmatrix} \underline{y}_t \\ \underline{v}_t \end{bmatrix} = - [A\ B]^{-1} . \left[C\underline{z}_t + D\underline{x}_t + \sum_p A_p \underline{y}_{t-p} + \Sigma\, B_p \underline{v}_{t-p} + \underline{e} \right] \qquad \text{(I.A.2.4.a)}$$

where:

$\begin{bmatrix} \underline{y}_t \\ \underline{v}_t \end{bmatrix}$ is the (J + I) xl vector of the endogenous variables and

$[A\ B]^{-1}$ is the normal inverse of [A B] to be supposed a non-singular (J+I) x (J+I) matrix.

For any given values of the policy instruments one can generate the time-paths of the endogenous variables, using system (I.A.2.4.a) because the values of $\underline{x}_t$, $\underline{y}_{t-p}$ and $\underline{v}_{t-p}$ are supposed to be predetermined (t=1,...,T; where T denotes the horizon of the simulation).

Par. I.A.3. Evaluation of the economic policy management models

In I.A.3.1 we shall evaluate the policy management models briefly reviewed in the preceding paragraphs. Besides, in I.A.3.2 we shall indicate another possible way of analyzing the effects of alternative economic policies on the behaviour of an economic system i.e. the flexible target-policy simulation model.

Par. I.A.3.1. The four main policy models

In section I.A.2 the fixed target policy model was mentioned first. Tinbergen who introduced this approach, in principle suggests the existence of a preference function, but he goes on right away to deny the possibility of knowing this function of the policy decision making unit, mainly because of the lack of knowledge of its mathematical form.
In the fixed target policy approach we are not faced with a maximization problem as we are in the cases of the fixed-flexible respectively flexible target approach (cfr. I.A.2.1, I.A.2.2 and I.A.2.3). Targets are fixed and instruments to reach these targets can only be applied by taking into account boundary conditions on the practical use of the instruments. In reality the way in which the values of the targets are specified, taking into account the boundary conditions of the national economy has to result from a reasonable discussion between the responsible policy makers of a democratically governed country in which economic planning is a generally accepted way of life.
Often the target values are chosen as the highest (or lowest) possible values considered attainable by the policy maker e.g. values that might correspond to at least the main objectives of 'successful management' mentioned in paragraph I.A.1.
The way in which the values of the targets have to be fixed in democratically governed countries i.e. by reasonable discussion, seems to be one of the practical constraints imposed on the use of the fixed target policy model for application to practical policy management. Many experts think it highly questionable that in big countries like the United States a policy maker is willing to commit himself to a specific set of values for the target variables and the irrelevant endogenous variables. It is doubtful whether the policymaker will reveal the values of his targets in a precise manner. Thus, the information needed for solving the fixed target policy model is simply not available to the analyst, who finally likes to analyse the effects of alternative economic policies on the behaviour of an economic system e.g. of the U.S., by using the fixed target policy model.
Another practical constraint of this policy model can be mentioned. When taking a look at the systems I.A.2.a, I.A.2.1.a and I.A.2.1.b, we see that

a solution of the fixed target policy model can only be obtained if the number of instruments (= K) at least the number of targets equals (= J). If there are fewer policy instrument variables than targets, the number of unknowns (i.e. the policy instruments) in the econometric model I.A.2.a and its 'reduced form' I.A.2.1.a is smaller than the number of equations and a solution is impossible, except for special cases.
On the other hand, if the number of instruments exceeds the number of targets, the number of unknowns will exceed the number of equations (J < K), and thus an infinite number of solutions will be possible. If J > K, the 'Analytical problem' mentioned in I.A.2.1 (1) can be solved only either by increasing the number of instruments or by reducing the number of targets until there is an equal number of equations and unknowns (J=K) in (I.A.2.a) and (I.A.2.1.a).
The 'Political Problem' mentioned in I.A.2.1 (2) can be solved in those cases in which K > J i.e. when the number of unknowns exceeds the number of equations, by assigning arbitrary values to (k - J) instrument variables and by solving system I.A.2.1.a for the remaining non-arbitrarily valued instrument variables.
One ought to admit that the problem of balancing the number of equations and the number of instruments is frequently a serious limitation in the practical application of the fixed target policy model to policy management and thus also as an analysis model of the problems in this field of welfare economics, especially because (as we saw in par. I.A.1) the reality of economic policy merely shows far more targets than there are instruments for attaining them.

The second analysis model of policy management mentioned in section I.A.2 was the flexible target model, especially emphasized by Theil. In this approach not only the existence of a preference function is assumed but also the possibility of deriving such a function for use in quantitative optimal policy management and by means of objective mathematical optimization techniques. It provides an instrument for a more flexible solution of the problem of specifying numerically the (fixed) targets in the fixed target policy models, as well as of conflicts which may arise within the group of policy makers. It will leave more room for action by aiming at

maximizing the known preference function, taking into account the boundaries of the economic system (i.e. the model of the economy).
However, the flexible target approach stands of falls with the question whether or not it is possible to derive a numerically known preference function. We shall return to this problem in par. I.A.4 and I.A.5. As concerns the fixed-flexible target policy model, we can make the same remarks as we did for the fixed-flexible target policy model (see solution systems (I.A.2.2.b) and (I.A.2.3.c).
It corresponds to the flexible target approach in so far as we are dealing with maximizing an objective function subject to the constraints of the economic model by using, for instance, the classical mathematical optimization technique (see I.A.2.3.a and I.A.2.3.b).
The last model described in the preceding paragraph was a simulation one. There we mentioned the capacity of the policy simulation model to generate for any given values of the policy instruments, the time paths of the endogenous variables of model (I.A.2.a). It does not assume a preference function and many experts emphasize the simulation technique, because it makes it possible for econometricians to put only two questions to the policy maker:
1. "What output variables are of particular interest to you?"
2. "What sets of policy variables appear to be politically feasible?".

Simulation makes it easy for the economist to show the policy maker the consequences of the proposed policies. Besides, he may propose a few policies of his own for consideration by the policy maker.
The latter can then select the policies that are most compatible with his 'implicit' preference function, which is unknown to the economist according to many experts. The results of initial simulation runs may suggest other policy variable configurations for trial runs.

Par. I.A.3.2. <u>Another Possibility</u>

Evaluation of the four main policy models in I.A.3.1 makes clear that the flexible target and the policy simulation models are more appropriate analysis instruments than the fixed target or fixed-flexible target policy models. They leave more room for analyzing the effects of alternative economic policies on the behaviour of an economic system especially because they allow for more varied actions of the policy decision making unit.

A synthesis of the two approaches will result in an even stronger application and analysis instrument making possible 'optimal control' by the policy decision making unit of an economic system. Such an synthesis can be found with authors as Paelinck c.s.[8)]

However, with them we cannot speak yet of 'optimal control' because in their model they do not as yet introduce a quantitative optimization technique. Accepting, however, the existence of a numerically known integral preference function over time, and using it in their simulation model of the Belgium economy, they are able to 'evaluate' the reactions of the economy for a certain number of changes to a set of elementary policy instrument variables, by performing a series of 'historical' and 'exploratory' runs.

If in such a simulation model a quantitative optimization technique is introduced for maximizing the preference function subject to the side condition of the economy, both being already integrated in the simulation model, 'optimal control' by the policy decision making unit has become a real possibility. One may now simulate optimal time paths in the future with regard to the target as well as to the policy instrument variable.

Let us now turn to the discussion of some problems concerning the measurement of preferences and derivation of numerically known preference functions to be used in 'optimal control' models.

Par. I.A.4. Measuring preferences and establishing preference functions[9)]

A brief review of the international economic literature already shows a considerable disagreement about the possibility of obtaining useful preference functions. There is similar disagreement about the possibility of performing 'optimal control' on an economic system.

There are various reasons why many experts take this negative view. They argue that operating with a preference function suffers from the shortcomings connected with the fact that in the real world we simply do not know the contents, functional form and numerical parameters of ω.

The Von Neumann-Morgenstern utility index and other techniques for quantifying preferences simply require too much information to obtain meaningful results, information that is not likely to be forthcoming from either present or future policy decision units. A policy decision maker whose main concern is his own political survival is not going to reveal his preference function to any economist.
The negative thinkers consider the several examples of hypothetical preference functions for policy making decision units as proposed by economists in the literature as only academic exercises, trying to evaluate the effects of economic policies with macro-econometric models and a preference function te be optimized, which are not likely to be very helpful for real world policy decision units.
They prefer to spend less time trying to specify the preference function and want to spend more time seeking solutions to some of the 'real' problems of the policy decision unit of a country.
However we think the problem of establishing a preference function is one of those 'real' problems and to reject out of hand all the real possibilities of arriving ultimately at optimal control models as being just beautiful instruments in the laboratory of the academic economist is, we feel, going too far. It cuts short one of the most promising possibilities of economics of being able to indicate and to advise on optimal lines of action for policy units in the future.
With regard to short-term planning as well as to long-term planning, many others have arrived to the same conclusion.[10)]
Any potential instrument for gaining a better insight into the problems of policy making has to be investigated and will have to be the object of further research, irrespective of the many hours to be spent in order to get out of the stage of laboratory experimentation.

Before we shall review our own contribution in section I.B we want to indicate some problems and the ways in which authors have tried to overcome or to bypass them with regard to establishing numerically known preference functions.

Par. I.A.5. Derivation of preference functions

Derivation of preference functions to be used for quantitative optimal planning as described in scheme (I.a) requires the solution of two main problems i.e.:

1. Specifying such a function of preference rankings on economic states has to satisfy conditions of collective as well individual rationality because the function will be used for decision making about those alternative states of the economy to be preferred by the policy decision making unit, the latter generally consisting of more than one individual.
2. There are difficulties of quantification of the preference ranking function.

The first of these two major problems concerns the fact that the preference function, to be used in deciding on actions to be taken by the policy decision unit, is assumed to be a function representing in some sense the individual preference rankings of all the individual policy makers being members of the unit. One can imagine such a preference function to be derived either directly from all the individual preference functions of these members or not.
Direct derivation of the p.f. from individual ones may be possible by means of aggregating the individual p.f.'s to collective ones.
The aggregation procedure gives rise to problems with regard to conditions of collective and individual rationality as well as with regard to the technique to be used in order to actually perform the desired aggregation. These problems will be discussed briefly in the next paragraphs I.A.5.1, I.A.5.2 and I.A.5.3.
The second major problem referred to above results from the requirement of having ultimately at one's disposal of a numerically known preference function to be used for the optimization procedure mentioned in our scheme of quantitative economic planning (I.a). Here we are dealing with problems of specification of the mathematical form and contents of the p.f. in (I.b) and besides with problems of determination of the numerical values of its parameters. We shall discuss these in the paragraphs I.A.6 and

I.A.7. These two paragraphs are devoted to the two different approaches which are possible with regard to the numerical determination of the preference function i.e.:

1. The a priori approach and
2. The ex post approach.

The difference between these two approaches results from different thinking about the point of time at which one may establish a numerically known preference function. Referring to our scheme (I.a) two possibilities, as concerns this point of time, can be distinguished:

1. In the a priori approach, one tries to arrive at the numerically known preference function, before that point of time at which decisions on actions $\underline{a}$ are actually taken by the policy decision unit and, in doing so, before the actually resulting states of the economy indicated by the values of the target and instrument variables $\underline{y}$ and $\underline{z}$ in the p.f. (I.b), caused by these actions, are known.

2. In the ex post approach, one tries to work out the numerically known p.f. after the points of time in which the decisions are actually taken; the resulting states of the economy will be known by means of observations of the values of target and instrument variables $\underline{y}$ and $\underline{z}$ in the p.f. of (I.b).

The determination techniques to be used and the question of what information will be desired in the two different approaches will be discussed in paragraphs I.A.6 and I.A.7.

