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The Contribution of Microanalytic Simulation Models to the Theory of Income Distribution

1. Microanalytic Simulation Systems and the Theory of Income Distribution

The purpose of this paper is two-fold. First, it gives a progress report on a large microanalytic simulation project which is done at the Universities of Frankfurt/Main and Mannheim. In 1971 the socio-political research group Frankfurt/Mannheim was founded. The members of the group have intended the development of a socio-political indicator and decision system for the Federal Republik of Germany. The project has been called SPES-Project[1].

The basic idea was to develop a system which gives information needed for an active social policy. Information on socio-structural trends and interdependencies is necessary for this purpose, as well as information on the consequences of actual measures of economic and social policy.

This task requires an analysis and discussion of the goals and objectives of an active social policy. A system of social indicators may serve as a framework for this purpose[2]. It permits, moreover, the control of social policy in an operational way. If the goal variables of social policy are formulated in an operational way, it is possible to measure the difference between intended and actual values. If policy instruments are chosen, it may be measured whether they are successful with respect to the goals.

The preparation of policy decisions requires the knowledge on the relation between policy instruments and goals. For this purpose a decision system is developed[3].

For purposes of social policy a high degree of disaggregation is needed. Especially when considering the situation of marginal groups in society, it can be shown that the analysis can not be restricted to aggregates. The decision system therefore is conceived as a microanalytic simulation system implemented on a computer. The system allows to make forecasts and to analyse the effects of hypothetical political instruments. The effects are measured in the system of social indicators which is incorporated into the decision system. Therefore the output of the decision system are values for the different social indicators which serve as goal variables.

The combination of an indicator- with a decision system raises a broad spectrum of problems which will not be dealt with in this paper. A short overview of the system is given in Section 4.

One of the variables which describe the economic and social situation of individuals and households is the income of individuals and households. The decision system therefore includes the generation of individual- and household income. The distribution of individual earnings, of household income and household income per head can be determined by using the concept of gross and disposable income. It is possible to make forecasts of the development of incomes and their distribution as well as to show the influence of policy instruments on these values.

The subsystem of the decision system which generates incomes can be regarded as an operational theory of income distribution. Hypotheses used in the simulation system are hypotheses which are also useful for the theory of income distribution. Therefore a microanalytic simulation system of this type constitutes an approach to the theory of income distribution too.

This leads to the second purpose of this paper. An assessment is made of the current state of the theory of income distribution with special emphasis on the requirements a meaningful theory of income distribution should fulfill and on the role microanalytic patterns and paradigms can play in the further development of the theory of income distribution.

2. Some Requirements for a Meaningful Theory of Income Distribution

The Social Indicator Movement has lead to a more extensive discussion of goal dimensions. This is valid for the problems of income distribution too. The goal system related to this field has to include quite different dimensions[4)]. The most important ones are:

1. The adequacy of the income of a person with respect to his contributions in the production process.

2. The degree of equality of consumption possibilities

3. The level of poverty

4. The steadiness and security of incomes.

The first dimension requires the explanation of the income of individuals, the other the explanation of incomes of households. Some of these problems allow the restriction to a small number of social groups, others require a differentiation which shows the situation of fringe-groups too.

From this broader goal system the following requirements for the theory of income distribution can be deduced:

1. The theory must allow a relatively high degree of disaggregation. A unit of analysis has to be chosen which allows the formulation of goal-oriented questions. In any case, two units of analysis as in the two-group -systems are not sufficient. The usual two-group-scheme

of the so-called functional distribution theory is not very useful because the groups are very heterogenous and because of the fact that all social groups have incomes from different functional sources. The minimum requirement would be a disaggregation that is related to the social status of the head of the household and the income level.

2. The income distribution theory must distinguish between the distribution of income of individuals and of households or spending units.

3. The theory of income distribution must include the information available up to now on the determinants of income. If we accept only the different explanations of income distribution presented at this Symposium, we have to include a large number of factors which determine the distribution of income. The minimum requirement is here the relation to the economic process on the one hand and on the other hand the inclusion of socio-economic characteristics of individuals and households. This means that a purely functional distribution of income is as inadequate as a theory of size distribution of income which neglects the macroeconomic conditions. Monocausal theories are not very helpful in this situation.

