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REGIONAL PLANNING

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1. Introductory

In this paper we are going to discuss the scientific methods which may be used in regional planning. The problem we want to consider is how a plan can be constructed which specifies the activity levels in a number of sectors and a number of regions simultaneously. Characteristic therefore for our problem is a two-dimensional subdivision of total production (in the widest sense of that word) and the corresponding investment programs. We will not discuss questions of organization and procedure which were already touched upon in the paper on "The Organization of Planning". For convenience's sake we discuss our problem as if all the work to be done could be done by the Central Planning Organization.

Three main subjects will be discussed in the three sections which follow: in section 2 we will discuss some features of a model for simultaneous sectoral and regional planning; in section 3 we will discuss the minimum of information needed in order to make regional policy decisions on the basis of project information and in section 4 a few remarks only will be made on the role to be played by so-called "industrial complex analysis". The reader should be aware of the incompleteness of our knowledge on the subject of two-dimensional planning and consider this paper as an orientation paper only.

One useful concept is the one of regional versus national and international sectors. As set out before, we define a regional sector as one whose products cannot move from one region to the other: their transportation costs are prohibitive. Similarly we define national sectors as the ones whose products cannot move from one nation to another, but are able to move

from one region to another. We already indicated as regional sectors those of building, the operation of buildings, retail and a portion of wholesale trade, a number of personal and government services, a portion of small-scale industry, for example bakeries, a portion of transportation. National sectors may be further portions of wholesale trade, government and transportation as well as energy.

Another useful concept is the one between non-shiftable or concentrated and shiftable sectors. This criterion depends on differences in production costs proper and not transportation costs. The extreme case on the side of non-shiftable sectors is the one where the activity concerned can only be carried out in one region, as may be the case for mining or ocean transportation (harbour facilities). The extreme on the other side is an activity which shows equal costs in each region; this may be so for manufacturing of light goods. There are various intermediate positions; mining may be possible in more than one region, but not in all regions. Or there may be cost differences of a moderate extent between various regions. Sometimes it may be possible to introduce such more refined shades into the model.

As a result of these characteristics we may conclude that the problem of choosing the volume of production of each sector in each region must satisfy some restrictions which limit the number of degrees of freedom. Regional activities must be performed in each region and even in a certain relationship with the region's total activity (as a first approximation) or all its other activities (as a refinement); national activities must be performed within the nation at a level depending, again on (as a first approximation) its total activity or (as a second approximation) on its various activity levels of all

sectors. Non-shiftable activities - whenever chosen - must be located in the regions concerned. International activities of the shiftable type can be located everywhere. Their sector and region components as well as the location of the national activities are the unknowns of the problem of finding the best pattern of development for the economy; on them the levels of the regional and total income will depend. In the following section a simple model will be discussed which enables us to solve the problem.

2. A Simple Model of Regional - cum - Sectoral Planning.

The model we are going to discuss will be very simple and hence easy to handle. We can obtain this simplicity only at the price of some approximations. The author thinks these are not too high a price. In a way the model may be considered a macro-model in comparison to the eventual refinements required. Its set-up differs somewhat from the usual input-output set-up in that the main variables are not the volumes (and values, since all prices will be considered given and constant) of production but the (constant-price) incomes of each sector in each region, to be indicated by $r_y h$ where r indicates the region and h the sector. We will assume the existence of three regions only and of five sectors. The sector numbers are chosen as follows:

1. regional sectors, aggregated into one sector;
2. Shiftable national sector;
3. non-shiftable national sector, supposed to be concentrated in region 1 only;
4. shiftable international sector;
5. non-shiftable international sector, supposed to be concentrated in region 2 only.

As a consequence the building blocks of the model are:

1_y1	2_y1	3_y1
1_y2	2_y2	3_y2
1_y3	- -	- -
1_y4	2_y4	3_y4
-	2_y5	-

Of these, the first-row variables are supposed to be linked immediately to the regional income r_y (r = 1, 2, 3):

$$1_y1 = 1_n1 \cdot 1_y \; ; \; 2_y1 = 2_n1 \cdot 2_y \; ; \; 3_y1 = 3_n1 \cdot 3_y \quad (1)$$

The second-row variables only have to obey one relationship, linking their total with national income:

$$1_y2 + 2_y2 + 3_y2 = n^2 \cdot y \quad (2A)$$

For 1_y3 we have the corresponding relation:

$$1_y3 = n^3 \cdot y \quad (2B)$$

Finally we may write down the equations for the regional incomes:

$$\begin{aligned} 1_y &= 1_y1 + 1_y2 + 1_y3 + 1_y4 \\ 2_y &= 2_y1 + 2_y2 + 2_y4 + 2_y5 \\ 3_y &= 3_y1 + 3_y2 + 3_y4 \end{aligned} \quad (3)$$