Par. I.A.5.1. <u>Aggregation of individual preference functions to 'collective' preference functions</u>

Assuming the preference function which is used for quantitative optimal planning, is in some way or other based on lower-level preference functions, we may distinguish two alternatives as concerns the problem of direct derivation of the preference function of a policy decision unit from the individual preference functions of the members of this unit. If the policy decision unit of a country consists only of non-democratically elected responsible policy maker i.e. a dictator, the preference function for quantitative optimal planning will be the same as the individual preference function of this dictator and thus the aggregation problem referred to above does not exist. However, if the policy decision unit consists of one or more democratically accountable policy maker(s), somehow representing different interests among all the members of a country, carrying out quantitative optimal planning in such a democracy will require the establishment of a preference function somehow related to and derived from the individual preference functions of the individual policy makers. In this case we are dealing with the aggregation problem consisting in aggregating the individual preference functions to the 'collective' preference function, taking into account certain conditions of rational collective and individual decision making by the policy decision making unit that have to be satisfied and finally using the 'collective' p.f. for optimal planning.

For a brief and concise analysis of the most important problem that arises in the aggregation procedure i.e. the well-known 'Kenneth Arrow paradox', we shall assume a policy decision making unit to consist of three democratically elected responsible policy makers representing three groups that are rather homogenous with respect to preference orderings about the possible states of the economy of a democratically governed country. In this way we can avoid the question of the links between the three policy makers and the other individual members of the country.

Par. I.A.5.2. The Kenneth Arrow paradox

The rational possibility of aggregating individual preference functions into 'collective' ones has been questioned by Arrow.[11)] Considering our scheme of quantitative economic planning (I.a), Arrow argues that at the moment of establishing a preference function the experts involved do not exactly know the set A of feasible actions of the policy decision making unit in the economy, and that besides the relation between the actions and the resulting states of the economy i.e. $\underline{s} = f(\underline{a})$ is still unknown.

In this case it will be necessary to establish a preference function which allows a wide variety of possible individual preference orderings over a wide variety of possible states of the economy i.e. we have to take into account a wide variety of possible individual preference functions aggregating them into the 'collective' preference function. Arrow concludes that there is no preference function which simultaneously satisfies all the conditions of rational collective and individual decision making. At least it will never simultaneously satisfy the following four well-known conditions:

(1) The condition on the Pareto principle;
(2) The condition of non-dictatorship;
(3) The domain condition;
(4) The condition of independence of irrelevant alternative states of the economy.

In the literature, condition (4) is generally indicated as being the condition one must ignore if one wishes to overcome the problem of the Arrow paradox. Coleman demonstrates how condition (4) may cause the Arrow paradox in a situation in which there are three policy makers and three alternative states of the economy.[12)]
Let us imagine the preference rankings given by the policy makers are:

Rank \ policymaker	No. 1	No. 2	No. 3
I	s'	s''	s'''
II	s''	s'''	s'
III	s'''	s'	s''

<u>diagram I.A.5.2</u>

In addition, we assume that the policymakers accept the idea of majority voting in order to come to decisions.

Now looking at diagram I.A.5.2 we may derive that if we eliminate alternative $\underline{s}'''$, $\underline{s}'$ is preferred by the policymakers No. 1 and No. 3. In this case alternative $\underline{s}'$ wins and the collective preference function generates a collective preference ordering in the sense that $\underline{s}'$ wins over $\underline{s}''$ i.e. $\underline{s}' > \underline{s}''$.
Eliminating alternative state $\underline{s}''$, $\underline{s}'''$ is preferred to $\underline{s}'$ by the policymakers No. 2 and No. 3 and therefore s''' wins over $\underline{s}'$ i.e. $\underline{s}''' > \underline{s}'$.
If alternative state $\underline{s}'$ is eliminated, $\underline{s}''$ is preferred by the policy makers No. 1 and No. 2 and therefore $\underline{s}''$ wins over $\underline{s}'''$ i.e. $\underline{s}'' > \underline{s}'''$.

Reviewing the three cases of eliminating respectively $\underline{s}'''$, $\underline{s}''$ and $\underline{s}'$ we get:

a) $\underline{s}' > \underline{s}''$
b) $\underline{s}''' > \underline{s}'$
c) $\underline{s}'' > \underline{s}'''$.

From a) and b) follows: $\underline{s}''' > \underline{s}' > \underline{s}''$. However, c) denotes $\underline{s}'' > \underline{s}'''$ and from this we must conclude that this is a case of inconsistent collective preference ordering because the condition of independence of irrelevant alternative states of the economy is not satisfied. In the situation described above the other three conditions (1), (2) and (3) are satisfied:

1. Starting from the majority voting procedure in which a state $\underline{s}'$ would be preferred to another state $\underline{s}''$ according to all the three individual preference rankings of the policy-makers, the same state $\underline{s}'$ would be also preferred to $\underline{s}''$ according to the collective preference rank ordering i.e. the condition of the Pareto principle is satisfied.
2. We found for each policy maker a situation in which strict preference on his part was overruled by the collective preference ordering (by means of majority voting), i.e. the condition of non-dictatorship is satisfied.
3. The given orderings in diagram I.A.5.2 on the set of possible states of the economy are logically possible orderings i.e. the domain condition is satisfied.

Par. I.A.5.3. Bypassing or overcoming the Kenneth Arrow paradox

In principle there are three possible ways to bypass or to overcome the impossibility theorem of Kenneth Arrow:

1. One may acknowledge its existence but assume this Arrow problem is somehow resolved before the economist enters the scene.
2. One may attack the theorem and deny it because one of the conditions referred to in I.A.5.2 (1), (2), (3) and (4) might actually themselves be inconsistent with rationality in collective as well as individual decision making.
3. One may acknowledge the theorem but question how far one can seriously weaken, in one way or another, the conditions of the Arrow theorem with regard to the practical use of the preference function to be established in the institutional framework of actual economic planning.

The first possibility is used by applied economists like van Eyk and Sandee who in their a priori approach use a linear preference function of the policy decision-unit without discussing any possibly existing difficulties concerning the relation between this 'collective' preference function and the individual one of each member of the unit (see paragraph I.A.6).[13)] This same possibility is used by those who try arrive at numerically known preference functions by means of the implicit determination methods applied in the ex post approach e.g. Somermeyer and Nijkamp.[14)] When we demonstrated our own determination method in the past we also assumed an a priori known mathematical form of the preference function and we accepted the idea that it does not seem unreasonable to assume 'ex post' that the policy decision making unit of a country based its past decisions on some set of preferences. Ex post one sould be able to define a preference function representing the preferences of the policy decision making unit, no matter in which way they were related to the individual preferences of the policy makers.[15)] The eventual lack of exact knowledge as to how to derive the preference function directly from the individual ones is (then) not important anymore. Ex post we are able to observe the actions taken and the resulting states of the economy caused by these actions. This means that the members of the policy decision unit actually arrive at a compromise for decision making. Postulating a certain institutional framework of quantitative optimal planning, for instance that of scheme (I.a), this enabled us to derive the results of the compromise of numerically known parameters of an a priori mathematically specified preference function. Thus we got an indicator function denoting retrospectively the various preferences finally settled on by the policy decision making group on economic states.

The line of thought in the ex post approach is not permitted in the a priori approach. In the latter approach we are faced with a situation in which a compromise for decision making on actions and possible states of the economy between the policy makers have not yet been reached, actions have not yet been taken. In order to find out whether it may be possible or not to arrive, in the future, at a compromise for decision making between the different policy makers, we have to interview each member of the policy decision making unit with regard to their preference orderings on possible actions to be taken and on the resulting states of the economy. In this way one may derive their individual preference functions; if one wants to derive a preference function to be used for quantitative optimal planning by the whole group of the policy decision making unit, an aggregation-method is required which involves the procedure generally accepted by the policy makers to arrive at a compromise. Thus we face again the Arrow problem.

The second possible method of overcoming the Kenneth Arrow paradox has been used, among others by Coleman. He suggests that the Arrow approach to the derivation of a preference function leaves out of consideration things which are extremely important in the empirical cases of collective choice and that it is this ommission which makes some authors accept the Arrow paradox. This paradox would only be relevant to those collective choice mechanisms in which it is not possible to express relative intensities of preferences on possible states of the economy. But when it is possible to express such intensities, the condition of independence of irrelevant alternatives (condition (4) in I.A.5.1) is inconsistent with 'collective rationality' as well as with 'individual rationality' in decision making.

Coleman tries to show that when the outcome of this decision making is uncertain (i.e. decision-making under risk) each individual policy maker attaches to each possible outcome a subjective probability and thus attaches to the decision an expected utility. If he has various kinds of behaviour he can carry out, he will act in such a way as to maximize the expected utility and may imply that the original preference orderings of the individual policy makers and so the collective preference orderings are changed. In this sense the three results from eliminating respectively the three alternative economic states in the example of I.A.5.2, discussing there how the condition of independence of irrelevant alternative states (condition (4)) may cause the Arrow paradox, may now be considered to be consistent with collective and individual rationality in decision making.

Johansen is one of those who use method 3 to overcome the Arrow paradox.[16)] He tries to find a reasonable procedure for establishing a collective preference function only from individual preference ordering functions.

He does not deny that intensities of preferences influence individual behaviour of the policy maker (see: Coleman). However, no convincing method has been devised to measure and compare, in a relevant way, strength of preferences on the part of one individual policy maker, as regards various pairs of alternative states of the economy and certainly not as concerns comparing the preference intensities of the different policy makers.

Thus by only confining his considerations to orderings concerning the domain as well as the range of the preference function to be established, he must accept the Arrow paradox. Trying to overcome this paradox he recommends to weaken the conditions of the Arrow theorem somewhat and to see how far this will detract from the practical use of the established preference function (only satisfying weakened conditions) in the real world of quantitative optimal planning. If the reality of national economic planning may be described as we did in scheme (I.a), Johansen concludes that in this case probably the condition of independence of irrelevant alternatives can be given up without too many serious consequences. If in scheme

(I.a) the relation $\underline{s} = \underline{f}(\underline{a})$, and the set A and the set S are known, indicating which alternatives are relevant at a certain moment, then we can obtain a preference ordering over the set of relevant alternatives S_t from which we have to choose.
In this way we are not going to use the implied orderings on other sets than S_t itself and so condition (4) of I.A.5.2 does not play a part anymore.
Establishing first the set of feasible states S_t and only then, by means of the information about S_t, establishing the preference function of the policy decision unit, produces a 'reasonable' possibility of applying the optimization procedure to the economic planning of existing national economies. Of course it will be very important that the models of such national economies which delineate the set A_t of feasible actions and so the set of feasible alternative states S_t by relation $\underline{s} = \underline{f}(\underline{a})$ in scheme (I.a), are very seriously established for each national economy (see also relations (I.c) and (I.A.2.a)).
If this is not done, there is a risk of establishing a preference function which is not quite valid for an actual situation in which we have to take optimal decisions deriving them by maximizing this preference function subject to the constraints. Applying the optimization procedure to the wrong preference function and the wrong economic model results in decisions on actions and desired states of the economy which are not optimal.

Par. I.A.6. The A Priori Approach

The a priori approach with regard to numerical determination of the preference function of the policy decision unit is characterized by the line of thought that such a determination may be possible before the point of time at which actual decisions about economic planning have been taken.
Establishing the a priori numerically known preference function is realized by using the explicit determination method.

Par. I.A.6.1. The Explicit Determination Method

Using this method one specifies a priori the mathematical form of the preference function (see for instance ω_t of I.A.2.2.a). Numerical values of the as yet unknown parameters of the preference function are derived from data which are obtained by using interview techniques. Interviewing the different policy makers will produce an insight into their different individual marginal preference orderings on, and into the marginal rates of substitution between, all the valued arguments of the individual preference functions (i.e. all the valued targets either with or without all the valued instruments).

Par. I.A.6.2. Application of the explicit determination method

The literature on the determination of preference functions by means of the explicit determination method provides many illustrative examples although they have never left the stage of laboratory experimentation. We shall mention three of them.

Frisch tried to establish a preference function by systematically interviewing 'one' responsible politician.[17)] This interview consisted in putting to the policy maker distribution questions i.e. requesting from him a desirable distribution of a given sum over a number of items of the national economy. These interview data delineating the preference structure of the "dictator" were finally translated into a suitable form for the quantitative optimal planning technique in such a dictatorially governed country i.e. the construction of a quadratic preference function.

