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# *Models, Planning and Basic Needs*

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payments model beginning from initial trade balance and ignoring within-country income distribution;

- monetary expansion leads inevitably to inflation and has small effects on real income growth (from a large Monetarist literature on Latin America): result depends on an assumption that real wages will stay constant under inflation, i.e. that there is no government labour repression or wage lag.

Many other examples could be added.

#### *Clues from Simple Models*

The foregoing discussion and the numerical performance of the models themselves suggest that the income distributions they generate are likely to be very stable. The same conclusion applies to actual economies, if the general outlines of the models' Keynesian price theory (forget about the details, which are mostly bound to be wrong) are approximately correct.

How then do income distributions change in the large, if they change at all? Accumulation of things like capital, education, better nutrition, and so on may contribute, though the details are fuzzy. Even more fuzzy are the workings of other cumulative processes like unequal exchange, or skewing of the distribution from persistent investment response to growth of luxury-goods demand over time. *Formal* theory of such processes is scarce and extremely crude (e.g. the very simple models in Bacha,<sup>6</sup> Taylor and Bacha,<sup>7</sup> and Chichilnisky, Cole and Clark<sup>8</sup>) though verbal discussions abound. Although none of the discussants are as perceptive as Keynes, the clues they provide may prove invaluable in setting up quantifiable models of the income distribution in the long run.

<sup>6</sup>Bacha (1978).

<sup>7</sup>Taylor and Bacha (1976).

<sup>8</sup>Chichilnisky, Cole and Clark (1977).

## *A Model of the Relation between Technology and North-South Income Distribution*

GRACIELA CHICHILNISKY, SAM COLE and JOHN CLARK

### *Introduction*

The macro-economic model described here is one part of a larger study with a broader interdisciplinary methodology.<sup>1</sup> Other aspects of the work are described later in the report.<sup>2</sup> This presentation represents a progress report of the first part of a longer-term effort. The main body of the work consists of the evaluation of North-South linked strategies founded on technology policies and satisfaction of basic needs of the majority of the population. These experiments use the model as an intermediary tool to project future possible scenarios of the world economy.

Technology is intertwined with many important economic variables, both at the macro and micro levels. In order to evaluate domestic technology policies we must study them within the whole structure of the economy. In addition, since policies in underdeveloped countries can seldom be divorced from the interplay of domestic economic variables with those of industrialised countries, we need to study these policies in the context of a North-South model of the world economy. Because technology policy usually takes place at the sectoral or project levels, we must also attempt to take account of empirical data emerging from studies at that level, and to provide a framework within which such specific policies can be discussed.

The structure of the macro-economic model reflects a need to provide further tools of analysis of these issues. For example, the need to incorporate in the economic model of a developing region main

<sup>1</sup>See Cole and Chichilnisky (1978) and UNITAR (1978).

<sup>2</sup>Pages 159-62.

relations with international markets and with the choices of technology. Also, the need to incorporate relations that reflect the possible resistance to change in response to policy of important economic variables, such as income distribution, in mixed as well as in market economies. Because technology is caught in the middle of supply (production of goods, amounts and types) and demand (wages, employment, income distribution) patterns this requires both sides of the supply-demand or equilibrium equations to be evaluated in a meaningful way.

The question of the relationship between the system of production, income distribution, growth and consumption in countries of the North and South is, therefore, a particularly complex one. For example, cheaper imports from the South may on the one hand benefit the lower income consumers in the North through lowering the prices of goods they consume, but, on the other, may hinder employment in the North. From the point of view of a country in the South similar contradictory effects arise. For instance, an export-led growth policy may on the one hand be consistent with higher rates of GNP growth, but, on the other, may deteriorate the income distribution and diminish in absolute as well as relative terms the welfare of the very poor. One way this latter effect may come about is through the implied choice of products and of prices by producers in a Southern country engaged in an export-led growth path. Producers may in these cases tend to regard the bulk of the local population more in terms of labour cost than as consumers, when making decisions about what products to produce and their prices. If their production is mostly for export, it may be in their interest in many cases to produce luxury products and if possible to pay lower wages to decrease costs, without regard to the possible effect of such a policy on their revenue, since a relatively lower aggregate income of the wage earners may not, in this case, negatively affect demand for their output. It is with such problems of North-South development in mind that we constructed the model described in this paper.

The structure of the economic model being developed in our study describes both domestic economies for the North and South and the economic relations between them.<sup>3</sup> The model contains endogenous

<sup>3</sup>The model was originally specified by Chichilnisky (1977).

explanations for determination of wages, prices and income distributions in the domestic economies and of imports and exports and terms of trade in the international sector. In the short run this is achieved in a constrained general equilibrium fashion. In the longer run, dynamics can be simulated to account for investment flows and population changes. In each domestic economy, the economic factors are described in two main groups: 'low' and 'high' income. Finally, the goods produced are considered in three broad classes: basic consumption goods, luxury goods and capital goods. The structure of the model for a single region is shown in Fig. 1.

