CHAPTER 33

Viability of the socio-economic system in the Netherlands: an examination of its future with the aid of interactive goal programming for input–output models

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The Erasmus University was established in Rotterdam in 1973 as a combination of The Netherlands School of Economics and Rotterdam's Medical Faculty. At that time the School of Economics consisted of three faculties: Economics, Law, and Sociology; since 1973 several other faculties have been added to the Erasmus University.

This chapter deviates somewhat from the editors' requested framework for contributions to this book. Instead of describing a failed and a successful OR project, a short review is presented here of three successive stages in the same—in fact continuous—project. However, mistakes that were made should be blamed on the problems that produced them, especially when making changes in the original project plan.

The first phase of this project started in 1979 with an accidental meeting between Professor J. A. Hartog of the Statistics Department in the Economics Faculty at Erasmus University, Rotterdam (EUR), and the author working in the Finance and Investment Department of the same faculty.

Professor Hartog had just completed a study with Dr G. J. van Driel and C. van Ravenzwaay called *Limits to the Welfare State*. A problem encountered in that study concerned the choice of limiting the political conditions, and it appeared that Interactive Goal Programming (see Spronk, 1981) might also be used to find a solution in the present project. The reason was that limiting conditions could be systematically and continuously varied with this method; consequently, a number of experiments were done which led to a smaller version of the Input–Output Model that had been developed by Hartog.

On the basis of these experiments we were invited to carry out an investigation in the style of our previous study entitled *The Place and Future of Dutch Industry* for the WRR (the Board for Scientific Investigation of Governmental Policies in the Netherlands). The same interactive method had been used in that study in conjunction with a larger version of the aforementioned Input–Output Model.

In the second phase of this project a number of considerations appeared, clearly indicating that in this phase the course of action lay elsewhere.

The third phase concerned a new study by the WRR: *Background Study for the Policy-Directed Future Reconnaissance—Part II*. Once again the same interactive procedure was used. Relatively, a lot of time was spent adapting the Input–Output Model to the wishes of the WRR. The approach followed in this phase complied with the project's specifications, namely the WRR wanted to use the procedure regularly after it had been developed.

33.1 Phase one: plan of the procedure and some experiments with it

The Input–Output Models described in *Limits to the Welfare State* (see van Driel *et al.*, 1980) were designed for Western Europe, and this much larger model was developed for 17 conventional sectors and for 5 pollution abatement sectors; later, a smaller version with 3 conventional and 1 anti-pollution sectors was made. In this phase the smaller model was used for the experiments with Interactive Goal Programming, the heart of which was formed by the dynamic Leontief inequalities:

$$x_1 \geqq (A + D)x_1 + K(w_{t+1} - w_1) + v_t, \quad \text{for} \quad t = 1,\ldots,10, \tag{1}$$

and

$$x_t \geqq w_t, \quad \text{for} \quad t = 1,\ldots,10. \tag{2}$$

In these relationships the variables are expressed in constant prices and defined as:

x = the vector for the effective production of the sector in year t;
w = the vector for the production capacity of the sector in year t;
v = the vector for the final consumption and export surpluses in year t;
A = the matrix of input–output coefficients;

D = the matrix of sectorial depreciation coefficients;
K = the matrix of sectorial capital coefficients.

From the start the project in question was especially selected for the behavioural relationships which were not taken up. The philosophy behind this was that the correctness and relevance of many behavioural relationships could lead to expressions which, usually, were not straightforward. On the other hand, the mathematical relationships in (1) and (2) possessed an exactness that was not open to misunderstanding. The next step required the decision-maker, who used this model, to choose between the alternatives described by (1) and (2). The choice had to be based upon the judgement of the decision-maker with respect to the viability of the socio-economic system and the desires and wishes for the future. In the *Limits* study, the decision-maker's choice was simulated with a single goal variable; consequently, it seemed that the behavioural relationships that were not taken up would create a greater freedom of choice. Also, optimization of one goal variable could lead to some unrealistic solutions. This mistake was corrected in *Limits* by introducing *ad hoc* political constraints.

Through the use of IMGP (Interactive Multiple Goal Programming), the opportunity arose to vary such limiting conditions systematically and to weigh one against another. The first step in formulating the smaller Input–Output Model consisted of removing all the political constraints which had been introduced earlier. In their place, a number of goal variables were formulated as functions of the procedural variables; they were the original goal variables plus one for each of the political constraints that had been removed. The interactive play between the decision-maker and the computer model in IMGP began by imposing a heavy penalty on each of the goal variables. Then, each of the alternatives was examined in order to assess the potential improvement value of each goal variable and this information indicated to the decision-maker the needs which could be allocated to the goal variables. This was done in the next step so that each need became a fixed constraint in the model; thereafter, the cost of each allocation was calculated in terms of the potential value for all the goal variables. When the cost of a certain need was too high, then another selection would have to be made until all the needs had been satisfied with the best possible alternatives (Spronk, 1981).