Another example can be found with Theil.
He assumes that there exists a group of 'n' policy decision makers which decides for itself that decisions on a certain action (see scheme (I.a)) should be taken on the basis of 'collective' preferences; the latter should be a sort of aggregate or compromise of their individual preferences. In order to arrive at optimal 'committee' decisions by means of quantitative optimization techniques a 'collective' preference function is established and is used as an agreement in the 'committee' of policy decision makers to adopt a formalized procedure of making compromises. In analyzing this situation Theil uses the 'symmetry approach'.

By first constructing quadratic individual preference functions one is able to derive from the latter the 'loss functions' for all the members of the committee.
These individual loss functions indicate the losses inflicted on each member if a certain state of the economy is realised rather than the most preferred state for each of them.
(Here, too, the numerical values of the parameters are derived from interview data.)
Aggregation of the individual loss-functions into the 'collective' loss-function occurs by constructing a linear combination of the individual loss-functions.
In this linear combination each individual loss-function has been multiplied by an as-yet unknown coefficient indicating the weight to be attached to the loss inflicted on any individual member of the committee if one of the alternative states of the economy is realized rather than the individually most preferred state.
Numerical determination of the weights by trying to get complete symmetry (or a 'best-approximation' of it) between the treatment of all the individual members of the committee in the collective loss-function, finally results in the numerically known quadratic collective loss-function to be used for optimal 'committee' decision making.

As a last example of establishing a numerically known preference function we shall mention again the attempt by van Eyk and Sandee.
They developed a linear preference function by setting up a priori the linear form of this function with as only arguments the target variables. They avoid any discussion of the possibly existing difficulties in deriving the linear preference function from the individual preference functions of policy-makers (see also I.A.5.3).
By examining the marginal rates of substitution for all the target variables, derived from 'imaginary' interview data, they work out the as-yet unknown numerical values of the parameters of the linear preference function.
Many of such preference functions are distinguished as appropriate to different situations in which a national economy can find itself. An example has been given in the form of an experiment in finding an optimum

policy by the government and the social and economic council ("SER") of the Netherlands in 1957 taking into account the main targets and instruments of economic policy in this country during that year.
The optimum policy had to be found by maximizing the numerically known linear preference function, derived by means of the described explicit determination method subject to the constraints of the Dutch economy. For this optimization problem a linear programming technique was used. A graphical presentation of a similar optimization problem has been set out in an article by de Wolff and Sandee. Although they do not work explicitly with a formalized preference function, they show how the Social and Economic Council in 1958 found an optimum policy with regard to a reduction of the existing subsidies on milk consumption and an increase in controlled rents, within the framework of an acceptable development of wages and prices.[18)]

Par. I.A.6.3. <u>Evaluation of the A Priori Approach</u>

Evaluating the applications of the explicit determination method to numerical determination of preference functions discussed in I.A.6.2 may give us a clearer answer to the question as to how precisely the 'a priori' approach is able to make a real, practical contribution to the possibility of arriving ultimately at quantitative optimal management of national economies i.e. the question how far experts are able to derive practically usable preference functions emphasizing the a priori approach.

Frisch's quadratic preference function of one responsible policy maker can in principle only be used for economic planning in dictatorially governed countries. Besides, this preference function is based on interview data which are the result of raising different questions about the distribution of some sum, whereas on the other hand the items of the national economy can hardly be influenced by the dictator interviewed only. He will always need to the co-operation of the general public so as to arrive finally at the optimal values of those items.
However, in spite of these two disadvantages there also is an advantage:

in Frisch's case there is no problem with the Kenneth Arrow paradox because real aggregation of different individual preference functions into a collective one is not required.

Theil's method of establishing a preference function by aggregating the individual preference functions of the various members of a national policy decision unit, and using his 'symmetry'-approach, can be regarded as being a 'second best` solution to the Kenneth Arrow problem.
Only in those real situations in which the condition of independence of irrelevant alternative states of the economy can be disregarded his line of thought is allowed; i.e. referring to our scheme of the system of economic planning (I.a), only in those situations in which the relevant alternative states of the economy are known before establishing the preference function can his method produce useful different preference functions, each of them only being available for the known different possible economic situations. His method does not allow derivation of a definitive preference function in the Arrow sense i.e. the derivation of a preference function available in all possible economic-political situations and allowing a wide variety of possible individual preference-orderings on a wide variety of possible states of the economy. Here the expression 'possible' is used in order to denote the two sets of all, relevant and irrelevant possibilities of the individual preference orderings and of the states of the economy in any realistic situation respectively.
For any realistic situation, delineated by the available economic model (see scheme (I.a)) a realistic preference function has to be established over and again.
Although this line of action can be adopted theoretically in order to arrive finally at optimal policy management in a democracy by means of quantitative optimization procedures, there are doubts about its practical applicability. Establishing over and again a realistic preference function always requires an enormous amount of up-to-date information on the part of the policy makers.
To get this information in the short term and so in time by interviewing the policy makers over and over again is a precarious matter. Besides, there is another important difficulty: all members of the policy decision making unit in a democracy will not always reveal exactly and/or honestly

their various preferences about economic-political states during the interview. In this case establishing the preference function by using Theil's approach will result in numerically-known parameter values deviating from the reaslistic or 'optimal' ones.
Maximizing such a function subject to the constraints probably yields non-optimal solutions such as we got in the situation of non-seriously established economic models delineating the constraints of the economy (see par. I.A.5).
The non-optimal solutions consisting of non-optimal decisions could create conflicts between the members of the policy making group and thus a preference function which because those non-optimal solutions cannot be accepted.
The application of the explicit determination method by Van Eyk and Sandee shows the same difficulties with regard to obtaining exact information in time, information about individual preference orderings on states of the economy and actions to be taken, as we saw with Theil if one uses data resulting from genuine interviewing instead of the data used by Van Eyk and Sandee resulting from 'imaginary' interviewing of the policy makers.
Besides they deliberately avoid a serious discussion of the possible existence of the Arrow paradox and the aggregation techniques to be used in order to establish finally the preference function based on the enormous amount of information on the part of the individual policy makers.

Summing up we can say that the efforts discussed of numerically determining a preference function within the train of thought of the a priori approach, were in the first place experiments in analyzing the theoretical questions and difficulties which arise if we want to get a perference function before actual policy management is performed. In practice the a priori approach did not contribute much to the real applicability of quantitative policy management. Problems such as the Arrow paradox, the interview- and aggregation techniques to be used, the wide diversity of preferences within one policy decision making unit and so on, do not only obviate a once-and-for-all determination of the preference function but also prevent a preference function from being determined for a certain realistic economic-political situation, from being operational in time to perform actual policy management.

Because of this circumstance some authors abondoned the a priori approach and tried to find better solutions to the problem of determining a useful preference function. They emphasize the ex post approach as we shall do in order to find a determination method for so-called implicit preference functions.

Par. I.A.7. <u>The Ex Post Approach</u>

In this approach one assumes that the policy decision making unit of a country was guided in the past by preferences on actions to be taken and on the resulting states of the economy caused by these actions during the decision processes.
Starting from this assumption, one tries to arrive at numerically-known preference functions to be determined after the points of time at which the decisions were actually taken and the resulting realised states of the economy are known. This kind of information can be obtained by opserving the realised values of all the economic variables; among them the values of the target- and instrument variables $\underset{\sim}{y}$ and $\underline{z}$ in scheme (I.a) are of particular interest because they are considered to be the arguments of the preference function to be derived (see I.b).
The ex post numerically-derived preference function will, in the first place serve an 'indicator function' indicating on which preference structure of the policy decision making unit optimal decisions were taken, and thus which optimal economic-political situations were realised, the latter of which are assumed to have become known by means of observation. Establishment of the ex post numerically known preference function is realised by using the implicit determination method. The preference function numerically-determined by means of this method is often called the 'Implicit Preference Function', because in this case the preference structure with regard to actions and states of the economy is derived implicitly without making use of interview- and aggregation techniques.

Par. I.A.7.1. <u>The Implicit Determination Method</u>

Using this method for the derivation of numerically-known preference functions, one accepts the idea of virtual quantitative optimal economic planning by the policy decision making unit of a country which is performed by maximizing a preference function of (I.b) subject to the side conditions of the economy of such a country (see f.i. (I.c)).
The optimization procedure is supposed to be performed by means of a quantitative optimization technique.
What optimization technique is actually used depends on the way in which the preference function and the side conditions are mathematically formulated.
If one obtains ex post all (approximated) information desired about:

1. The mathematical form and contents of the preference functions to be maximized;
2. the structural form of the side conditions of the economy;
3. the optimization technique applied in the optimization process, and
4. the realized optimal values of the economic-political variables, it may be possible to determine the numerical values of the as yet unknown parameters of the preference function implying that the realized values of the economic-political variables in the preference function i.e. those of the targets and instruments of the policy decision making unit are indeed optimal.

In the ex post approach using the implicit determination method, the above desired information is assumed to be available because:

1.1. the mathematical function can be (un)specified a priori

2.1. the structural form of the side conditions of the economy ("the econometric model") can be derived by standard econometric determination techniques or is known by a priori knowledge.

3.1. From 1.1 and 2.1 it will be clear which optimization technique may be assumed as having been used by the policy decision making unit for the quantitative optimization procedure which consists in maximizing the (approximated) preference function subject to the constraints of the econometric model.

4.1. One assumes that the decisions on values of the target- and instrument vectors ($\underline{y}$ and $\underline{z}$ in (I.a)) corresponded exactly to the preferences of the policy decision making unit which implies that the known realised values of these vectors, obtained by empirical observation may be considered as being optimal.

From 1./4. and 1.1/4.1 we can derive the conclusion that the implicit determination problem with regard to preference functions may be considered to be the inverted case of the quantitative economic planning problem (see scheme I.a).The quantitative economic planning-problem consists of maximizing p.f.

$$\omega_t = \omega(\underline{y}_t, \underline{z}_t) \qquad \text{(I.A.7.1.a)}$$

subject to

$$\underline{f}_t(\underline{y}_t, \underline{v}_t, \underline{z}_t, \underline{x}_t, \underline{y}_{t-p}, \underline{v}_{t-p}) = \underline{0} \qquad \text{(I.A.7.1.b)}$$

which finally results in the optimal values of the elements of the target- and instrument variable vectors using an appropriate quantitative optimization technique.

With the implicit determination problem we are considering a number of observations of all the economic variables in (I.A.7.1.a) and (I.A.7.1.b) among which those of the targets and instruments are of particular interest. Their observed values are considered to be optimal. Specifying or not the a priori (approximated) mathematical form and contents of p.f. (I.A.7.1.a) one has to derive the as-yet unknown parameters of this (approximated) preference function to be maximized, taking into account of the known structural form of the side conditions in (I.A.7.1.b).

Par. I.A.7.2. Applications of the Implicit Determination Method

Up to now a lot of applications of the ex post approach with regard to numerical derivation of preference functions by means of the implicit determination method are known.[19)]

Somermeyer emphasized the ex post approach and suggested the implicit determination method as being the right method for detecting the as yet undetermined numerical values of the parameters of a given preference function of specified form and contents for the Common Market.[20)]
Knowledge of the existing side conditions within the Common Market will make it possible taking into account also the tariffs agreed upon at the Treaty of Rome (1956) as variables in his Common Market Model, to determine those as yet indeterminate numerical values of the parameters of the a priori mathematically specified preference function which will be consistent with the results of the maximization procedure with regard to the preference function subject to the side conditions. Ultimately, they could be found, using the implicit determination method.
The numerically known preference function obtained indicates the weights to be attached to its different variables implying that the agreed decisions on:

1. the possible abolition of all tariffs on trade flows between the member countries, and
2. the adoption of certain uniform tariffs by all member countries on imports from third countries were optimal.

The suggestion that the policy decision unit of the Common Market possibly had too little understanding of the full implications of the decisions agreed upon will let unhindered that the analysis of the weights determined of the different variables of the preference function allows for finding out whether these weights were the intended ones in 1956 or not. If they were not, it would be possible to analyze which tariff-changes are desired so as to arrive finally at the desired optimal situation.