4. The broadening of the goal system reflects also the improved data situation. The use of computers in economics and statistics has allowed the construction of large microdata bases. Even if the situation may be regarded as unsatisfactory with respect to some questions, the statistical situation has improved considerably. The minimum requirement would be that the theory of income distribution uses the available information.

5. The income distribution theory should be flexible enough to answer changing questions. The process of social change leads to changing questions. It is not advisable to develop in each case single purpose theories.

A very simple formal framework may serve the definition of the minimum requirements of a theory of income distribution[5].

Generally, distributions can be described by distribution vectors where the elements represent the share that a unit or a group gets of the income. The sum of all elements of these vectors is 1. By using this concept it is possible to define the distribution of income over persons by the vector vy where the elements show the share which the different persons have in the overall income. Principally, the same approach can be used for groups. In this case an element of the vector represents the share of the group.

Distribution vectors of this type can also be defined for the different types of income. The vector v_f describes the distribution of the f^{th} type of income or the income derived from the f^{th} sector. The factor distribution vectors v_f can be regarded as columns of a distribution matrix VYF which shows how the different types of income are distributed over the persons. The functional distribution may be described by a distribution vector vY where the elements constitute the share of the different factors for types of incomes in the overall income. Then it is valid by definition

$$vy = VYF \cdot vY.$$

The relation between functional and size distribution of income depends on the matrix VYF. It is an empirical question whether the vector vY can be used as a proxy for vy. This is merely then possible if the non-diagonal elements of VYF are equal to zero. This, however, is not the case as regards most industrialized countries.

If the income of households has to be considered too, it is necessary to find an algorithm A which generates the household distribution vector hy. This algorithm has to add up the shares of persons who belong to the same household and it has to rearrange the household vector.

In many cases the distribution per head has to be taken into account too. It can be derived in dividing the household distribution vector hy by the household size matrix QN which solely has diagonal elements that represent the number of persons in a household. The result is the household income per head

$$ky = (QN)^{-1} \cdot hy.$$

It can be empirically shown that the distributions represented by vy, VY, hy and ky differ considerably. An income distribution theory related to the different distributional goals has to include all these vectors into the consideration.

3. Shortcomings of the Theory of Income Distribution

By using the requirements as developed above, the state of the art in the field of income distribution theory is not very satisfactory. It has been indicated that the requirements have increased considerably due to the goal discussion and the improved scientific and statistical possibilities. Therefore it may be unfair to judge the traditional theories of income distribution by these increased requirements. It must be stated, however, that the traditional theories of income distribution do not meet these requirements. The development of new approaches or new paradigms therefore is necessary.

The so-called functional distribution theory is still related to heterogenous groups and neglects the fact that incomes of the same people may originate from different sources. A differentiation of the personal base is not possible, i.e. individual and household income can not

be distinguished. In the formal framework of the last section only the functional distribution vector vY can be explained. Trivial conclusions to the other distribution vectors are impossible. It may be asked whether this type of theory has social relevance at all.

Contrary to the above, theories of size distribution of income are usually related to a small number of socio-economic characteristics. A relation to macro-economic processes usually is not possible. Most of these theories have a strong inclination toward a mono-causal argument. In some approaches, in the final analysis one single factor is used for the explanation of the variance of income.

In the formal framework of the last section, in most cases the distribution vector for one kind of income is analysed. This means that only one row of the distribution matrix VYF is explained. Neither the distribution of the sum of all incomes of an individual nor that of households can be clarified in this manner.

An explanation of the functional distribution vector vY is as necessary as that of the size distribution vectors for the different types of income. In this respect the approaches mentioned above contribute to a theory of the income distribution. Each constitutes a necessary, but not sufficient part of a theory of income distribution.

It is necessary to combine these different approaches. Especially useful are attempts to relate the size distribution of income to macroeconomic variables by combining personal and functional elements. These attempts still pose many problems, especially because of the difficulties of handling large theoretical systems. Therefore many of the factors which have been shown to be important in partial analyses are still neglected in these approaches.