It is a further feature of our model that we somewhat change the usual way of formulating the optimum problem. Instead of looking for a maximum income in one way or another, with given investments we assume the <u>incomes</u> for each region

and hence for the nation to be fixed targets and we try to obtain these with the aid of a minimum of investment outlay. We also assume that in a previous stage of planning at the national level the total income to be derived from the international sectors has already been determined. Under the simple assumption of constant capital-output ratios this means that one sector is optimal; if we assume that this sector is 5, the implication is that $1_y4 = 2_y4 = 3_y4 = 0$. For our 11 r_yh we then have 11 equations and the problem is solved without any degree of freedom for the minimization of investment outlays. If the international sector chosen is 4, we have only one additional equation $2_y5 = 0$, leaving us with 2 degrees of freedom.

We will illustrate the solution of this case with the aid of a partly numerical example. Let us take $1_n1 = 2_n1 = 3_n1$ $n^2 = 0.2$; $n^3 = 0.1$ and $1_y = 2_y = 3_y = 1$, hence $y = 3$. Eliminating 1_y1, 2_y1, 3_y1 and 1_y3 with the aid of equations (1) and (2B) we are now left with the following set:

$$1_y2 + 1_y4 = 0.5 \qquad (4)$$

$$2_y2 + 2_y4 = 0.8 \qquad (5)$$

$$3_y2 + 3_y4 = 0.8 \qquad (6)$$

$$1_y2 + 2_y2 + 3_y2 = 0.6 \qquad (7)$$

By the further elimination of 1_y2 , 2_y2 , 3_y2 , and 3_y4 we retain as the only variables 1_y4 and 2_y4.

Let the capital-output ratios of the sectors contained in equations (4) to (7) inclusive be indicated by $r\ h$ for $r = 1, 2, 3$ and $h = 2, 4$; then the portion of investment outlay which can be influenced is:

$j = {}_1k^2\ {}_1y^2 + {}_2k^2\ {}_2y^2 + {}_3k^2\ {}_3y^2 + {}_1k^4\ {}_1y^4 + {}_2k^4\ {}_2y^4 + {}_3k^4\ {}_3y^4$ which,

expressed in terms of ${}_1y^4$ and ${}_2y^4$ becomes:

$$j = ({}_1k^4 + {}_3k^2 - {}_1k^2 - {}_3k^4)\ {}_1y^4 + ({}_2k^4 + {}_3k^2 - {}_2k^2 - {}_3k^4)\ {}_2y^4$$
$$= A\ {}_1y^4 + B\ {}_2y^4$$

Since six independent constants appear in A and B, some of them with negative signs, A and B can both be positive or negative with all conceivable constellations. Excluding cases where A and B are equal we will have the following situations and their solutions.

Table 1. Possible signs and relative sizes of A and B and the corresponding solutions.

Case	A		B	${}_1y^4$	${}_2y^4$	${}_3y^4$	${}_1y^2$	${}_2y^2$	${}_3y^2$
I	+	$<$	+	0.5	0.2	0.8	0	0.6	0
II	+	$>$	+	0	0.7	0.8	0.5	0.1	0
III	+	$>$	-	0	0.7	0.8	0.5	0.1	0
IV	-	$<$	+	0.5	0.2	0.8	0	0.6	0
V	-	$<$	-	0.5	0.8	0.2	0	0	0.6
VI	-	$>$	-	0.5	0.8	0.2	0	0	0.6

These various cases have been represented graphically in figure I.

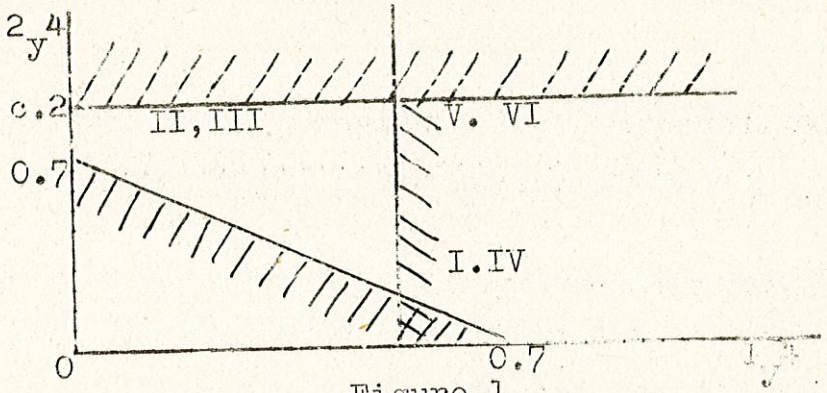

Figure 1.