Different applications of the implicit determination method to realistic economic political situations can be found in an important paper written by Nijkamp.[21)]
He adopts a deterministic as well as a stochastic approach in order to determine, or to estimate, the numerical values of the parameters of the preference function, by means of the implicit determination method.
Listing first some reasons why other attempts of applying the implicit determination method by authors as G.L. Reuber, W. Dewald and H. Johnson

and J. Wood[22] were not satisfactory or even negative, Nijkamp starts out by setting up his deterministic static model for numerical determination of the parameters of the preference function. In this case he disregards stochastic aspects and only assumes preference functions which bear on a planning horizon of one time period (year).
An application of this deterministic static determination model to the economic political situation in the U.S.A. for the year 1933 is given. The side conditions are provided by Klein's Model I, being a simplified description of the American economy during the years 1921-1941. Because this first example is illustrative of Nijkamp's line of thought we shall briefly review the steps to be taken so as to arrive finally at his deterministic static implicit determination model for preference functions. Besides it makes it possible to compare the model with the ones we have developed and restated in the next section as well as in the past.

Following the line of thought of Theil and others he sets up a priori a quadratic preference function:

$$\omega_t = \underline{b}_t^* \underline{y}_t + \underline{c}_t^* \underline{z}_t + \tfrac{1}{2}\underline{y}_t^* P\underline{y}_t + \tfrac{1}{2}\underline{z}_t^* Q\underline{z}_t \qquad \text{(I.A.7.2.a)}$$

which is replaced (in order to get a clearer insight into the implicit determination problem) by a simplified version given in (I.A.2.2.a) i.e.

$$\omega_t = \tfrac{1}{2}\underline{y}_t^* P\underline{y}_t + \tfrac{1}{2}\underline{z}_t^* Q\underline{z}_t \qquad \text{(I.A.7.2.a')}$$

Preference function ω_t of (I.A.7.2.a') has to be maximized subject to the linear constraints described by the linear model of (I.A.2.a) or its reduced form of (I.A.2.1.a) i.e.

$$\underline{y}_t = S\underline{z}_t + T\underline{u}_t \qquad \text{(I.A.7.2.b)}$$

Using the classical solution technique for this optimization problem one can get an optimal policy instrument-vector like that of (I.A.2.2.b) i.e.

$$\underline{z}_t = -[Q + S^*PS]^{-1} S^*PT\underline{u}_t \qquad \text{(I.A.7.2.c)}$$

($[Q + S^{*}PS]$ is negative (semi) definite)
The optimal solution system of the flexible target policy of (I.A.7.2.c) is the basic starting point of the last major steps to be taken in order to arrive at Nijkamp's determination model.
In this case all the coefficients of system (I.A.7.2.c) are known except for those of the diagonal matrices P and Q (the elements of which are the as yet unknown parameters of preference function (I.A.7.2.a'). Besides $\underline{z}_t$ and $\underline{u}_t$ are known from observations relating to one year.
Let now us see which steps remain to be taken.

Applying certain standard matrix operations on system (I.A.7.2.c) results in the following linear and homogenous system of equations:

$$[I_k \; N_t].\begin{bmatrix}\underline{q}_t \\ \underline{p}_t\end{bmatrix} = \underline{0} \qquad \text{(I.A.7.2.d)}$$

where: $[I_k \; N_t]$ is a K × (K+J) matrix
I_k is the K × K unity matrix
$N_t = \hat{\underline{z}}_t^{-1} S^{*} (\hat{\underline{v}}_t + \hat{\underline{w}}_t)$ is a K × J matrix
where $\hat{\underline{z}}_t^{-1}$ is the normal inverse of a diagonal matrix of order K with the elements of the K × 1 instrument-vector $\underline{z}_t$ on the main diagonal.
$\hat{\underline{v}}_t$ and $\hat{\underline{w}}_t$ are the diagonal matrices with the elements of the J × 1 vectors $\underline{v}_t$ respectively $\underline{w}_t$ on the main diagonals whereas $\underline{v}_t$ and $\underline{w}_t$ are defined as:

$$\underline{v}_t \equiv S\underline{z}_t$$

$$\underline{w}_t \equiv T\underline{u}_t$$

$\underline{q}_t$ and $\underline{p}_t$ are the (K×1) and (J×1) vectors respectively of the unknown parameters of the instrument and target variables in preference function ω_t of (I.A.7.2.a').

$\underline{o}$ is the K × 1 null-vector.
Because the rank of matrix $[I_k \; N_t]$ of the homogenous system of (I.A.7.2.d) equals K, there are K+J-K = J degrees of freedom.

From the infinite set of possible non-trivial solutions for system (I.A.7.2.d) one may derive $\binom{K+J}{K+1}$ elements setting $\binom{K+J}{K+1}$ times J-1 elements of the vector $\begin{bmatrix} \underline{q}_t \\ \underline{p}_t \end{bmatrix}$ equal to zero and 1 element (the basic element) equal to one. In this way the a priori mathematically specified preference function (I.A.7.2.a') can be numerically specified encompassing only K+1 parameters (and thus K+1 variables) instead of the original K+J parameters. Therefore, in this case one speaks of a partial function instead of an overall-preference function.

Only if it is assumed that preference function (I.A.7.2.a') contains K instruments and one target, the K+1 parameters of such an overall function bearing on a horizon of only one period (year) can be determined in a unique way up to an arbitrary factor (i.e. basic element = 1).

This is possible because the preference function of (I.A.7.2.a') is invariant against a monotonously increasing transformation, and therefore attributing a value to the remaining basic element, setting it equal to one, <u>is possible</u> without any loss of generality.

Let us return to system (I.A.7.2.d) from which one may derive:

$$[I_k \ \bar{N}_t].\begin{bmatrix} \underline{q}_t \\ \bar{\underline{p}}_t \end{bmatrix} k = \underline{c}_t \qquad \text{(I.A.7.2.e)}$$

where $\bar{N}_t$ represents N_t without the first column, while $\bar{\underline{p}}_t$ denotes the vector $\underline{p}_t$ without its first element.

The vector $\underline{c}_t$ is extracted from the first column of N_t multiplying its elements by minus the value of the first element of $\underline{p}_t$, setting it arbitrarily equal to 1.

If J-1 elements of the vector $\begin{bmatrix} \underline{q}_t \\ \underline{p}_t \end{bmatrix}$ in system (I.A.7.2.e) are set equal to zero we get:

$$\overline{[I \ \bar{N}_t]}.\overline{\begin{bmatrix} \underline{q}_t \\ \underline{p}_t \end{bmatrix}} = [\underline{c}_t] \qquad \text{(I.A.7.2.f)}$$

where: $\overline{[I\ \bar{N}_t]}$ represents matrix $[I\ \bar{N}_t]$ in system (I.A.7.2.e) without those columns corresponding to the J-1 elements of the vector $[{g_t \atop p_t}]$ which are set equal to zero.

$\overline{[{g_t \atop p_t}]}$ represents the vector $[{g_t \atop p_t}]$ without the J-1 elements which are set equal to zero plus 1 element set equal to one.

In order to get the $\binom{K+J}{K+1}$ possible solutions mentioned above we have to solve a system as (I.A.7.2.f).
From (I.A.7.2.f) we derive the solution vector (if the first element of p_t of system (I.A.7.2.d) is taken as basic element) as follows:

$$\overline{[{g_t \atop p_t}]} = \overline{[I\ \bar{N}_t]}^{-1}.[c_t] \qquad \text{(I.A.7.2.g)}$$

in which: $\overline{[I\ \bar{N}_t]}^{-1}$ represents the normal inverse of the non-singular (K×K) matrix $\overline{[I\ \bar{N}_t]}$ of system (I.A.7.2.f).
Corresponding to the $\binom{K+J}{K+1}$ solutions to be obtained in a similar way as denoted in (I.A.7.2.g), we may derive numerically a similar number of partial preference functions replacing the elements of the diagonal matrices P and Q of p.f. (I.A.7.2.a') by their numerically-known values.

Par. I.A.7.3. Evaluation of the Ex Post Approach

Evaluating the line of thought of the ex post approach in which one makes use of the implicit determination method to determine numerically-known preference functions and comparing its advantages and disadvantages with those of the explicit determination method to be used in the a priori approach, we come to the conclusion that one should prefer the ex post approach to the a priori one.
Various reasons can be given. In I.A.5.3 we already set out why the ex post situation enables us to avoid Arrow problems and other questions about aggregation of individual preference functions into 'collective' ones. Moreover, other advantages can be mentioned in favour of the impli-

cit determination method. By making use of observed values of the different economic variables (see I.A.7.1 and I.A.7.2), the numerically determined implicit preference function is based on more 'objective' information than the explicit preference function of which the numerical values of the parameters are based on 'subjective' interview data.
For reasons mentioned in I.A.6.3 such as the possibility that inexact and/or dishonest information is given by the individual policy makers during the interviews, the explicitly derived individual preference functions will often deviate from the 'realistic' preference structures of the individual policy-makers and because of this the same can be said about the collective preference function of the policy decision making unit to be established by aggregation of the individual preference functions.
Another advantage of the implicit determination method to be used in the ex post approach consists in the circumstance that one only needs that information (i.e. observed values of the economic variables) which is in many cases already known to be used for other purposes in a national economy. Because 'interviewing' of the policy-makers is not required in the implicit determination method, one needs far less time for collecting and processing the desired information and because of this the implicit determination process of numerically-known preference functions proceeds quicker than the explicit one of the a priori approach.
All this contributes to making the preference function established by means of the implicit determination method more 'reliable' and more 'up to date'. It may give a far better insight into the preference structure of a policy decision making unit than we can obtain when using the explicit determination method of the ex post approach.
The more 'reliable' and 'up to date', the more appropriate such a preference function will be for use as an objective function for quantitative optimal economic planning.
However, also in the ex post approach using the implicit determination method, various theoretical and practical problems are to be solved (some of which appearing in the explicit determination method of the a priori approach too), and which we shall discuss below.

In both approaches and the foregoing examples one specifies a priori the mathematical form of the preference function.

Such an a priori specification of the mathematical form (and contents) of the preference function to be determined numerically has to satisfy conditions of mathematical tractability and of theoretical economic-political consistency.

Mathematical tractability of the preference function has to do with the question whether it is appropriate or not for such a preference function to undergo the necessary mathematical standard operations belonging to a certain mathematical optimization technique to be used for solving the existing quantitative optimal economic planning. The requirement of theoretical economic-political consistency means that for a preference function to be used as objective function for quantitative optimal economic planning, it must only obey properties which are consistent with real thinking on optimal economic planning by the policy decision making unit i.e. it has to correspond in a unique way to the existing preference structure of this unit.

Let us first discuss the condition of mathematical tractability of the preference function.

The policy making unit dealing with quantitative economic planning is assumed to make use of one of the known classical, Lagrangean optimization- or mathematical programming techniques.

Literature on mathematical optimization techniques indicates which one has to be applied, depending on the different situations in which one has to maximize or minimize an objective function subject to certain side conditions.[23] In other words, the mathematical optimization technique to be used is determined by the mathematical forms of the objective function and the mathematically formulated side-conditions. Besides the length of the period over which one has to optimize will play a part with regard to the technique to be chosen.

If for a certain optimization problem an appropriate mathematical solution-technique can be found, the objective function and the side-conditions which together describe the important elements of the optimization problem in mathematical terms, are said to be mathematically tractable. However, if such an appropriate mathematical solution technique is not available one may try to find the mathematically tractable situation by changing the mathematical form of the objective function and/or of the side conditions together with or without the development of a new mathematical solution technique.[24] Of course the changed objective function and/or side conditions must remain consistent with the original optimal economic planning problem.

In order to satisfy the condition of mathematical tractability of the a priori mathematically specified preference functions to be determined numerically by using the implicit determination method one is ultimately faced with the following problem:

Try to find such an a priori mathematical form of the preference function ω_t of (I.A.7.1.a) as would make it possible to calculate the optimal values of its arguments (i.e. the observed values of $\underline{y}_t$ and $\underline{z}_t$) by maximizing this preference function subject to the structural form of the side conditions in (I.A.7.1.b) using one of the existing mathematical optimization techniques, if the numerical values of the parameters of preference function ω_t had been known.

If such a priori mathematical form cannot be found one should try it again after a permitted modification of the known structural form of the side conditions and/or the development of a new mathematical optimization technique.