In this situation it may be asked to what extent a micro-analytic simulation approach may be helpful for the de-

velopment of a theory of income distribution.

4. The basic framework of the simulation approach of the SPES-Project

It is not feasible to give a detailed description of a large socioeconomic system on a few pages. This is especially true if the reader has a different degree of experience with simulation methods, particularly with the microanalytic approach. The presentation of the system shall therefore be restricted to a systematic sketch of the whole system and to a flow-chart that shows the microanalytic part.

Figure 1 gives a systematic view on the whole system. It demonstrates how social welfare, operationalized in social indicators, is determined by non-controllable factors and policy instruments. The simulation system consists of two subsystems which are linked together. On the one hand macroeconomic models constitute the macroeconomic framework which secures the circular flow conditions. For most purposes the Bonn Model V (Krelle) ist used[6].

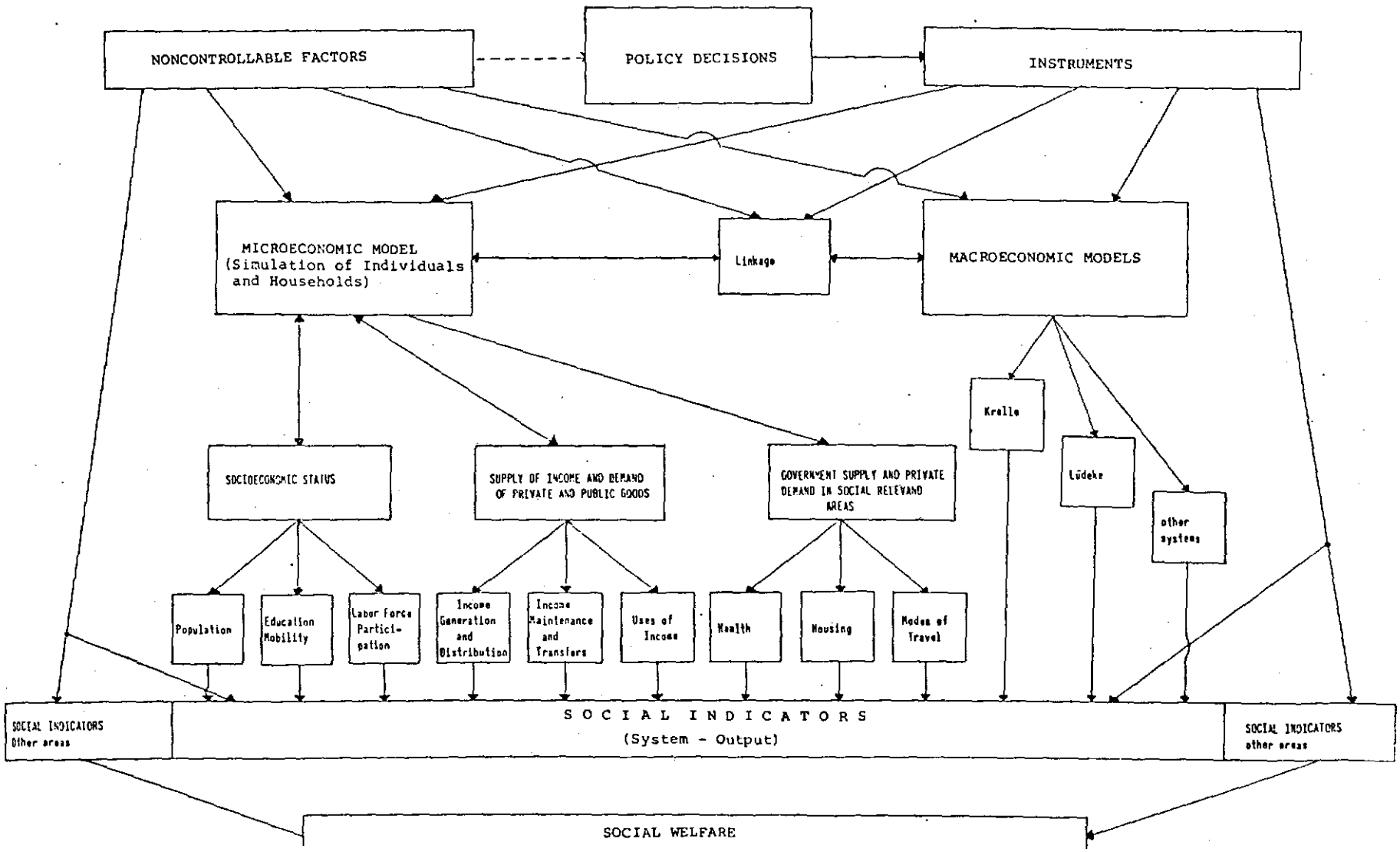
The central part of the system is the microeconomic model which uses microanalytic simulations methods for individuals and households. It is built up in a modular way; the single modules can be seen in Figure 1. The block "Supply of Income and Demand of Private and Public Goods" is most important in the context of income distribution. This block contains three modules:

Income Generation and Distribution
Income Maintenance and Transfers
The Uses of Income.

Figure 2 shows the technical structure of this system with an emphasis on the microeconomic model. The simulation is controlled on three main levels: The period loop allows the application of the system in different periods.

FIGURE 1:

Sociopolitical Decision and Indicator System for the Federal Republic of Germany



The interdependence loop permits feed-backs between the macroeconomic and the microeconomic system. It may be necessary to have an iteration run of the microeconomic model depending on the results of the macroeconomic model.

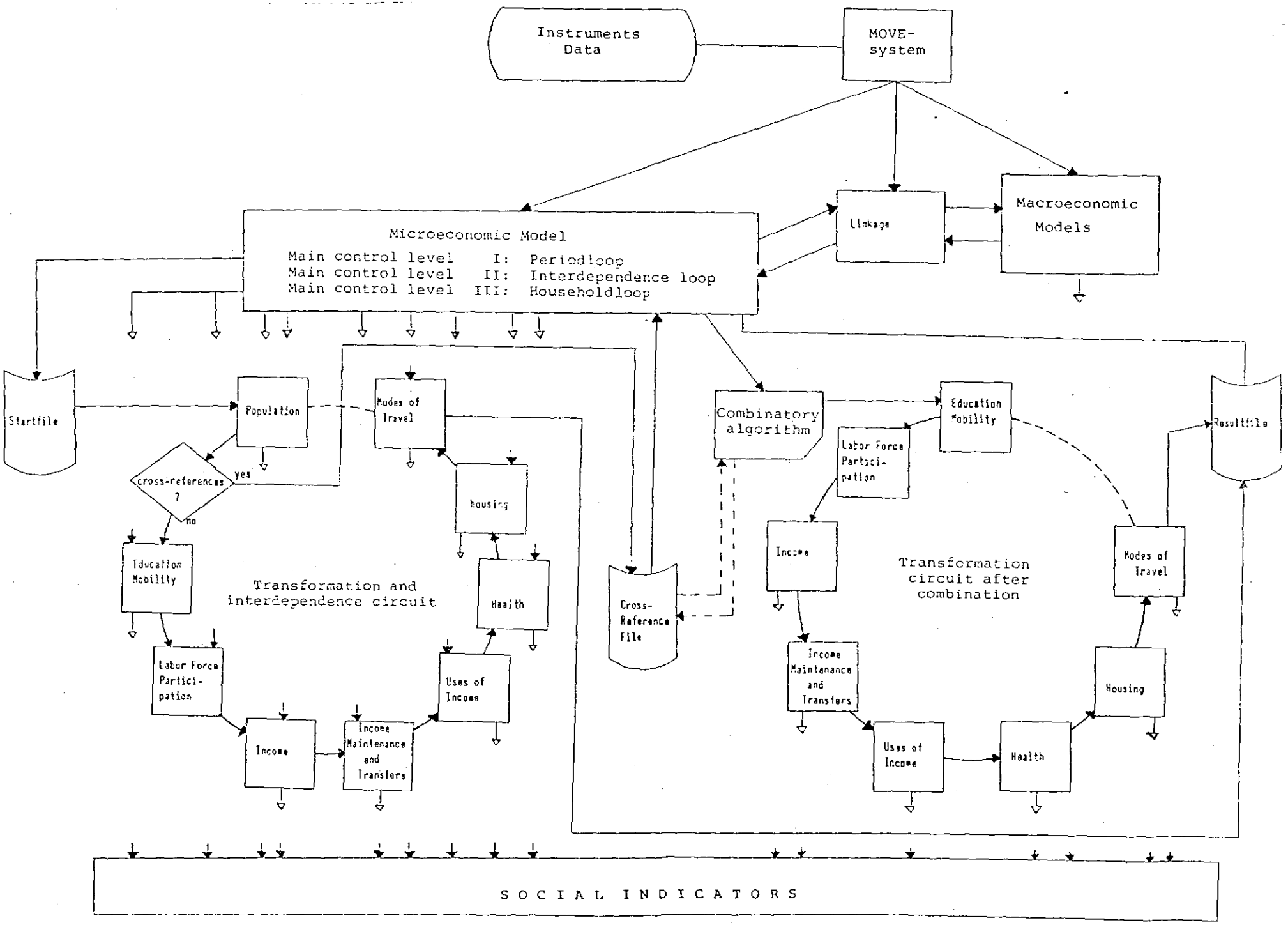
The household loop controls the different operations for the single household. The necessary information for these households is available on a start-file which is fed into the computer, household by household[7]. This information is then changed by the operators included in the modules of the transformation and interdependence circuit (left circuit in Figure 2). Some operators involve more than one household. Marriage, for example, brings together two persons who normally come from different households. In this case the necessary information is stored on a cross-reference-file. If the transformation and interdependence circuit is at least run through for all households, it is possible to applicate the necessary combinatory algorithm. For new households and for households which have been changed by this procedure the transformation circuit after combination has to be applied.