The macro-economic model used in the present study tends to simplify and aggregate variables so as not to obscure the reasons for the results obtained, while retaining the main categories necessary for the analysis. In addition, aware of the serious data restrictions, and of the need for better analytic tools to aid our analysis of complex issues, the study attempts a more sophisticated yet relatively more qualitative study of economic behaviour of North-South developments than is usual in existing models.

The choice of a theoretically sophisticated aggregated macro-economic model reflects much current thinking arising from inadequacies of highly disaggregated multi-sectoral models, where disaggregated details sometimes obscure the reasons for the results obtained. This is not to say that details are not important to policy, they obviously are, but our work shows that they may be better treated as exogenous elements to the macro-economic model to be obtained through other aspects of our analysis. For example, because of our emphasis on technology, the treatment of production, use of factors, and import content, micro-macro integrated analysis has an important role in the study. The other failure of current modelling techniques is the neglect of most social and political variables. In our study a procedure is developed for integrating the macro- and micro-economic analysis with a systematic treatment of socio-political analysis.

The calibration of the model<sup>4</sup> is approximate in that the model is intended to capture the basic character of each economy rather than to

<sup>4</sup>Clark, Cole and Lucas (1978); see also Chichilnisky and Cole (1978).

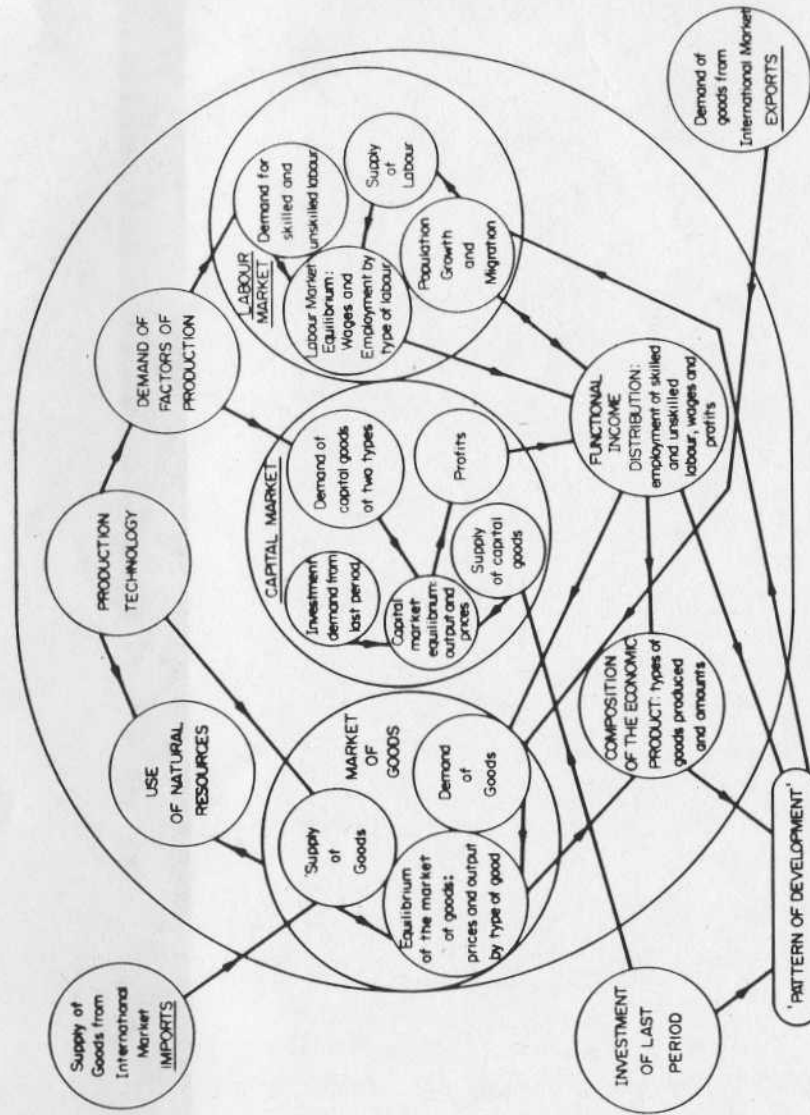


Fig. 1. Diagram of the short-run equilibrium model of the domestic economy of one region.

look for a highly significant estimation. There are several reasons for this approach to calibration. First, much of the data relevant to the central variables and relationships in the model are comparatively poor, especially for developing countries. This includes, for example, data concerning capital stock or the consumption and production of 'basic goods' by different income groups and production sectors. However, within reason it is better to include variables if they are vital to a theory (however bad the data) than exclude them altogether while at the same time carrying out adequate sensitivity analysis.