Together with the conditions of mathematical tractability the a priori mathematically specified form of the preference function has to satisfy conditions of economic-political consistency i.e. the a priori form of the preference function and besides its contents (the arguments) have to be consistent with the realistic preference structure of the economic policy decision unit.

In the literature on preference functions many different mathematical forms of these (or approximations of them) are suggested of which the three most important ones are the linear, the log-linear and the quadratic forms of ω_t in (I.A.7.1.a) depending on the assumptions, made by the various authors, concerning the preferences of the policy makers with regard to possible combinations of the real-valued arguments of ω_t. Starting from a certain mathematical form two basic notions are often used to indicate the properties to be assumed with regard to the preference structure of the policy decision making unit i.e. those of the marginal preferences of

the various arguments of the preference function and those of the marginal rates of substitution of any pair of these arguments.
The marginal preferences are obtained by taking the first derivatives of ω_t with respect to its various arguments, whereas the marginal rates of substitution may be derived by taking the ratio of any pair of marginal preferences. The linear preference function will produce constant marginal preferences as well as marginal rates of substitution, whereas the latter two will not be constant but decreasing in the cases in which we are dealing with log-linear or quadratic preference functions.
As concerns the contents of the a priori preference function there are authors who suggest that only the target-variables $\underline{y}_t$ have to be taken as arguments of ω_t whereas others also want to introduce all the instrument variables $\underline{z}_t$ as arguments of this function. The latter authors believe that the members of a policy decision making unit base their decisions not only on preferences about the possible combinations of real-valued target variables but also about the possible combinations of real-valued policy instruments to reach the targets. This will become clearer when we realize that the individual members of the policy decision making unit are not only maximizing social welfare in the sense that they only try to realize optimal values of the economic target variables, but at the same time, being after all politicians, they want to assure their own political survival depending on the political, social and ideological consequences of the extent to which the economic policy instruments are used.
Thus one may accept the idea that policy makers will also have preferences on the different possibilities (different combinations of real-valued instruments) to reach the targets and as a matter of fact these preferences will ultimately exert their influence on the optimal target values to be determined.

From what has been said so far, it will be clear that an a priori specification of the mathematical form of the preference function can never be unique because there exist many different mathematical forms; every one of these may be realistic, mathematically tractable and consistent in different situations for which an optimum economic policy has to be determined (a priori approach) or had to be determined (ex post approach).

If in spite of this last consideration one wants (in the ex post approach, using the implicit determination method) to determine numerically the virtual preference structure (on which the policy decision making unit is supposed to have based its decisions in the past, making use for each observation period of realised optimal economic planning of the same a priori specification of the mathematical form and contents of the preference function), it will be desirable to set up such an a priori mathematical shape which is rather universal i.e. which meets a priori requirements of mathematical tractability and economic-political consistency available for any period (year) of the observation horizon.

We shall end this section by evaluating Nijkamp's application of his deterministic static implicit determination model of preference functions to the economic-political situation in the U.S.A. for the year 1933 (see also (I.A.7.2)).
His first effort resulted in a set of fifteen alternative partial preference functions. Nijkamp himself already had to conclude that the resulting parameter values corresponding to the different alternatives of the contents of these partial preference functions were still unsatisfactory, especially because of the fact that parameters belonging to the same targets and instruments showed large variations in their values with regard to the different alternatives. He indicates four points of explanation i.e.:

a. the a priori specification of the preference function ω_t in (I.A.7.2.a') may have been too simple;
b. The results are very sensitive to even small variations in the observations for a single period;
c. dynamic elements may be overlooked;
d. there may have been some inconsistencies in American policy.

He tries to improve these unsatisfactory results by assuming the more extended form of the overall preference function (I.A.7.2.a) and besides he takes into account an observation horizon or more than one year. His deterministic-static model becomes now a stochastic-static one. However,

this line of action did not mean an improvement, a fact which was manifested in the large standard errors of estimation of the parameter values especially with regard to the quadratic terms of ω_t (I.A.7.2.a).
Only the fact that his stochastic-static implicit determination method made possible a numerical derivation of an overall preference function in which all the target- and instrument variables were included instead of partial ones, stood forth as an improvement.
However, in this case one had to assume a priori that a preference function would remain the same during the whole observation horizon, or that at least the marginal preferences of its different arguments would do so, which seems to us less realistic than the assumption of a preference function changing in the course of an observation horizon of more than one year. Nijkamp also saw his problem and therefore he considered a dynamic preference function in his dynamic-stochastic analysis although an application of the resulting dynamic-stochastic implicit determination model has not been given.

We shall return to his deterministic-static implicit determination model and sum up more fundamental shortcomings of this procedure, some of which are removed in the dynamic-stochastic analysis mentioned above i.e.:

1. Developing this deterministic-static implicit determination model (see I.A.7.2) always requires an a priori quadratic specification of the mathematical form of the preference function which is assumed to be maximized subject to constraints of a linear and static econometric model in order to get an analytical solution using the normal inverse technique.

   Although the combination of a quadratic preference function together with a linear econometric model of itself may often be considered a priori as giving an appropriate approximation of the functioning of and of the relations between the various variables of a realistic economy and, in addition it may be mathematically tractable, we think that, when using this combination as an important input for setting up a determination model of implicit preference functions, already implies a certain restriction of the analytical power of such a model with respect to our aim of using it for the derivation of the best indicators of the preference structures on which the policy decison making unit are assumed to have decided in the past.

Aiming at the best indicators requires the best information on which their derivation has to be based. The more the results i.e. the numerically known indicator or implicit preference functions are sensitive to deviations of the available information from the correct one, the more one has to try to get this correct information.

In our case it means that one should look for an a priori specification of the preference functions which may be less restrictive than those e.g. of the quadratic kind. With respect to the constraints, i.e. the econometric model whose structural form in the ex post approach was supposed to be known a priori, one should, for instance, ask for non-linear dynamic econometric models, especially because empirical evidence has shown that models of this kind may often give a much better description of the economic reality in quantitative terms.

Thus the combination of a less-restrictive preference function and a more refined econometric model may often be an essential improvement of the implicit determination model.

2. With regard to our knowledge about the circumstances under which economic policy was made in the past we may conclude that in almost all countries the policy decision making units have planned for the short-term.

   Because of this we may only derive implicit preference functions which are based on short-term observation horizons (e.g. one year). So in fact we need short-term period analysis and short-term determination models for implicit overall preference functions.

   In Nijkamp's case the possibility of deriving this short-term implicit 'overall' preference function is an exception. As we saw in I.A.7.2 generally only partial preference functions could be numerically determined, setting up a number of elements of the set of unkown parameters equal to zero.

   This fact immediately raises the problem of the disappearance of quite a few relationships before the ultimate numerical determination of the remaining parameters of the preference function has taken place i.e. those relations which correspond to the disappearing J-1 elements of the vector of unknown parameters $\begin{bmatrix} \underline{g}_t \\ \underline{p}_t \end{bmatrix}$ of system (I.A.7.2.e) will disappear.

From this last circumstance, together with the fact that one uses different units of measurement it follows that the numerical determination of the different partial preference functions takes place on the basis of different kinds of input information and so this situation already cuts short the possibility of comparing the different results.

3. Last but not least we shall mention another shortcoming of Nijkamp's model referred to above, for the determined parameter values are only influenced by the observed values of the instruments $\underline{z}_t$ and the data $\underline{u}_t$. However, because the structural economic model has not been built into the determination model into where $\underline{z}_t$ is expressed in terms of the other variables the observed values of the target variables do not play a part anymore. Besides, if there are targets appearing only in the linear part of the p.f., they are singled out by the maximization procedure and consequently they do not come back in the optimal instrument vector system on which the determination model is based i.e. one or more relations of the reduced form are singled out before having obtained the optimal $\underline{z}_t$-vector.

Section I.B. Two alternative determinationmodels for preference structures

Par. I.B.1 The DSID-model for Relative Preference Elasticities

Foregoing section I.A. concerned theoretical and empirical investigations on preference functions by different authors. Some of these investigations were especially based on the a priori approach which did not convince all experts of its practical value. Empirical workers preferred to use the ex post approach seeming to be a better way to derive - in an objective way - the preference structures of the policy decision unit.

Of course it is premature to claim in both approaches that the state of the arts is already such that optimal policies could right away be based on preference functions.

We accept the purely pragmatic argument that the concept of a macro preference function should be introduced if it is useful, even if we know that neither individuals nor societies are maximizing such a function. In this case the preference function must be viewed as an "as-if" concept i.e. if a preference function had been maximized at all what would have been its characteristics.

We proved in earlier contributions that the exercise of determining important characteristics of the implicit preference function can tell us something about relative preferences and their evolution over time. In our train of thought these relative preference structures should be computed ex post, the corresponding preference function being viewed as the result of economic - political activity.

Instability in economic - political relations will show up in the instability of the relative preferences. How these relative preferences are measured and the problems that beset this measure was the main field of our investigation.

We developed a determination model and used it for getting a valid knowledge about the evolution of implicit relative preference structures in France, Belgium and the Netherlands.[25)]

Application of our theoretical results to these situations implies the measurement of the evolution of the ex post revealed preferences during a certain number of years. They could be compared with the ex ante political intentions in these countries and in this way one may deduce something about the efficiency and consistency of economic-political activity there.

Looking again to scheme (I.a) and the functions (I.b) and (I.c) in the foregoing section, our concern is with an ex post measure of $\omega(\underline{y},\underline{z})$ or more likely with measure of economic concepts as marginal preferences, relative preferences, preference elasticities and relative preference elasticities for which the mathematical formulations can be derived from this function.

In section I.A. we indicated that an optimal quantitative economic policy can be mathematically formulated as follows:

$$\max \omega\,(\underline{y},\underline{z},\ t)$$

$$\underline{y},\ \underline{z},\ \varepsilon\ V(t) \qquad \text{(I.B.1.a)}$$

where $V(t) = \{\underline{y},\underline{z} \,|\, (\underline{y},\underline{z})\ \varepsilon\ E^{J+K},\ f_n(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t)=0;n=1,\ldots,N\}$

$\omega(\underline{y},\underline{z},t)$ is the preference function in year t, being a scalarvalued function, which is assumed to be continuously differentiable in the neighbourhood of the optimum.
The arguments $\underline{y}$ and $\underline{z}$ are the vectors of the target - resp. instrumental variables of economic policy, and are of order J resp. K defined in an Euclidean space of corresponding orders; they are the sub-elements of the argument-vector $(\underline{y},\underline{z})$ of order J+K, defined in an J+K dimensional euclidean space.
$f_n(\underline{y},\underline{z},\underline{v}, \underline{x},\underline{y}_{-},\underline{v}_{-}, \underline{e},t)$ are the constraints or the side conditions describing the structure of the economy concerned and are also assumed to be continuously differentiable in the neighbourhood of the optimum. The meaning of the other vectors has became clear already in the introduction of the preceding section. Considering the optimisation problem of mathematical programming of system (I.B.1.a) we can ask for a solution of the next four problems:

a) Which are the functional forms and arguments contained in both the preference function and the side model of system (I.B.1.a)?

b) If the econometric specification of the side model and the mathematical specification of the preference function are known, how can we derive the numerical values of the parameters of the preference function?

c) Which are the important characteristics of the preference function and how can they be measured in a numerical way?

d) What are the dynamic properties of these important characteristics viz. what are the dynamic properties of entities like relative preferences and relative preference elasticities, these being considered as indicators of the dynamic properties of the implicit social preferences?

These four questions are concerned with the ex post approach of the optimizing problem formulated in system (I.B.1.a) i.e., we suppose this problem has been solved in the past and the realised values of the vectors of this system are known and can be observed for different years. Solution of

the four problems ask for hypotheses as regards the optimation procedure corresponding with (I.B.1.a).
In fact we are dealing with an inverted optimizing problem which can be formalized as follows:

"Which are the specifications of the preference function and the side conditions and which was the corresponding mathematical programming procedure compatible with the realised values of the vectors of the target- and instrumental variables $\underline{y}$ and $\underline{z}$ being optimum values of economic policy management performed in the past?"