It is not too difficult to generalize this model so as to contain a larger number of regions and of sectors. Calling the number of regions R, the number of regional sectors H_1, that of national sectors H_2 and that of all sectors $H = H_1 + H_2 + H_3$, where H_3 is the number of international sectors, we will have the following sets of equations, with their numbers stated behind them:

Equations

Set (1) $r_y h = r_n h \cdot r_y$, $r = 1 \ldots R$, $h = 1 \ldots h_1$; RH_1

Set (2) $\sum_r r_y h = {}_n h \cdot y$, $h = H_1 + 1 \ldots H_1 + H_2$; H_2

Set (3) $r_y = \bar{h}\ r_y h$, $r = 1 \ldots\ldots R$; R

Set (4) $y^h = \sum_r r_y Y$, $h = 1 \ldots\ldots H$; H

Eq. (5) $y - \sum\sum_{rh} r_y h$, $r = 1 \ldots\ldots R$, $h = 1 \ldots H$. 1

When regional planning follows a phase of sectoral planning, we are given y^h for $h = H_1 + H_2 + 1 \ldots H$. ..... H_3.

This implies that y is given; in addition we are given the r_y, except 1, following from (3) ..... R - 1
to the extent that concentrated sectors occur, a number
E of $r_y h$ must be empty, ... E

We therefore have a number of equations adding up to

$$RH_1 + H_2 + R + H + 1 + H_3 + R - 1 + E - R(H_1+2) + 2H - H_1 + E$$

Since the number of unknowns is all y's, that is $RH + R + H + 1$, the number of degrees of freedom left is

$$F = (R - 1)(H_2 + H_3 - 1) - E$$

The minimum number of empty places E evidently is 0; its maximum is $(R - 1)(H_2 + H_3)$, since in each national and international sector there may be R-1 at most. In this case we even find $F = -(R-1)$, meaning that the problem is over-determined. But if E is nearer to its minimum, there may be a considerable number of degrees of freedom; up to $(R-1)(H_2 + H_3 - 1)$. In the particular example dealt with before we had the situation where R = and $H_2 - 2$, $H_3 = 2$ and $E = 4$, leading to $F = 2 \times 3 - 4 = 2$.

3. Regional Planning on the Basis of Projects; Minimum Information Needed.

Since a considerable portion of the execution of a development plan must consist of the execution of individual projects there is a point in saying that "in the end" always projects are needed. One has to keep in mind, however, that in some sectors the units of production are too small to give separate attention to each piece of investment as a project, described in a precise way. This is true for agriculture, small-scale industries, retail trade and so on. For them we must complete any collection of projects by "quasi-projects" representing estimates of groups-often large groups-of individual investments. For the education sector this may also be desirable.

Another difficulty about working with projects is that it is hardly possible to prepare projects for a future period of execution which is still far ahead. Here again estimates will be necessary.

One big methodological difference between the sector (or "channel") and the project approach is the capacity limits usually set to projects. They are supposed to have a given capacity, let us hope as a rule the so-called optimum capacity prevailing in the sector. But we are not always aware of the possibility or even desirability of repeating projects which make the best contributions to the aims of development. Upon finding that some project is particularly favourable we should, in fact, add identical projects of the same type.

In this paper another important difference between the preceding sector approach and the project approach will consist of the consideration of a larger number of aims and of scarce factors than just one of each. In fact our preceding methods were silently based on the assumption of the existence of one aim only, namely to increase income (or production) and of one scare factor only, namely capital, the use of which had to be minimized. Other scarce factors are supposed to be made available in the proportion to capital which is needed.

As in one of our preceding papers[1] we will assume that the projects available are described in sufficient detail to disclose the contributions made to each of the policy aims as well as the quantities of scarce factors the project requires for its execution. We also assume that the projects have been grouped in complementary bunches with the complementary national and regional capacity extensions, estimated with the aid of the semi input-output method. Finally we assume that the projects

1) J. Tinbergen, "The Appraisal of Investment Projects", report to the Syrian Government.

have alreadybeen arranged in the order of attractiveness derived, as the case may be, with the aid of shadow prices for the scarce factors. In this order the projects will be indicated by numbers, the best by No. 1, the second-best by No. 2 and so on.