Second, the model is admittedly crude in terms of detail, although compared with some other models it is sophisticated in its theoretical content. It is this theoretical sophistication rather than the detail which is important to the qualitative behaviour we wish to demonstrate. At this stage in the analysis we are interested in types of behaviour and policy strategies relevant to questions of the NIEO and development rather than nation-specific results. In any case, although for the results to have relevance for any given country the model and data would clearly have to be refined, the level of detail is not significantly less than that used for many models used in policy. Finally, given current theory and data limitations and the difficulty of implementing policy, detailed long-term forecasting does not make sense. An aggregated long-term model such as ours offers only broad guidelines for more detailed analysis relevant to experimental, closely monitored and flexible short-term policies.

**Preliminary experiments with the model**

To date, attention has been focused on finding appropriate means of solving the model equations and on carrying out experiments to determine, in broad terms, some essential features of model behaviour. To this end, a preliminary calibration of the model for the UK and for Brazil has been carried out; no claims are made for the precision of these initial calibrations, which are intended only to provide consistent data sets and to capture some of the major differences between two representative economies for experimental purposes. Tests have been carried out on the model as calibrated for each of these countries separately, and on the models linked through a trade sector.



*Experiments with isolated regions*

The main feature of interest in these experiments was to find the effect of changes in the technical coefficients on such factors as income distribution and employment. It is important to note that the initial values of labour/output ratios for the skilled and unskilled groups reflect the (necessarily somewhat arbitrary) way in which the total workforce is allocated between these groups, as well as their relative productivities. In calibrating the model for different regions, the available data do not permit this allocation to be made according to the same criteria; hence large differences in, for example, the unskilled labour/output ratios we have chosen for the two different regions may not be immediately assumed to reflect large differences in efficiency.

A reduction in a labour/output ratio may reflect either an improvement in technology such that fewer inputs are needed to produce a unit of output, or the choice of a more capital intensive technique (in which case it will be accompanied by a rise in the capital/output ratio). For both sets of data a simple increase in labour productivity has the effect of reducing wages and employment and raising the rate of profit; income differentials are reduced if the higher-income groups become relatively more productive. An increase in capital productivity increases employment and wages, the effect on the rate of profit being less clear.

One would expect that additions to the capital stock in use would tend to counteract the effects of increased labour productivity; to examine this, a dynamic form of the model was used in which investment in each time step augments the capital stock available in the next. A simple Keynesian representation, with investment dependent on GNP and the rate of profit, was chosen. This investment is net of depreciation and has the effect of increasing production rather than reducing costs (by, for example, displacing labour). The effects of the latter type of investment are simulated by appropriate changes in the technical coefficients. Labour productivity is assumed to increase uniformly in these runs, and hence there is very little change in income distribution in both regions. However, a notable difference between the regions is that the returns to capital in the 'northern' region are higher relative to those labour than in the southern, an effect apparently reflecting the lower capital intensity of the latter.

Other runs have tended to confirm the effects observed in the static model. Higher initial investment leads in general to lower consumption in the short term, but higher growth and consumption in the medium term; however, the effect is to reduce the rate of profit, leading to a disincentive to invest in the longer term. Income differentials are reduced if the productivity of the high-income group increases more rapidly. An increase in capital productivity has a similar effect to increased investment, while increasing capital/output ratios lead to higher rates of profit and depress consumption and employment. These results highlight the importance of the type of investment (labour displacing or capital-stock augmenting) as well as its magnitude, and also indicate that the values of the technical coefficients are very significant in determining the effects of investment.

*Experiments with interacting regions*

A primary aim of the project is to study the mutual interactions between developed and developing economies. Two types of trial runs have so far been carried out linking the calibrated North and South models. The first was designed to illustrate the direct effects on the income distribution of one region of changes in the income distribution in the other. The procedure used depends on the form of the dual cost equations of the model.

The second type of experiment with interacting regions involves an explicit treatment of the magnitude of trade. Suitable amendment of the supply equations in the model permits the effects of various specified levels of trade between the two regions to be investigated. An example of the results obtained is shown in Table 1.

TABLE 1

$A^T$	$B^T$	$I^T$	$r^N$	$r^S$	$L^N$	$L^S$	$Y^N$	$Y^S$
-100	100	-11.1	0.094	0.108	558	211	91	127
0	0	0	0.090	0.072	556	228	88	146
100	-100	27.7	0.086	0.031	554	245	86	168

Key:  $r$  = rate of profit,  
 $Y$  = low-income group basic goods consumption,  
 $L$  = low-skilled employment.