During the operations on the household level all information that is necessary to calculate the input variables for the macro-system and the social indicators is stored. After one period a result-file is available and may serve as a start-file for the next period, and for values of the relevant macro-variables and social indicators.

These few remarks may at least give an impression of the volume and the operating of the system. Most parts of the simulation system as described above are programmed and working. There still are technical restrictions in the linkage of the whole system. Therefore, up to now, partial analyses are prevailing.

Many of the hypotheses used are, however, very crude or on a weak empirical base. Therefore it may be useful to

FIGURE 2: Structure of the Decision and Indicator-System



ask for the experience that has accumulated up to this point as regards this type of microanalytic simulation system. For this representation the discussion will be restricted to hypotheses that concern the distribution of income, e.g. to the income- and transfer modules.

5. Types of Hypotheses used for the Microanalytic Simulation of the Income Distribution

The most important hypotheses used in microanalytic simulation processes[2] that are related to the problems of income distribution can be grouped as follows:

1. The macro-hypothesis
2. The transition hypothesis
3. The correlation hypothesis
4. The causal hypothesis
5. The institutional hypothesis

The macro-hypothesis uses macro-information for the generation of a micro event. It is found very often, especially in the field of income distribution, as it allows the reliance on available macro-information to generate non-available micro-information. A very simple example is the use of different growth rates for different types of income. In the national accounts the growth rates of the macro-aggregates are given. It is possible to determine the size of the individual income by applying these different growth rates to the different components of the household income. If, as an example, the wage income increases at a lower rate as income from profit, the effect of this development on the size distribution of income may be shown. This example requires the hypothesis that the size distribution matrix VYF is constant, at least for a short period, and that changes in the size distribution of income are only due to changes in the functional distribution vector vY. It is not very likely that this hypothesis holds generally. If the household income is also taken into account, a further hypothesis on the constancy of working

force participation of the different members of the household is necessary. Again this may be valid solely for the short-run. So it is very likely that this simple type of macro-hypothesis which relies mainly on the functional distribution is solely of limited importance.

The macro-hypothesis may also be used in more sophisticated manners. For wage income it is possible to distinguish between fixed and proportional increases. This would change the columns of the distribution matrix VYF related to the wage income. This may be especially useful if the result of collective bargaining agreements includes wage increases by a fixed amount as well as proportional increases.