The new element we add for the purpose of regional planning is the indication, with each project, of the regions in which it can be carried out (at about equal cost). Indicating the regions by letters - their number should not be taken too high anyway - the character of the list we obtain can be illustrated by the following example:

1	DE
2	AB
3	ADE
4	ABCDE
5	B

and so on.

From the implications of our assumptions the nature of the basic assumptions involved may be derived. As in section 2 of this paper we made a distinction between "shiftable" and "non-shiftable" projects, implying that we can draw a limit between these two categories somewhere. In principle, there should be no differences in costs of production between regions for shiftable projects and "infinite" differences for non-shiftable projects. In reality there are less sharp distinctions, so we must arbitrarily accept a certain tolerance and call a project shiftable if the difference in production costs does not suprpass the tolerance chosen. If the difference surpasses the tolerance limit we may introduce two or more different projects, adding perhaps - but not necessarily - the condition that only one out of the set will be carried out.

There is another complication with which we may reckon. Some of the complementary investments implied may not take place in the same region as the one chosen for the project. There is no unsurmountable difficulty in introducing this feature into the present model.

With the information described in the preceding paragraphs we may now do a piece of regional planning. The precise rules to be followed will now be described. They depend on the aims set for the development of the various regions. As example I of a regional policy - as described by its aims - we take the "liberalist" policy followed, say, half a century ago. The projects were simply chosen in the order of the national priority indicated by the list. As a result there will be a certain development of each region; those in which many "good" projects are situated will develop more quickly than those in which not many such projects are found. We may call this "policy I "a passive regional policy. It was assumed that people would move from the less favourable to the better regions. The policy described was not entirely rigid in so far as some projects can be carried out in various regions without damaging the national interest. This creates some freedom to also further regional interests, but there are limits set to these possibilities.

For various reasons policy I was found to be unsatisfactory. Sometimes it is very difficult to migrate from one region to another. There may be linguistic and other cultural barriers, as between the Northern and Southern part of Belgium. Widespread unemployment may make it improbable for the migrants to find financial power of the families concerned. Hence more active forms of regional policy developed. There are very many shades

of them. As example II we assume that the policy is first to develop the poorest region, say region B, until it reaches the level of income perhead of the next poorest, say region C. Instead of income per head other measures or aims may be used. Policy II then consists of not starting with project No. 1, but with project No. 2, and next projects 4 and 5, since they can be carried out in region B. Some less good projects will be chosen now before project 1 or 3 are chosen. This will go on until region B has reached the level of region C. From that moment on projects will be picked which, in a fixed proportion, add to the income of regions B and C. This may go on until the level of the third region from below (in terms of income per head) has been reached. The final choice of projects will, as a rule, still contain some less good projects (from the national point of view) instead of some better ones which happen not to carry the letter of the favoured regions. The difference in income and other aims to be obtained by the set now chosen and the set chosen under policy I constitutes the price, in terms of the aims of development, of the regional policy II. The policy - makers may decide whether it is worth its price.

Superfluous to say that many alternatives are conceivable. Thus, instead of raising region B's income to the level of region C, one may imagine a policy which only aims at reducing the difference on income per head to one-half or any other fraction of what it was initially. Many other versions are possible.

It will have been clear to the reader that one of the operations to perform is to estimate, after each project selected, the new level of income and other target variables of the region under consideration. The information contained in the description of the project bunches enables us, in principle, to do so,

provided that we have some general information about the regions such as their population, and so on.

4. Industrial Complex Analysis.

A type of analysis has been developed recently which is known as industrial complex analysis. Being of a technological and business-economic character its main purpose is to find the optimum size as well as the best combination and location of combined industrial processes, especially in such complicated industries as the chemical and engineering industries. Recently extensive use has been made, in such analysis, of mathematical programming. The availability of precise data permits the use of refined methods. A word may therefore be added about the role such industrial complex analysis can play in the general planning process. The present author prefers to think of this analysis as a powerful instrument, but an auxiliary one, in general planning. As a rule this analysis should precede the type of central planning discussed in this and some of the preceding papers[1] and supply the information about simple projects and about sectors. Clearly there may be some interaction, however, between this auxiliary research and the central planning process proper to the extent that the outcome of the latter may, in principle, change some of the basic assumptions made in the industrial complex analysis. Under such circumstances revisions will be needed of which one must hope that they rapidly converge.

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1) J. Tinbergen, loc. cit and "Organization of Production, Policy and Planning" Reprot to the Turkish Planning Bureau.