$A^T$  and  $B^T$  (trade in non-basic and basic goods) was specified exogenously, while  $I^T$  was determined endogenously by specifying that the overall trade be in balance in each region. A positive value indicates traded goods moving from North to South, and vice versa. It can be seen that changes in all variables are monotonic as the pattern of trade changes. Increasing exports of non-basic goods by the North (and a reverse trend in the movement of basic goods) is beneficial for the consumption and employment of low-income workers in the South (with a labour-intensive basic goods sector). This is accompanied by marginal (if slightly detrimental) effects in the North. We are currently experimenting with representations in which all trade is determined endogenously, subject, for example, to the condition of equal prices for each good in the two regions.

It must finally be stressed that all results presented in this section are intended to be illustrative only, and there is no claim that any real-world phenomena have been adequately reproduced. Further work is needed to determine the precise relationships between the technical coefficients on which the various kinds of results depend, and to seek further evidence for the existence of these relationships in real economies and their applicability to the scenario analysis.

*North-South factor intensities, elasticity of supply of factors, and the terms of trade*

The calibration of the model with UK and Brazil data was also used to test the relationship between technologies and the trends in the North-South terms of trade. The production of basic, luxury and capital goods of the North and of the South have different factor intensities. For example, basic goods are produced in the North in a relatively more capital-intensive fashion, both with respect to the South's production of basic goods and also with respect to luxury and capital goods in the North. In addition, the supply of factors of production (capital and labour) is different in each region. For example, supply of unskilled labour is quite price inelastic in the South and relatively more price inelastic in the North, since unskilled labour can be quite abundant in the South and in addition for small increases in wages, migration from rural to urban areas increases.

In the trade model each region was calibrated so as to be in a

temporary equilibrium with existent trade patterns. This yielded a composition of the output and prices for each good. In these temporary equilibria the South was found to produce certain goods cheaper than the North. It was assumed then that an increase of exports from the South to the North of such goods would occur. Under the new trade conditions, the temporary equilibria of the North and of the South were recomputed. In a neoclassical framework, an increase of trade would tend to equalise the prices of the goods that the South produces cheaper than the North. This would occur because by increasing exports of the good that is its relative advantage, the South would tend to drive up the prices of inputs and thereby increase costs and prices relative to the prior situation. However, the model showed in several runs, and with relative stability, that the dynamics of the situation could be just the opposite. More exports of the relative advantage of the South would lower the prices of those goods, and, effectively, tend to deteriorate the terms of trade of the South with respect to the North in a self-sustained fashion. A close examination of the dynamics of the data shows how this Prebisch-like effect comes about. Increased exports of basic goods increase demand for unskilled labour and capital in the South. Even though these goods are produced in quite a labour-intensive way, the supply elasticity of factors is such that with increased exports the wage increases are minimal, while the capital costs increase relatively more. This has no major effect on the costs of basic goods, but, in a general equilibrium fashion, it tends to affect relatively more the costs of luxury and capital goods, which are more capital-intensive, in the South. One could expect, however, that if demand of basic goods increases due to increased employment, then these effects on relative prices in the South could be checked. The new income distribution with increased exports, however, does not bring about such a compensating demand effect. The mirror effects occur in the North, where basic goods are relatively more capital-intensive and labour supply more inelastic. The results show the effects of the technology at macro levels, as well as of elasticities of supplies of factors, on trends of terms of trade. As a policy matter, this illustrates the range of choices of technologies that would be desirable if betterment of North-South terms of trade is a goal.<sup>5</sup>

<sup>5</sup>See Chichilnisky (1978) and Chichilnisky and Cole (1978).



**Conclusion**

The level of precision is at present much lower than could be expected of such an exercise. Therefore, the results obtained so far are preliminary and mostly indicative of the nature and trends of change of the main economic relationship within the calibrated model as it is presently. With this caveat, findings can be summarised as follows:

1. The results give a strong indication that the pattern of North-South trade (amounts of goods traded, by type and their prices) may have an important inter-relation with the pattern of income distribution, the choice of domestic product and growth of domestic economies in the North and in the South. Hence, a development planning model should incorporate or explain endogenously the relationship between international market behaviour and domestic policies, or otherwise it may miss the important elements in the analysis of feasibility and sustainability of domestic policies. This is especially the case for the use of technology as a tool of policy, since technology is tied up with income distribution and growth on the domestic side; and with patterns of trade, international financial flows and the terms of trade on the other.
2. The results indicate that the income distributions within the North's and within the South's economies are related to each other. Mediators between these two variables in the international market are the terms of trade and types of goods exchanged, and on the domestic side, productivity and the choice of techniques, as related to employment and wages. Therefore, income distribution policies in the South and in the North should be explored for consistency. For example, the improvement of employment and growth in the South through the use of labour-intensive manufactures leading to an export-oriented growth strategy is shown to adversely affect some areas of employment and growth in the North.