A further improvement may be reached if different average wage increases for different social- or occupational groups are known. Thus, in many cases the different results of collective bargaining agreements for different groups are known. In using hypotheses on the wage drift, it might be possible to include this information as macro-hypothesis, too.

The set of hypotheses necessary to use the macro-hypothesis seems to be very restrictive. Nevertheless, the macro-hypothesis in many cases generates very useful results which are at least more reliable than the ones based on other approaches. The distributional impact of economic policy and of collective bargaining can be derived in this way in a more or less sufficient manner, at least for the short-run. Therefore the macro-hypothesis will remain a very powerful instrument of micro-analysis, at least within the years to come.

The transition hypothesis relates to a transition matrix approach. It is useful in the context of a cell concept where the cells are determined by a set of socio-economic characteristics. In this context it is necessary to explain, respectively to forecast, the transitions of individuals from one cell to another. The theoretical background may be a stochastic process that generates the transition.

A simple example can be taken from the field of education. The participation of an individual in the different stages of the educational system may be simulated by transition quotas which are governed by a stochastic process. A similar approach could be used to explain social mobility.

In this context Markoff-processes have been used very often. This leads, however, in many cases to considerable difficulties since the hypothesis that an event is independent of an individual's history, longer than one period, may be a wrong specification. This is, however, not a principle obstacle as it is possible to develop transition hypotheses which include the history of individuals too.

The transition hypothesis is typical of a cell concept. Even if one does not use a pure cell concept, it is possible to use this approach to alter different characteristics of the individual. The question changes slightly. One does not ask whether this individual will move into a different cell, but, on the contrary, one asks whether this individual will change a certain socio-economic characteristic.

If one leaves the pure stochastic interpretation of the transition hypothesis, one comes close to correlation hypotheses. This hypothesis uses information on the correlation between the generated variable and explanatory variables. This information usually is taken from cross-section surveys. Mostly the multiple linear regression approach is used for the estimation of coefficients. Variables which are measured on ordinal or nominal scales are usually introduced by defining a set of dummy variables. Besides multiple regression method other multi-varied methods are applicable too.

Examples for this approach can be easily given. It is possible to use correlations among income, the different types of income, age, education, region, mobility, experience, race, sex, experience in the participation in the labour force, religion, and others for the determination of income or its components. If the income of the last period is known, it may be easier

to restrict the analysis to the forecast of the change in the income.

One considerable advantage in using this type of hypothesis is the possible differentiation for purposes of microanalytic simulations. If the simulation is done on an individual level, i.e. the operations are performed for each unit, it is possible to determine the coefficients on a level of disaggregation which can be obtained for each function. If, for example, the wage income is to be determined, it is possible to form subgroups suitable for this purpose. The coefficients are then determined for these subgroups. If on the other hand the spending behaviour is to be generated, it is possible to choose a completely different grouping for this purpose. Generally, it is not surprising that this approach is widely used in microanalytic simulation systems.

The correlation hypothesis usually is related to one point in time or to one time-period. It therefore does not include causal information. It does not say anything about the relation between a cause and an effect.

The causal hypothesis relates causes and effects. It is that type of hypothesis which we usually call explanatory hypothesis. An event is explained by its causes. The wage income of an individual, for instance, could be explained by the individual or the collective bargaining process, the influence of supply and demand on the labour market, and similar causes.

There is no doubt that the use of causal hypotheses is most satisfactory on theoretical grounds. On the other hand, the difficulties related to the use of this type of hypothesis are considerable. A sequence of cross-sections which include the same population would be the necessary data base. This type of data is available in a few rare cases only. Usually it is solely related to the household sector. An information about both sides of the labour market, for example, in the necessary degree of disaggregation usually is

not available. Therefore this type of hypothesis is very rarely used in microanalytic simulation approaches.

The last type of hypothesis is the institutional hypothesis. It uses institutional regulations like tax laws or social security laws for the generation of income or transfers. Examples may be given especially in the field of positive or negative transfers.