In the first phase a great deal of attention was paid to the development of a system of computer programs that the decision-maker could use to express his wishes while sitting at a terminal, so that he could see the consequences of each choice directly on the screen. Little attention was paid to selecting goal variables, since the model could take care of them itself. This interactive model was demonstrated to some practical decision-makers and their reactions were positive, although they thought that a few allocations were rather more fortunate than others, some could have been omitted, whilst others should

have been reformulated. Furthermore, it appeared that more attention should have been paid to the procedural variables than had been anticipated. Repeatedly, each might be replaced in order to improve the goal values. Finally, the decision-maker did not always have the needs to allocate to the goal values and produce Pareto-optimal solutions. (Pareto-optimal solutions were combinations of goal values in which none of the values could be further improved without impairing one or more of the other goal values.) Meanwhile, the fact that there was some latitude had been appreciated (in this case, a collection of solutions which satisfied a certain condition).

33.2 Phase two: a model study within the framework of the study entitled *The Place and Future of Dutch Industry*

As a result of the experiments described, the WRR commissioned a study within the framework of *The Place and Future of Dutch Industry*. Interest was shown in the structure of sectors in the Netherlands for certain conditions such as economic growth, work opportunities, balance of trade, and life style. Limits were set for the maximum fluctuations that the economy could withstand from year to year.

In this research the large model from the *Limits* study was used; the original political constraints were removed from it in order to comply with the requirements of the WRR. A number of political constraints were added by the WRR where they would not interfere with the process. This time, modifications were included in the original model, other than for experiments in the first phase of the project; however, not all of them could be handled because sufficient time was not available.

During the execution of this work there was continual liaison with a staff member of the WRR so that a sector structure could be developed satisfactorily according to the WRR's requirements. In this way the procedure functioned like a search mechanism, but because the procedure had to be linked to computer operations that were outside the designers' control, some problems arose which were due to the computer being overworked (the computer at Delft University was used) and a system of priorities ws employed for it. Therefore it was impossible to play the rapid 'question-and-answer' game which had been devised in phase one; however, the WRR did not object because each allocation result had to be studied in detail using iteration. It was concluded that the speed of the 'question-and-answer' program made it best suited to relatively small models, such as those developed in the first phase of the project. Finally, it appeared that a number of the goal variables selected were capable of further improvement, although, to a certain extent, inherent changes in the model would be needed to achieve this.

With respect to some features of this investigation, in phase two the author felt uneasy, even though a good picture of how the total problem should be

tackled had been obtained. Fortunately, the opportunity to test these doubts came in the project's third phase.

33.3 Phase three: a model study in the framework of the study entitled *Policy-Directed Future Reconnaissance—Part II*

Early in 1981 the WRR requested Hartog and his colleagues to work with its staff on a study called *Policy-Directed Future Reconnaissance* in which the consequences on socio-economic affairs of a number of characteristically Dutch political views would be investigated. Once again the large Input–Output Model described in *Limits* was used as the starting point, with the fundamental modifications that had been introduced by that time. In the first instance, the model had been revised in order to update data in the light of recent experience; for example, the five anti-pollution sectors had been combined into one sector and two new sectors had been added in order to look into energy-saving and job-creation. In the second instance, a number of variables were formulated and the model was revised at the same time. After a few experiments with this modified procedure, it was finally decided to exchange one goal variable for two new ones.

When compared with the first two phases, implementing these modifications and revisions took up a lot of time. In view of earlier experience and the good results obtained with the new model, it was time well spent and three characteristic political views were examined with this procedure during the next three months. They are described in the expanded report which was published at the end of 1982 (van Driel *et al.*, 1982). Now, description will be restricted to details of the philosophy behind the project's development.

In the previous phase of the project a fairly strong emphasis had been placed on the search for socio-economic situations which would meet the goals investigated as closely as possible. Subsequently, it was realized that the interactive procedure could function (and perhaps function better) as a teaching aid in addition to a search mechanism. As such, this procedure played a significant role in the third phase, especially for making the goal variables more explicit. Even more important, the use of this procedure as a search mechanism had a strong influence on the background development. Therefore, it would appear to be particularly useful as a preparatory procedure, not so much for its ability to predict future actions as for suggestions about what *could* happen. This was based upon the following observations:

1. The hard core of the model consisted of the two relationships in (1) and (2), plus a number of political constraints introduced by the WRR about which there was a large degree of agreement throughout the country. On the other hand, some constraints were included about which strong doubts existed. One way or another, they implied that actions which

were permitted in practice may not be suitable for achieving the goals, since there was always the chance that other people would upset the balance.

2. Within the interactive procedure, a collection of political needs had been translated into constraints for a number of goal variables, which now gave rise to two difficulties. First, these (goal) constraints allowed the model to produce a solution, even though this solution might be impracticable. On the other hand, a practical solution might *not* be considered by the model, because the constraints would not allow it. Consequently, there was the chance that sometimes the results would be false. Nevertheless, the interactive model allowed decision-makers systematically to try out a wide range of different requirements.

The experience gained in this project helped the author to draw the conclusion that analysing alternative policies with Interactive Goal Programming could be very fruitful if sufficient attention was paid to the formulation of goal variables by the decision-maker (also by those who had to interpret his wishes) and the analysis was performed as described here.

References

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