## PART 4

*Planning and Dependency*

You can never plan the future by the past.

Edmund Burke

The state will not collapse simply because a planned quantity target has not been fulfilled.

Chairman Mao

has the Bariloche model been in this respect? As we have seen the Bariloche model does link the demographic and economic variables. It is an optimisation model with the expectations of life as the target variable to be maximised. This makes the demographic aspects central to the analysis, and the allocation of resources among the five main economic sectors of the model are linked to the demographic model. In the maximisation solution the marginality conditions would equate the impact of the marginal unit of each of the sectors on the expectation of life at birth. The establishment of theoretical or empirical basis for evaluation of such relationships is not an easy task. We know from recent demographic studies, particularly for the developing countries, that a large number of complex factors influence expectations of life, and, in the light of recent trends, that a number of new factors are beginning to be dominant. Some old-established theories are undergoing radical revision. In any case, among the factors influencing expectation of life at birth the more dominant appear to be non-economic. All this makes me a little uneasy about building a formal model that allocates national resources so as to maximise expectations of life at birth, although the goal of maximising life expectancy is a noble enough one in itself. Given the state of the art in so-called 'soft' models, the difficulties encountered in establishing formal quantitative models interlinking economic and social variables are clear. On the theoretical side there is a lack of accepted theories which would help formulate causal relationships, interlink the variable to be empirically tested and verified. On the side of the quantitative statistical information even the collection of such data is made difficult by the lack of well-defined statistical concepts. Unfortunately, most of these difficulties appear to apply to the Bariloche model. Given this state of our present knowledge a little caution in the use of such tools to applied policy-related situations such as national planning is advisable. If training workshops in tools of integrated planning, as UNESCO is planning, are held, it is advisable to include, and even emphasise, the more familiar tools of analysis in integrated planning used at present.

GRACIELA CHICHILNISKY

A recurrent theme in this conference was the use of large-scale models for the setting of policy guidelines by international organisations. One

of the points raised was the relationships between the targets of the institution and the results of the models that it sponsors. It was felt by some that institutional targets tend to influence the results of their models. The Leontief model (also called the UN World Model) makes an interesting case study for such questions particularly in relation to its use for studying questions of consumption of the very poor and of relative wealth of the developed and underdeveloped world, as referred to by Kodikara.

In this work the Leontief model is used to analyse at a relatively disaggregated level the natural resources and environmental implications of development goals reflected in some of the emerging ideas of the NIEO. However, since the Leontief model is restricted to an input-output framework of analysis, it is not fitted to study employment questions, and does not specially address questions of intra-regional (or national) income distribution. In particular, the trade sector does not provide an adequate framework to study NIEO questions on the terms of trade and exports shares; in this model the equations of exports are such that they assign, at all times, a fixed proportion of the world's exports to each region, while the import equations give at all times levels of imports that depend only on the region GNP levels, mimicking present patterns. In addition the main economic parameters of the future underdeveloped countries' economies (uses of resources, imports, input-output coefficients) are assumed to reproduce exactly, with a lag, present patterns of more developed countries. These characteristics of the model pose some questions about its adequacy for the study of UN development goals. In particular, the assumption on the future reproduction by the underdeveloped regions of present economic patterns of the developed regions is somewhat in contradiction with the UN policy of setting alternatives for the world development. The complexity and high level of disaggregation of the model makes it difficult to shift its basic focus. Therefore, other NIEO issues, linked with international market structures, cannot be studied properly in an input-output framework. We then have a case study that seems to disclaim some statements made in this conference on the relationship between model results and the goals of the institution that sponsors it. In the case of the UN, the very nature of the model makes it less than appropriate to carrying a detailed study of the UN goals altogether.

These last characteristics may give us a more sophisticated and somewhat unexpected understanding of some of the relationship between institutions and their models. If the decision-makers in the institution do not desire to share decision-making with the modellers, and decisions are still in the making, it might be their choice under uncertainty to seek models that will not give answers.

GIORGIO TONELLA

Discussion of the Bariloche world model could have presented an excellent opportunity to analyse the gap between assumptions and techniques, principles and tools, concepts and instruments. This was not done. The use of mathematical models was accepted or rejected without efforts to find alternative ways, or to obtain a compromise between the two extreme positions. The clear division between conceptual and mathematical model in the Bariloche work, and the general agreement with the first one and partial rejection of the second one, was not used as a basis for looking into the reasons, the causes and the effects of such division. It is through this analysis that I foresee at least three directions of research towards new tools for planning. One direction is related with the conceptual model, another one with the mathematical model and a third one with a possible 'interface' between them. In addition, there is a direction related to the need of more specific and practical tools of planning. Despite the fact that this one will not be discussed here, some of its characteristics are included as part of the other three directions.