Formalizing this inverse problem by means of a mathematical system of equations and solution of this system will finally offer possibilities of getting a better knowledge about implicit preference structures for an economy in the past (i.e. ex post).
In section I.A. we made an evaluation of a few empirical applications of this ex post approach. We saw a solution of the inverted optimisationproblem resulting in the numerical derivation of an arbitrary implicit preference function, the latter being a retrospective indicator function for which the determination techniques could still be improved.
Confining ourselves for a while to the first two questions a) and b), an improvement may consist of setting up a more general mathematical form of the a priori specified preference function, having as arguments all possible target- and instrumental variables of an economy.
Of course the number and nature of the feasible target- and instrumental variables will always depend on the side model specification.
Therefore another improvement can be the introduction of more realistic alternative side models (often of the non-linear and dynamic kind).
Moreover, the quantitative values of the parameters to be found should be influenced not only by the observed absolute values of the variables but also by the economic structure itself and the development of this structure.
Finally we may ask for a determinationmodel that should admit the derivation of the "overall preference function" i.e. a preference function that contains all the a priori target- and instrumental variables.
Numerical experiments based on an a priori specified "overall preference function" can make it clear in how far the a priori considered variables

of the preference function were relevant or not for optimum economic policy.

Results of investigations as regards the first two questions a) and b) of which we also gave an account in the mentioned earlier studies, have shown the possibillity to set up more generalized a priori - mathematical forms of the preference function of which we could be convinced a priori that the parameter values ultimately to be derived could have more meaning as regards preference structures of the economy concerned.

In our special case, created in the aforementioned contributions, we suggested to use the a priori mathematical specification of the Cobb-Douglas type and even an unspecified functional form of the preference function has been investigated. The parameters of the first function-type are preference elasticities, as contrasted with the parameters of the a priori quadratic specification of Nijkamp and others. However, in the beginning we limited ourselves like these authors to a quadratic specification using arguments connecting with problems of certainty-equivalence. Afterwards we adheres the argument of an a priori more realistic meaning of the parameters should be preferred to that of the certainty equivalence one. Besides, the comparison of the results of our earlier study where we performed numerical determinations based, among other things, on a partitioned quadratic form of the preference function with those of our D.S.I.D. - model for the Belgium situation shows the influence of differentiating the form of the preference function. We shall report these results in the research memorandum, forthcoming as 'An Exercise In Welfare Economies (IV)'. However, as long as we use a priori specified preference functions, the aforementioned improvements included, one cannot avoid the circumstance that all results will always be influenced by any a priori specification of the preference function and of the side model of system (I.B.1.a). Size and direction of this influence can be investigated using sensitivity analysis applied to the resulting mathematical programming models as concerns the optimisation problem (I.B.1.a) and its inverse.

The latter indicates how incorrect specification of the mathematical form and contents of the preference function and of the side model are relevant as regards the quantitative results.[26)] Although one could make an ultimate choice to be based on a set of more or less arbitrary norms in order to get the "best-approximate" results, the aforementioned problem of influence remains as regards the search of solutions to the problems a) and b).

Besides another big problem arises here viz. that of the second order conditions to be satisfied by the quantitative results of the mathematical programming problem (I.B.1.a) and its inverse.

Authors as Theil, Somermeyer and Nijkamp took great care in making sure that the second order conditions would be satisfied. The latter achieved this essentially by imposing conditions on the main diagonal of the Hessian of his quadratic preference function after substitution in it of the side conditions (see also section I.A.).

Quadratic programming was applied to ensure this result.

However it often happens that constraints of the side model do not have such a simple structure as is supposed in most of the theoretical and empirical investigations.

In these cases imposing second order constraints on the results may be easy in a theoretical sense but in practice this difficulty is hard to overcome. The problems mentioned of the inverted optimisation problem i.e. those of the influence of incorrect specification and of the second order conditions could be side-stepped if we are more interested in questions c) and d).

For, apart from the question whether it is premature or not to claim that the state of the arts is already such that optimal policies could right away be based on preference functions, the specification of these functions is always fraught with difficulties like those we discussed above.

So the best thing to do is to ask for a method to get a better knowledge of the preference structure of an economy, whereas the difficulties, especially those in the methodological field, are minimised.

We hope to prove this study can deliver a new perspective to arrive at a better compromise between the need of a better knowledge of social preferences on the one side, and methodological claims on the other one. If we turn our special attention to the questions c) and d) it becomes clear why some problems of incorrect specification of the preference function and those of the second order conditions can be avoided.

For, in this case we are interested ultimately in the trends of some important characteristics of the preference structure of an economy. These characteristics are derived theoretically from the preference function in system (I.B.1.a) without knowledge of its exact mathematical specification.

One of the main objectives of this section will be the restatement of the "Deterministic-Static-Implicit-Determination"-(D.S.I.D.)-model for theoretical and empirical investigations concerning the questions how to measure relative preferences and relative preference elasticities.

We shall indicate a possibility to investigate the dynamical properties of these entities and test their aptness as indicators of the degree of stability of the implicit social preferences.

Let us first define mathematically the economic concepts of marginal preferences, relative preferences, preference elasticities and relative preference elasticities.

The marginal preferences denote the marginal changes in the value of the preference function $\omega(\underline{y},\underline{z},t)$ of system (I.B.1.a) resulting from marginal changes in the value of the individual target- and instrumental variables denoted by the elements y_j and z_k of vectors $\underline{y}$ and $\underline{z}$, being the arguments of the preference function in a certain year t. So we can write:[27)]

$$\forall_j \frac{\delta\, \omega(\underline{y},\underline{z},t)}{\delta\, y_j} = \omega^*_{y_j}(\underline{y},\underline{z},t) \qquad (j = 1,\dots,J\ ;\ t = 1,\dots,T)$$

as the set of the marginal preferences of target variables in year $t = 1,\dots,T$, and

$$\forall_k \frac{\delta\, \omega(\underline{y},\underline{z},t)}{\delta\, z_k} = \omega^*_{z_k}(\underline{y},\underline{z},t) \qquad (k = 1,\dots,K\ ;\ t = 1,\dots,T)$$

as the set of the marginal preferences of instrumental variables in year $t = 1,\dots,T$.

The relative marginal preferences or marginal rates of substitution are defined as the ratios of the marginal preferences of the target- and instrumental variables with respect to each other. So we can write:

$$\forall_{i,j}^{i \neq j} \frac{\omega^{*}_{y_i}(\underline{y},\underline{z},t)}{\omega^{*}_{y_j}(\underline{y},\underline{z},t)} \qquad (i,j = 1,\ldots,J \; ; \; t = 1,\ldots,T)$$

as the set of relative marginal preferences of the target variables with respect to each other, in year t = 1,...,T

$$\forall_{i,j}^{i \neq j} \frac{\omega^{*}_{z_i}(\underline{y},\underline{z},t)}{\omega^{*}_{z_j}(\underline{y},\underline{z},t)} \qquad (i,j = 1,\ldots,K \; ; \; t = 1,\ldots,T)$$

as the set of relative marginal preferences of the instrumental variables with respect to each other, in year t = 1,...,T, and

$$\forall_{i,j} \frac{\omega^{*}_{y_i}(\underline{y},\underline{z},t)}{\omega^{*}_{z_j}(\underline{y},\underline{z},t)} \qquad (i = 1,\ldots,J \; ; \; j = 1,\ldots,K \; ; \; t = 1,\ldots,T)$$

as the set of relative marginal preferences of the target variables with respect to the instrumental variables in year t = 1,...,T.
Other convenient entities for characteristing the preferences structure are the economic concepts of <u>preference elasticity</u> and <u>relative preference elasticity</u>. They give insight into the relative sensitivity of the value of the preference function to small changes in the value of the target- and instrument variables. If we denote the elasticityoperator as *E*, we can write:

$$\forall_j \frac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(y_j)} = \omega^{*}_{y_j}(\underline{y},\underline{z},t) \cdot \frac{y_j}{\omega(\underline{y},\underline{z},t)} \qquad (j = 1,\ldots,J; \; t = 1,\ldots,T)$$

as the set of preference elasticities of the target variables in year t = 1,...,T, and

$$\forall_k \frac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(z_k)} = \omega^{*}_{z_k}(\underline{y},\underline{z},t) \cdot \frac{z_k}{\omega(\underline{y},\underline{z},t)} \qquad (k = 1,\ldots,K; \; t = 1,\ldots,T)$$

as the set of preference elasticities of the instrumental variables in year t = 1,...,T.

As regards the relative preference elasticities, being the ratios of the preference elasticities of the target- and instrumental variables with respect to each other we define:

$$\forall_{i,j}^{i\neq j} \frac{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(y_i)}}{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(y_j)}} = \frac{\omega^{*}_{y_i}(\underline{y},\underline{z},t).y_i}{\omega^{*}_{y_j}(\underline{y},\underline{z},t).y_j} \quad (i,j = 1,\dots,J\ ;\ t = 1,\dots,T)$$

as being the set of relative preference elasticities of the target variables with respect to each other in year t = 1,...,T,

$$\forall_{i,j}^{i\neq j} \frac{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(z_i)}}{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(z_j)}} = \frac{\omega^{*}_{z_i}(\underline{y},\underline{z},t).z_i}{\omega^{*}_{z_j}(\underline{y},\underline{z},t).z_j} \quad (i,j = 1,\dots,K\ ;\ t = 1,\dots,T)$$

as being the set of relative preference elasticities of the instrumental variables with respect to each other in year t = 1,...,T, and

$$\forall_{i,j} \frac{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(y_i)}}{\dfrac{E\,(\omega(\underline{y},\underline{z},t))}{E\,(z_j)}} = \frac{\omega^{*}_{y_i}(\underline{y},\underline{z},t).y_i}{\omega^{*}_{z_j}(\underline{y},\underline{z},t).z_j} \quad \begin{array}{l}(i = 1,\dots,J\ ;\ j = 1,\dots K;\\ (t = 1,\dots,T)\end{array}$$

as being the set of relative preference elasticities of the target variables with respect to the instrumental variables in year t = 1,...,T.

With the help of the definitions stated herebefore we can indicate now why we are able to avoid the problems as regards the a priori specification of the preference function and those of the second order conditions.
Starting from system (I.B.1.a) we derive the mathematical formulation of the first order conditions for having a maximum as follows.[28)] Writing the Lagrange function in year t:

$L_t = (\underline{y}, \underline{z}, \underline{v}, \underline{x}, \underline{y}_{-}, \underline{v}_{-}, \underline{e}, \underline{\lambda}, t)$ or

$$L_t = \omega(\underline{y}, \underline{z}, t) - \underline{\lambda}_t' \, \underline{f}(\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \qquad \text{(I.B.1.b)}$$

where $\underline{\lambda}_t'$ is the transposed $\underline{\lambda}_t$-vector of Lagrangean multipliers, we find the first order relations by taking the first partial derivatives of L_t with respect to the elements $y_j (j = 1, \ldots, J)$, $z_k (k = 1, \ldots, K)$ $v_i (i = 1, \ldots, I)$ and $\lambda n, t$ $(n = 1, \ldots, N)$ of the corresponding vectors $\underline{y}$, $\underline{z}$, $\underline{v}$ and $\underline{\lambda}_t$, and setting them equal to zero i.e.

$$\begin{bmatrix} \underline{\omega}_y^* (\underline{y}, \underline{z}, t) - F_y^* (\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t \\ \underline{\omega}_z^* (\underline{y}, \underline{z}, t) - F_z^* (\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t \\ \underline{0}_1 \quad - F_v^* (\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t \\ \underline{0}_2 \quad - \underline{f} \; (\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \end{bmatrix} = \begin{bmatrix} \\ \\ \underline{0} \\ \\ \end{bmatrix} \qquad \text{(I.B.1.c)}$$

where $\underline{\omega}_y^*(\underline{y}, \underline{z}, t)$ is the $J \times 1$ vector of which the elements denote the marginal preferences with respect to the target variables; $\underline{\omega}_z^*(\underline{y}, \underline{z}, t)$ is the $K \times 1$ vector with elements denoting the marginal preferences with respect to the instrumental variables.

$F_y^*(\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t$, $F_z^*(\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t$ and $F_v^*(\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; \underline{e}; t) \, \underline{\lambda}_t$ are the mathematical expressions of the partial derivatives of L_t without $\omega(\underline{y}, \underline{z}, t)$ with respect to the elements of $\underline{y}$, $\underline{z}$ and $\underline{v}$, where the latter vector $\underline{v}$ is the vector of the irrelevant endogenous variables.