One of the most powerful properties of the microanalytic approach is the possibility to use institutional hypotheses. On the micro-level institutional regulations may be used in a very precise way. Whereas it is nearly impossible to use institutional regulations to establish a macro-relation, it is very easy to reproduce the single steps of institutional regulations on the micro-level.

The micro-data bases used mostly contain all the information necessary for this purpose. The results are very exact. If they are summed up, they come very close to the macro-aggregates.

These different types of hypotheses are used to a very large extent in microanalytic simulation approaches. Principally, all of them could be used, in practice, however, operational microanalytic simulation systems only use them partly.

Macro-hypotheses of the different types still are very widely used. The micro-data base necessary for microanalytic simulation usually stems from one or more cross-sectional samples. The number of available samples is restricted whereas on the other side macro-aggregates and marge-distributions are available to a larger extent. The macro-hypothesis allows to combine the structural information available in the cross-sections with the more actual information on the development that is included in macro-aggregates and marge-distributions. The use of macro-hypotheses may be regarded as a very simple technique. It still is a very powerful instrument.

If structural considerations will be included in the theory of income distribution, the use of correlation hypotheses is necessary and possible. Thus, microanalytic simulation systems related to problems of income generation include this type of hypothesis too. Usually the income of the last period is also introduced since the attempt to explain the income of an individual or household solely by its socio-economic characteristics has proved to be less successful. This is partly due to the fact that that part of the variance which is not "explained" by the independent variables remains very large.

The application of institutional hypotheses so far has been particularly successful. Especially the determination of positive and negative transfers has been solved by this type of hypothesis.

The transition hypothesis is not used very often, except in systems which are constructed by transition matrices that relate sets of cells. This approach, however, is restricted to special problems. The introduction of this concept into the normal microanalytic concept is still the exception.

The use of causal hypotheses is very rare as data problems can not easily be solved and since our knowledge as regards this type of hypothesis still is weak.

The use of microanalytic simulation methods in the theory of income distribution therefore is ambivalent. On the one hand, it is possible to generate income distributions and show in this way determinants of the distribution, on the other hand causal hypotheses in a very narrow sense are not available and thus are not used.

The explanatory and theoretical power of these different types of hypotheses varies greatly. A very narrow interpretation of theory would restrict ourselves to merely causal hypotheses. This would imply that the microanalytic approach could be built upon a few theoretical elements only.

This restriction, however, would be damaging to the development of theory to an unnecessary extent. The requirements for a complete theory of income distribution developed in section 2. are not met by any theoretical approach. The microanalytic simulation approach may not be a sufficient substitute. However, it can be an operational and pragmatic step to the further development of a theory of income distribution. At least right now there is no alternative as powerful as the one described visible.

Footnotes

+The author is Professor of Social Policy and President of the Johann Wolfgang Goethe-University in Frankfurt/Main. He is a member of the Socio-Political Research Group Frankfurt/Mannheim (Sozialpolitische Forschergruppe Frankfurt/Mannheim) which develops the system reported here.
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1. For a short review of the system see: Krupp (1973). A longer description is given in: Brennecke/Krupp (1976).
2. The system of social indicators used in the SPES-Project is presented in Zapf (1977).
3. Information on the decision system may be found in: Brennecke/Krupp 1976, Brennecke 1975, Brennecke 1976/2, Brennecke 1976/3, Galler 1976.
4. Compare: Glatzer/Krupp 1975 and Chapter 2 of Krupp 1975 and the contribution of Glatzer in: Zapf 1977.
5. The formal framework used here is developed generally in: Krupp 1968
6. A description of the latest version may be found in: Krelle 1974. The first version of the model of Lüdecke may be found in: Lüdecke 1969.
7. The SPES-Project uses for this purpose the integrated micro-data-file IMDAF 1969. The properties of this file are described in: Kortmann/Krupp/Schmaus 1976.
8. Overviews over microanalytic simulations systems and the methodological problems encountered in microanalytical model building are given by Orcutt (1976) and by Orcutt, Caldwell and Wertheimer II. References to prior work are listed therein. For further comments on the design of microanalytic simulation models, see also the discussion in the paper by Budd and Whiteman in this book.

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