The first direction is the evident need for a formalisation of the conceptual model. Little effort has been done in this line until now. The formalisation has to begin with assumptions and principles of planning and with the concepts of the idealised society such as the list of basic needs (material and non-material) that are in some cases still ill-defined. It has to be global, i.e. to include taxonomies of societal structure and functions. A good formalisation is the first step towards new tools of planning. Furthermore, it can be used directly as a tool without the need for further mathematical or non-mathematical models, and would receive probably more acceptance. Acceptance is all in a developing country.

The second direction is related to the failures of the mathematical models as planning tools. It has been said that the main reason has been sophistication or complexity. But these weaknesses are not inherent to models; they are the results of their faulty use. No attempt has been made to find out other possible causes. An exhaustive search of these might give new ideas for improvement either to the planners or to the modellers. Maybe one of the main reasons is that few mathematical models, if any, have taken into account all the different aspects of planning such as ends, means, resources, organisation, control and implementation. Normally only the first two or three aspects are included in mathematical models. Other causes might be the negligible amount of time spent in trying to 'sell' the models, the real interest of modellers to use them as planning tools more than academic tools, and the small effort made in finding a common language between politicians, planners and modellers.

The third direction is to analyse in more detail the passage from conceptual model to mathematical model, that is to say, the translation of complex problems from the verbal statement to the mathematical structure. It is in this stage that communication between politicians, planners and modellers has to be established and that the participation of people has to be introduced. For this reason a common language has to be used and the complexity has to be kept within certain ranges. A possible way towards an 'interface' between conceptual and mathematical models is a systematic analysis of systems structures, which allows a better understanding of the processes involved. Furthermore, this analysis can be used directly as a planning tool without the need to continue the completion towards a mathematical model. An example of research done in this direction is structural modelling, a new modelling area in contraposition to the traditional dynamic modelling.



the number of those who graduated at the end of the year. The validity of either number in measuring what it purports to measure is doubtful. Which one, or better, which estimate *should* be chosen is therefore a complete guess.

I am therefore making rather a mundane plea for much more care to be taken over the correspondence of the data series which are used with the conceptual variable desired. This is a complicated enough task even when we are considering quantities which are essentially derived from the SNA or extension: it becomes almost impossible when we are dealing with political or social variables. It really is important to look at the data before we leap into modelling.

This much is obvious, it bears repeating simply because it is so often neglected. What really worries me, however, and what prompted my 'two-cultures' remark, is that the skills and/or wills of mathematical modellers and social statisticians do not seem to be the same. I am not thereby vaunting my 'pofession' as a social statistician *against* that of a mathematical modeller, I am simply remarking that although their skills and, if you like, attitudes should be complementary, they rarely are.

I know that most modelling teams are, or intend to be, interdisciplinary as between people; what seems to be missing is an intra-personal interdisciplinarity. We will only start developing solidly grounded models when one and the same person develops and supervises the application of a model in the substantive area in which they specialise. I am all for collective interdisciplinarity: I just think that it works much better when most of the individuals are interdisciplinary. I realise that it is relatively boring to worry about the quality of basic data, it is unfortunately crucial to the use of models in a planning exercise.

My conclusion from these considerations is that UNESCO would be better advised to search for ways of improving the basic data and for ways of measuring important concepts rather than exploiting modelling techniques.

## *Models and Mystification: The Use of Mathematics to Support Vested Interests*

ROY CARR-HILL

I have been asked to introduce a short discussion on the topic of 'Models and Mystification'. The UNESCO Secretariat explained to us what they had in mind in organising this meeting. From their point of view, whilst they are of course very interested in the details of the Latin American World Model their major concern was somewhat different. What they really wanted to find out, from the 'experts', was whether or not they could use this model in their discussion with developing countries and especially with government planners in developing countries. In a word, is this kind of model 'saleable'? The answer is easy. UNESCO can easily sell this kind of model to almost any government planner. In the first place it creates employment; and if you think of the plethora of conferences on models of development, I do not think that it is as facetious as it sounds. More importantly, such models help government planners in one of their major tasks, which is to mystify people and therefore prevent them from taking control over their own lives.

Firstly, I would like to make it clear that I am not against all forms of model. I agree with Lance Taylor when he says that everyone has a verbal model (at least implicitly) whatever they believe or do, and such models are based on a theory about the real world, which can, in principle, be contested. Consider, for example, the almost universal model that human survival requires biological existence and therefore food to keep alive. Even in such an obvious case, however, there is a very small minority who believe that one is only really human when one is fighting for one's beliefs and who would subordinate biological exigencies to their political objectives (consider for example, the hunger strikes to the death by some prisoners of the Red Army Fraction). Thus

on the most elementary points, everyone has a model about everything and every situation.