$\underline{0}_1$ is the $I \times 1$ null-vector corresponding to the partial derivatives of $\omega(\underline{y}, \underline{z}, t)$ in L_t with respect to the elements of $\underline{v}$.

$\underline{0}_2$ is a $N \times 1$ null-vector. $\underline{0}$ is a $(2N + K) \times 1$ null-vector;

$\underline{f}(\underline{y}; \underline{z}; \underline{v}; \underline{x}; \underline{y}_{-}; \underline{v}_{-}; e; t) = \underline{0}$ is of course the original sidemodel of system (I.B.1.a).

As we saw already, the vectors $\underline{y}$, $\underline{z}$, $\underline{v}$, $\underline{x}$, $\underline{y}_-$, $\underline{v}_-$, $\underline{e}$ represent in the train of thought of the ex post approach, the already known values of the corresponding variables, respectively constant terms, of the econometric model of the economy concerned in a certain year t in the past.
We arrive now at the mathematical formulation of the first order conditions of the mentioned inverted optimizing problem.
In this case the unknowns in system (I.B.1.c) are the vectors $\underline{\omega}_y^*(\underline{y},\underline{z},t)$, $\underline{\omega}_z^*(\underline{y},\underline{z},t)$ and $\underline{\lambda}_t$.
Rearranging the first order relations of system (I.B.1.c) and realizing that $\underline{f}(\underline{y};\ \underline{z};\ \underline{v};\ \underline{x};\ \underline{y}_-;\ \underline{v}_-;\ e;\ t) = \underline{0}$, we derive the mathematical system of the inverted optimisationproblem as follows:

$$\begin{bmatrix} \underline{\omega}_y^*(\underline{y},\underline{z}.t) & - F_y^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t)\ \underline{\lambda}_t \\ \underline{\omega}_z^*(\underline{y},\underline{z},t) & - F_z^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t)\ \underline{\lambda}_t \\ \underline{0}_1 & - F_v^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t)\ \underline{\lambda}_t \end{bmatrix} = \begin{bmatrix} \\ \underline{0} \\ \\ \end{bmatrix} \quad \text{or}$$

$$\begin{bmatrix} I & - F_y^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t) \\ & - F_z^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t) \\ 0 & - F_v^*(\underline{y},\underline{z},\underline{v},\underline{x},\underline{y}_-,\underline{v}_-,\underline{e},t) \end{bmatrix} \cdot \begin{bmatrix} \underline{\omega}_y^*(\underline{y},\underline{z},t) \\ \underline{\omega}_z^*(\underline{y},\underline{z},t) \\ \underline{\lambda}_t \end{bmatrix} = \begin{bmatrix} \\ \underline{0} \\ \\ \end{bmatrix} \qquad \text{(I.B.1.d)}$$

Where I is an (J + K) × (J + K) unit matrix and 0 is an I × (J + K) null matrix; F_y^*, F_z^*, and F_v^* are J × N, K × N resp. I × N matrices of which the elements are known. Considering systems (I.B.1.a)/(I.B.1.d) makes clear that if we are able to prove that there always exists a function $\omega(y,\underline{z},t)$ for which the first order relations of (I.B.1.c) are necessary and also sufficient to be imposed on the results for having its maximum, we do not need to integrate explicitely the second 'order' conditions in the mathematical programming model in order to solve system (I.B.1.a). This means that system (I.B.1.d) denotes also the necessary and sufficient conditions to be imposed on the results of the inverted optimisation problem and, as we shall show hereafter, if offers the just starting point for the ultimate development of our D.S.I.D.-model.

In the literature aforementioned proof is sometimes given by construction only available if special conditions are satisfied.
However we have formulated a generalization of the proof in an earlier paper.[29)] Because we are not interested in the numerical form of the preference function itself in the first place, we need not bother about the second-order problems in the sense of having to let them enter explicitely in our determination model as others have done. (see: section I.A.).
We called our new determination model for preference structures: "Deterministic-Static-Implicit-Determination"-model. (D.S.I.D.-model). The qualification "Deterministic" results from disregarding stochastic disturbance terms. The model is "static" because optimisation concerns only one year and so the dynamic econometric model can be considered as a static one as concerns optimisation. This is because before performing the optimisation procedure not only the values of the constant terms ($\underline{e}$) and those of the exogenous variables $\underline{x}$ are known but also those of the lagged endogenous variables $\underline{y}_-$ and $\underline{v}_-$ of system (I.B.1.a). The same is true for the coefficients.
The determination model is an implicit model because it determines implicitely the preference structures underlying the assumed optimal decision-making in the past.
Establishing the theoretical D.S.I.D.-model no a priori mathematical specification of the preference function is assumed; the only neccessary input to be accepted is that <u>some</u> preference function is maximized by the policy decision unit whereas this maximization is constrainted by the dynamic linear model (I.A.2.a). Performing the optimisationprocedure using the Lagrange technique and reformulating this with regard to the inverted optimisationproblem (see (I.B.1.a)/(I.B.1.d)) we arrive at the linear and homogeneous system of equations (I.B.1.d). The number of the elements of the vector containing the unknowns $\underline{\omega}^*_y(\underline{y},\underline{z},t)$, $\underline{\omega}^*_z(\underline{y},\underline{z},t)$ and $\underline{\lambda}_t$ equals the number of arguments of the unspecified preference function ($y_j(j=1,\ldots,J;$ $z_k(k=1,\ldots,K)$) plus the number of the constraints i.e. the number of equations of the dynamic linear model in year t. If we denote the matrix of system (I.B.1.d), containing the known elements, with A_t and the vector of unknown elements with $\underline{p}_t$ we can write instead of (I.B.1.d):

$$A_t \cdot \underline{p}_t = \underline{0} \qquad \text{(I.B.1.e)}$$

System (I.B.1.e) will always be underdetermined if the number of target-variables exceeds zero and if the system only relates to one single year t.
To get rid of this difficulty we start with normalizing system (I.B.1.e) and get:

$$\bar{A}_t \cdot \bar{p}_t = g_t \qquad \text{I.B.1.f)}$$

by singling out the last element of the vector p_t, equaling it to the arbitrary base-value 1.
Multiplication of this base-value with the last column of the (N + K) × (N + J + K) matrix A and changing the sign results in the (N + K) × 1 vector g_t. So the $\bar{A}_t$-matrix of system (I.B.1.f) is of order (N + K) × (N + J + K - 1). This system will be solved for the as yet unknown elements of the (N + J + K - 1) × (1)-vector $\bar{p}_t$ up to the arbitrarily fixed value of 1 using a special generalized inverse technique i.e. making use of the Moore-Penrose inverse.[30)]
If system (I.B.1.f) is consistent and its rank equals N + K whereas the original unspecified preference function of system (I.B.1.a) only contains one target variable this technique boils down to the normal inverse technique which is well-known. However independently of this special situation we can get a solution of system (I.B.1.f) by using the Moore-Penrose inverse technique and get:

$$\bar{p}_{t,u} = \bar{A}_t^{+} \cdot g_t \qquad \text{(I.B.1.g)}$$

So the D.S.I.D.-model has been made up of the synthesis of the Lagrange-multiplier- and the Moore-Penrose generalized inverse techniques. From the geometrical point of view our method chooses in the hyperplane representing the degrees of freedom a point of minimum norm i.e. that of the minimum euclidean distance:
Let the Least-Squares-Solution Norm be defined as:

$$\min_{\bar{p}_t} // \bar{A}_t \cdot \bar{p}_t - g_t //^2 \qquad \text{(I.B.1.h)}$$

If system (I.B.1.f) is consistent, system (I.B.1.h) is solved by:

$$\bar{p}_{t,0} = \bar{A}_t^{+} g_t + (I - \bar{A}_t^{+} \bar{A}_t) r_t \qquad \text{(I.B.1.i)}$$

where r_t is an arbitrary (N + J + K - 1) × (1) vector;
$\bar{p}_{t,0}$ is a general (N + J + K - 1) × (1) Least-Squares-Solution (L.S.S.)-optimum vector.

The minimum Euclidean Norm can be defined now as:

$$\min_{r_t} // \bar{p}_{t,0} //_2 \qquad \text{I.B.1.j)}$$

for which the solution can be obtained, starting from (I.B.1.g), as follows: (If system (I.B.1.f) is consistent).

$$\bar{p}_{t,u} = \bar{A}_t^{+} g_t \qquad \text{I.B.1.k)}$$

where $\bar{p}_{t,u}$ is a Least-Least-Squares-Solution vector (L.L.S.S. vector) which denotes the "unique' solution vector of system (I.B.1.f), satisfying the minimum 'Euclidean Norm' condition. $\bar{A}_t^{+}$ denotes the Moore-Penrose Inverse of matrix $\bar{A}_t$ and is of order (N + K + J - 1) × (N + K).
Using this special concept of the generalized inverse and wheighting the first (J + K) elements with one of them results in:

a) the selection of a vector of ratio values indicating the relative preferences of the target and instrument variables according to the definitions stated above, whatever the true value of the last element of the p_t vector of system (I.B.1.e), i.e. that of $\lambda_{N,t}$, would be ($\lambda_{N,t} \neq 0$), in year t.
b) the possibility for a test of stability through time t (t = 1,...,T) of the relative preferences. It is important that the solution obtained by minimizing the Euclidean Norm be very sensitive to variations in the known elements referring to a certain year t, which biases them against the null-Hypothesis (H_0)-hypothesis, stability of relative preferences or of the preference structure.

In this case we want to see whether we are able or not to reject the H_0-hypothesis that preference structures are constant. If we are, there are many possibilities to formulate other H_0's consisting of hypotheses as regards the degree of stability and see which of them we cannot reject. In earlier contributions we tried to get the best polynomial curve fitting of the relative preference ratios through time. The goodness of fit was based on the analysis of variance using the F-test.

As already noted, in a forthcoming research memorandum we will broadly demonstrate the principles of the generalized inverse technique.

The difference and interrelationship between some important concepts of this inverse technique, especially with that of the Moore-Penrose one, will then be discussed.

In the same exercise we shall make clear why the L.L.S.S.-vector $\bar{p}_{t,u}$ of systems (I.B.1.g) and (I.B.1.h) are the best starting points for determinating relative preference structures of an economy in our case. In another study we used Graybill's computing formula for the Moore-Penrose inverse that appears to be the best one in terms of accuracy and speed of computation.[31)]

Par. I.B.2. The interactive respecification model[32)]

Another approach, slightly different from ours, also starts from implicit preferences. Emphasizing, policy decisions do not follow simple repeated optimisations authors as Ancot c.s. want to conduct policy experiments so that the characteristics of planning behaviour can be 'observed' and estimated. They argue, where policies can be treated as if derived from simulated experiments, the information on which options were preferred or rejected can be used to build up the associated preference structure via an interactive planning scheme. Earlier examinations on the mechanics of how implicit preferences can be constructed by a pseudo-simulation of a given policy choice have been succeeded by an empirical determination of the preferences implicit in the policy choices actually made by the Dutch government, over 1976-1980 inclusive. Their model of planning behavior is of a stochastic and dynamic nature. T planning-intervals are considered ($t=1,\dots,T$) each of which involves a vector of instruments, $\underline{z}_t$; a vector of targets $\underline{y}_t$; and a vector of uncontrolled and uncertain variables, $\underline{s}_t$.

Let $\underline{x}' = (\underline{y}_1', \ldots, \underline{y}_T';\ \underline{z}_1', \ldots, \underline{z}_T')$ and $\underline{s}' = (\underline{s}_1', \ldots, \underline{s}_T')$, and write their corresponding ideal but infeasible paths for the policy variables as $\underline{x}^d$ and the policy failures as $\tilde{\underline{x}} = \underline{x} - \underline{x}^d$. The constraints, as perceived by the planners, are represented by the econometric model:

$$\underline{y}_t = \underline{f}_t(\underline{y}_t, \underline{y}_{t-\ell}, \underline{z}_t, \underline{s}_t) \tag{I.B.2.a}$$

Linearizing this model about the sequence of historical values for $\underline{z}_t$ and $\underline{s}_t$ and then the successive linearisations stacking up to conform with $\underline{x}$ results in the model

$$\underline{y} = R\underline{z} + \underline{s} \tag{I.B.2.b}$$

where:

$$R = \begin{bmatrix} R_{11}. & & 0 \\ \vdots & \ddots & \\ R_{T1} & \cdots & R_{TT} \end{bmatrix} \text{ and } R_{tj} = \begin{Bmatrix} \partial \underline{f}_t / \partial z_j \text{ if } t \geq j \\ 0 \text{ otherwise} \end{Bmatrix} \text{ contains}$$

numerical evaluations of the dynamic multipliers for some level of economic activity $\underline{z}$ and $\underline{s}$. Deleting the equations for non-targets system (I.B.2.b) can be rearranged as follows:

$$I\underline{y} - R\underline{z} = \underline{s}$$

$$I(\underline{y} - \underline{y}^d) - R(\underline{z} - \underline{z}^d) = \underline{s} - (I-R)\ \underline{x}^d$$

$$[I - R].\tilde{\underline{x}} = \underline{s} - [I - R].\underline{x}^d$$

and if $H = [I - R]$ one can get:

$$H\tilde{\underline{x}} = \underline{s} - H\underline{x}^d = \underline{b}$$

$\underline{s}$ is assumed to follow some unspecified probability density function with known mean, $E_t(\underline{s})$, at each t. Besides $E_t(\underline{s}) = E(\underline{s};\ \Omega)$ denotes the conditional expectation based on the information set, Ω_t and is available to each agent at the start of period t. The latter set comprises past values of all the variables, current expectations of the components of $\underline{s}_{t+j}$, j > 0, current estimates of estimates of R, and so on. The only wish to rank $\underline{\tilde{x}}$ values implies that some performance index can be associated with each $\underline{\tilde{x}}$ through:

$$\omega = \omega(\underline{\tilde{x}}) \qquad \text{(I.B.2.c)}$$

satisfying the minimal set of axioms consistent with rational choices i.e. completeness, reflexivity and transitivity. For convenient sake the authors assume also convexity and differentiability for (I.B.2.c).

In order to arrive at a policy decision rule a second order approximation to (I.B.2.c) about some feasible $\underline{\tilde{x}} = \underline{x}^* - \underline{x}^d$ is given by

$$\omega = \tfrac{1}{2}\, \underline{\tilde{x}}'\, Q\, \underline{\tilde{x}} + \underline{q}'\, \underline{\tilde{x}} \qquad \text{(I.B.2.d)}$$

where $Q = (\partial^2\omega/\partial\underline{x}\ \partial\underline{x}')_{\underline{\tilde{x}}^*}$ and $q = -Q\,\underline{\tilde{x}}^* + (\partial\omega/\partial\underline{x})_{\underline{\tilde{x}}^*}$. The matrix Q is symmetric and positive definite if (I.B.2.c) is strictly convex and twice differentiable.

Taking $\underline{x}^d$ as the true ideal policy vector and $\underline{q} = 0$, the optimal decision is given by:

$$\underline{\tilde{x}}^* = \min_{\underline{\tilde{x}}} \{\omega(\underline{\tilde{x}})\,|\,H\underline{\tilde{x}} - \underline{b} = 0\} \qquad \text{(I.B.2.e)}$$

and yields the policy decision rule expression:

$$\underline{\tilde{x}}^* = Q^{-1}\, H(H'Q^{-1}H)^{-1}.\underline{b} \qquad \text{(I.B.2.f)}$$

as an approximation, while the point at which Q is evaluated differs significantly from $\underline{\tilde{x}}^*$. Finally, $\underline{b}$ in (I.B.2.f) is replaced by its conditional expectation at the moment of calculating $\underline{\tilde{x}}^*$. The latter calculation is repeated for each t = 1,...,T and starts from (I.B.2.f) using $E_1(\underline{b})$ and proceeds by (I.B.2.f) with expectations to be updated to $E_t(\underline{b})$ for each t, and this altogether with the appropriate adjustments to Q, H, $\underline{q}$ and $\underline{b}$. The way how $\tilde{x}^*$ can be represented at any stage of revision, from the initial calculation to the sequence of decisions actually implemented, is influenced by the way how the conditioning information has been obtained. Therefore, the author's estimation exercises for the analysis of the Dutch preference structure recognise two sets of results i.e. the case of the 'open loop policies' and the one of the 'closed loop policies'. The former case has been conditioned on the information of 1976, while the latter case reflects the actual policy choices of 1976-1980 rather than their planned values. In this same case the non-controllable variables in each information set were replaced by their realised values, and $E_t(\underline{y}_t)$ replaced $E_1(\underline{y}_t)$, for t = 1,...,T in the construction of $\underline{x}_p$ being any preferred 'second' best but infeasible policy. This preferred policy vector is a dominant part of the authors' idea of a planner's decision making. A single planner is supposed to take some sequence of candidate policies $\underline{x}^{(s)} \varepsilon F$; s = 0, 1,... . His selection process is to rank the candidates to:

$$//\underline{x}^{(s+1)} - \underline{x}_p//_2 < //\underline{x}^{(s)} - \underline{x}_p//_2 \qquad \text{(I.B.2.g)}$$

Where $//.//_2$ denotes the euclidean norm, while $\underline{x}^d$ remains the ideal. A satisfactorily selected policy recommendation requires the policy makers to experiment interactively with different values of the $\underline{x}_p$ vector in order to find the closest feasible choice i.e.

$$\underline{x}^{(p)} = \min_{\tilde{\underline{x}}} //\ \underline{x} - \underline{x}_p\ //_2 \text{ subject to } \underline{y} = R\underline{z} + \underline{s} \qquad \text{(I.B.2.h)}$$

As a special case of (I.B.2.f), setting Q = I and $\underline{x}_p = \underline{x}^d$, the authors consider the system:

$$\underline{x}^{(p)} = (I - H'(H\ H')^{-1}H)\ \underline{x}_p + H'(H\ H')^{-1}\underline{s} \qquad \text{(I.B.2.i)}$$

and prove that every feasible policy, rationally chosen with respect to $\underline{x}$ and according to some admissable preferences may be generated by fixing Q = $Q^{(0)}$ and varying $\underline{x}^d$ as necessary within (I.B.2.f). They call it the 'preferences implicit' procedure for policy selection and system (I.B.2.i) is a demonstration of this possibility by $Q^{(0)}$ = I and with $\underline{x}^d$ replaced by the $\underline{x}_p$-sequence. A fully equivalent procedure, the 'preferences explicit' one is the other way around and generates every feasible $\underline{x}^*$ by varying Q over the set of positive definite, symmetric normalised matrices, while $\underline{x}^d$ is fixed. For the aforementioned empirical Dutch policy study the second interactive respecification model has been applied. Given a special version of the Vintaff-II model, developed by the Dutch Central Planning Bureau, they evaluated Q during the five successive years and special interest was paid to the diagonal elements of this matrix by use of the correlation matrix for the 'open loop' solution as well as for the 'closed loop' one.

The latter results of their respecification experiment delivered a substantially more clarified preference structure compared with the former ones, probably, as concluded by the authors, because the Dutch policy strategy chrystalized, and became coherent with experience during the life of the Dutch administration during that time.

Par. I.B.3. Evaluation, Notes and Bibliography

The foregoing review on establishing collective preferences shows an overwhelming attention to objective functions whether or not explicitely used in macro-economic planning behavior. The a priori approaches clearly appear to be second to the ex post ones. And, indeed, two main reasons as Ancot c.s. speak about, are first the inevitable introduction in the case of public policy of the difficulty that often a planning agency represents a coalition of interests so that the policy solution model must incorporate a collective preference function which is capable of generating the necessary consensus decisions. The many contributors to planning and their substantially varying individual preferences seems to exclude the a priori possibility and thus the explicit objective function approach has been ruled out. A second important reason is that the many efforts in the literature to derive fixed policy reaction functions must be qualified as unstable and low explanatorily powered results.[32)] On the other hand the ex post approach to analysing collective planning behavior, starting from the implicit preferences idea seems to be a more promiseful one. It recognises that planning behavior involves constrained optimisation conditional on expectations of the future while constraints and the information set are relatively well understood. Besides, it takes into account fully consciously policy decisions do not follow simple repeated optimisations. Nevertheless, the determinationmodels of implicit preferences established within the scope of the ex post approach still leave a number of problems unsolved. However, in paragraph I.B.1 we saw how the D.S.I.D.-approach takes care of results not being influenced anymore by the a priori functional form of the preference function. Moreover, the problem of the second order conditions has been overcome by the use of the concept of relative preference elasticity. This is admissible because it has been proved in the past that there always exists an objective function that will be maximized by a policy decision unit.

The interative respecification model, discussed in paragraph I.B.2, starts from implicit preferences too. The way how these preferences are reconstructed by a pseudo-simulation of a given policy choice implies policy experiments so that the characteristics of planning behavior can be 'observed' and estimated in more detail compared with the D.S.I.D.-model's way of doing. On the other hand the second order approximation to an unspecified preference function, and the set of assumptions used in the respecificationmodel, may be reasons perhaps why the estimates approximate the true preference structure in a less precise way as those of the D.S.I.D.-model. Especially, this will become more likely if the attention is turned to test stability through time of relative preference elasticities rather than to simulate the planning behavior in itself.

Notes:

1) See the bibliography, in particular the numbers 12, 28, 47, 52, 68 and 70.

2) See the bibliography, numbers 8, 19, 37, and 73.

3) See the bibliography, numbers 47, 48 and 49. Other results will be published in the research memoranda, An exercise in welfare economics, (III) and (IV), both forthcoming.

4) See the bibliography, number 39.

5) See the bibliography, number 38.

6) See the bibliography, in particular the numbers 52, 54, 60, 64, 66, 69, 71, 72, 74 and 81.

7) See the bibliography, in particular numbers 70, 74 and 75.

8) See the bibliography, in particular number 12.

9) See the bibliography, in particular numbers 5, 7, 10, 15, 22, 24, 30, 34, 35, 40, 45, 63, 64, 65 and 79.

10) The present bibliography shows this platform of adherence to our way of thought.

11) See the bibliography, number 5.

12) See the bibliography, number 10.

13) See the bibliography, number 77.

14) See the bibliography, number 55.

15) See the bibliography, number 47. Afterwards, we did not restrict ourselves to this originally maintained hypothesis of an a priorily known preference function. See also note 3).

16) See the bibliography, numbers 34 and 35.

17) See the bibliography, numbers 20, 21, 50 and 76.

18) See the bibliography, number 80.

19) See the bibliography, in particular numbers 2, 3, 4, 6, 9, 13, 14, 16, 17, 18, 26, 27, 28, 29, 31, 32, 33, 45, 46, 47, 49, 53, 55, 56, 57, 58, 61, 62, 78, 81 and 82.

20) See the bibliography, number 69.

21) See the bibliography, number 53.

22) See the bibliography, number 13, 62 and 81.

23) See the bibliography, especially numbers 1, 8, 19, 23 and 73.

24) See the bibliography, numbers 2, 3, 4, 25, 29, 31, 55 and 70.

25) See the bibliography, numbers 47 and 49 and note 3).

26) See the bibliography, numbers 29 and 42. As it will become clear later on in our D.S.I.D.-model the Pseudo-Inverse technique plays an important role. Sensitivity analysis demands in such cases big attention to the pertubation theory. We refer to the Research Memorandum, An exercise in welfare economics (III), forthcoming.

27) Instead of $\omega^*_{y_j}(\underset{\sim}{y},\underline{z},t)$, we shall write often $\omega^*_{y_j}$ for convenient sake. Such abbreviation is applied too to the other analogous expressions.

28) See the bibliography, numbers 1 and 11.

29) See the bibliography, number 49.

30) We shall discuss this inverse technique in a more profound way in, An exercise in welfare economics (III), as Research Memorandum forthcoming.

31) See the bibliography, number 49.

32) See the bibliography, numbers 2, 3, 4, 28, 31, 32, 43 and 44.

33) See the bibliography, in particular the numbers 14, 16, 17, 33 and 36.

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