Secondly, I disagree with the idea that art, religion, science and technology are all neutral forms and that the political content comes from the way in which they are applied or used. There is an extensive debate as to whether or not particular forms of communication (and especially science and technology) are ideologically neutral. I happen to be on the side which believes that most but not all models and techniques used in scientific practice are neutral. At the same time, I think that we have to be realistic about the present conditions of exploitation and oppression, how they are maintained and are likely to develop, and as a consequence how the models that we might propose are likely to be applied and used.

With these two caveats, let us turn to the specific types of model being discussed at this conference, that is, computer-based mathematical models for central planning. Such models have two special features which make them mystifying and potentially oppressive. Firstly, they are mystifying in the very special sense that they are only comprehensible to those of us who are mathematically — or at least arithmetically — fluent. This fluency is automatically restricted to a small group in a predominantly verbal culture; further, in an integrated industrialised economy where mathematical skills will be required, such a group tends to constitute an élite whatever the political colouring of the society. Secondly, such tools are only useful for discussing central planning and in fact are often only available to planners. In so far as I believe that the basic problem for the future is to find ways in which people can collectively (re)gain control over their own lives, rather than being allowed to act only as individuals within a framework imposed by the state (witness the growth of the New Welfare Society which encourages individual imitators on the margins of the service sector). I think that such tools can potentially be used oppressively.

The latter problem has been touched upon rather obliquely already in this conference via the discussion of the extent to which it is possible to incorporate social and political factors into this type of model. It is clear, at least to me, that it is strictly impossible to discuss alternative political frameworks or the potential for social action within the structure of such a model. Such models can, of course, incorporate the

effects of a structural change such as the likely production resulting from indoctrinating the spirit of capitalism, or the *effect* of a social movement such as the need for multi-purpose households due to a change from living in nuclear families to communal households. And even these phenomena could only be incorporated as a stochastic shock process with perhaps a few added parameters.

Furthermore, the *incorporation* of certain types of political and social movements into a model which is alien to their basic assumptions denies their authenticity. I am thinking particularly of those attitudes, beliefs and social movements organised around the theme of popular power which has been my hobby horse in this conference. For what distinguishes a society organised around popular power from even a society where people are consulted on and can participate in decisions is that the former social organisation is one in which people *actively* take decisions about the way in which to organise their own lives whilst the latter reflects a *passive* form of relationship between the individual and his or her socio-economic environment. And, in such a society, the 'models' which would be used by each collectivity could not be captured abstractly and universally.

In such a society, the basic social module (even I have adopted some of the jargon) would be the community. At this level, not only would people's attitudes and tastes differ (which could be taken into account in a universal model) but also the criteria of evaluation adopted the community might vary. In concrete terms the meaningfulness, mode of and necessity for aggregation would differ from community to community. Of course, there would have to be some co-ordination between different communities, but domain of common interest would be decided by rather than for the people in power at the local level. In such a society, it is difficult to see what sense could be attached to global aggregation.

I know it all sounds very utopian to you but as I said earlier I perceive the fundamental problem for the future to be the extent to which people are going to be able to collectively (re)gain control over their own lives. Moreover, if you cannot be utopian in a university, where else?

We may relate all this to the discussion of the Bariloche model. In fact, for me the most interesting aspect has been the introduction of people's personal political commitments into the discussion and the

possible role of the 'counter-expert'. By counter-expertise, I mean the activity of taking the existing scientific tools (whether they be those of bourgeois economics or mathematical modelling) and applying them in a radical fashion in order to contradict the conclusions which are being drawn from the normal use of these tools. I take it that this is, at least in part, how the Bariloche team see themselves. I appreciate the motivations underlying such a stance, but I am a little worried about the political judgement they have made, from two points of view. Firstly, being a counter-expert usually involves being technically better than the (establishment) experts. I realise that this is often not very difficult... nevertheless it does impose an obligation on those involved to keep up with the literature, practise their art in order to perfect their expertise and so on. One is therefore likely to get over involved with the technical details of being a counter-expert and thus losing sight of the original political thrust to being a counter-expert. Secondly, there is an added danger with the type of models being considered here. Usually, an expert or counter-expert is working in a (superficially) neutral field. Thus being an 'economic advisor to a Ministry of Education' is quite likely to be a (politically) nasty occupation, but at least the concepts of 'economic' or 'education' are, in principle, neutral or positive. In the case of being an expert in 'computer-based mathematical modelling for central planning' I find it hard to put in a good word for any of the concepts involved.

I cannot lay down criteria as to where are the limits which justify when and in what circumstances to use counter-expertise. I recognise that I have myself on occasions used any statistical skills that I possess in the service of certain causes. On the other hand, I have decided not to impose such a framework on the daily work I do, as a general rule. Once they have developed the basic point that the answers crucially depend on the assumptions, I believe that mathematical modellers should do likewise. Fundamentally, of course, it is a political judgement.

GRACIELA CHICHILNISKY

In response to the points raised by Carr-Hill I would like to describe the use of Mathematical Mystification to keep women in their intellectual place. The higher places of the academic intellectual

community are organised around a few secretive priesthoods. As the business community has the locker-room talk, the squash games and the old-boy network, our intellectual élites have a monastery-like atmosphere to communicate and screen information, make reputations, and in general organise distribution of power.

Until puberty the distribution of mathematical talent is uniform across the sexes. Afterwards it changes drastically. Studies have confirmed that girls' interest in mathematics plummets at around age 12, when adolescence makes them more aware of roles (see 'Math Mystique: Fear of Figuring', *Time*, 14th March 1977; the work of Lynn Fox' doctoral dissertation at Johns Hopkins University; and the findings of the National Institute of Education meeting in Washington, D.C., USA, February 1977). The myth starts there. Young women are forcefully discouraged, intimidated and coerced into either thinking they are no good for mathematics, or that their chances are very slim.

If this punishment does not work, the real one starts at the postgraduate level. Not much energy is spared in pretensions there. Humiliation in front of peers (are you serious about getting your degree, it would be so nice if you would instead serve the coffee and cookies at the meeting, you must be a fraud, what you really need is a man, you are too beautiful to be intelligent) as well as other straightforward punishments (fewer fellowships, worse jobs and worse pay — according to statistics compiled by the Women's Bureau of the Labor Department, USA; the National Science Foundation, 1968 and 1969; and *Women in Mathematics*, page 166, by L. Osen, MIT Press, 1974).

It is not surprising that the departments of psychology, anthropology, sociology, music, literature are full of women students, while it is the smaller percentage of male students that become almost invariably the professors. Almost no women students, no black students either, for that matter, are in mathematics. The percentage of scientific doctoral degrees awarded to women in the US is in 1977 essentially the same as it was in the 1920s. *The percentage of women in university science faculties is actually smaller*. Only 1.6 per cent of Nobel Prizes given in science between 1901 and 1976 were awarded to women. And only 1.5 per cent of the members elected to the National Academy of Science between those years are women (see the report on a four-day conference on a study for the National Science Foundation,



Washington, October 1977, in the *New York Times*, 21st October 1977).

Most careers do use mathematical manipulation ability as a screen. Mathematical talent is used to measure creativity from grade school on — more so than other skills. This is used right then against women. Effectively, after all the noise on women's liberation in the US is made (and used as an argument that things are really changing, don't you see) women in science are worse off now than they were in the 1920s, as seen by the statistics above. Women do flock to the labour market, in the lower paid and recognised jobs: nurses, waitresses, secretaries. The same occurs in the intellectual labour market.

What to do? If you acquire the tools you become a mystifier as described by Carr-Hill. If you don't you are mystified and manipulated. Perhaps it is at least possible to introduce a subversive element: some young mathematically potent women among a congregation of priests. The deeply destabilising demonstrative effects of such elements on our system of intellectual control through mystification should not be underestimated. The contradictions have to be lived through: to identify with the victim, while not assuming the role of the victim; to demystify the tools while using them to pursue knowledge without mystification.

ERWIN SOLOMON

The interest of UNESCO in global modelling (in the intersectoral sense) is in the promotion of the use of the model as a tool of planning, with all the modesty that implies. In a sense modelling has been in the hands of modellers far too long and will not achieve its potential for demystification until it is used in real-world situations. We believe that UNESCO has a role in international and intellectual co-operation, bringing together for dialogue modellers and planners, developed and developing world representatives, etc. In particular, I believe that models, especially of the Bariloche type, can be instruments facilitating the consideration and the incorporation of quality of life components, i.e. non-economic factors vital to human development.

In this respect of concern for strengthening the capacity of planners and the understanding of decision-makers in developing countries with respect to indicators and models I find myself in complete disagreement with the thesis of Carr-Hill that models mystify. Models can be used to

mystify — especially when they are not understood by those to be mystified — but models themselves are tools of demystification and should be received as such.

Concepts like basic needs, or even quality of life, are mystifying only if they remain as vague concepts. When they are defined and quantified for use in models such mystification is made far more difficult.

The discussions have been very valuable to me. I am both encouraged in some convictions and discouraged in some beliefs — and this is as it should be. I see that the 'state of the art' is far from the state I believed it to be and I also see that the preoccupations of man as the centre of development, so important to UNESCO, are shared by you. Thus a move toward focusing on social, cultural and humanities variables is in order and this fits in exactly with UNESCO's interests.