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SOME REMARKS ON TINBERGEN'S APPROACH OF PROJECT APPRAISAL

by

Mr. C. J. van Rees

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CAIRO
3, MOHAMED MAZHAR - ZAMALEK

C o n t e n t s.

1. Introduction

Before the second world war the evaluation of investment projects was executed by the investors themselves. They only searched for factors influencing directly or indirectly their profits. After the second world war the governments came to believe that other factors played a role as well. This referred largely to the so-called direct and indirect effects of a project on the national economy. Several methods were developed to facilitate this work.

All methods which are used nowadays assume full information on the side of the planner. I.e. a model is used, which gives a representative but simplified picture of the economy. All coefficients are assumed to be known exactly, while for part of the variables the same goes. This concept is of great help. Unfortunately it is a very rough approximation of reality. Except for the uncertainty intrinsic to the use of an economic model, we also face uncertainty with respect to the coefficients and variables themselves. E.g., in a simple Keynesian model we have two equations:

$$Y = C + I$$

$$C = cY$$

where Y = national income, C = consumption, I = autonomous investment and the coefficient c= propensity to consume. Given the values for I and c, national income Y can be determined. It is equal to $Y = I/1-c$. Neglecting the intrinsic simplication of the model, we can distinguish two grounds for uncertainty:

1. The variable I. Deviations due to measurement errors are obvious. This means that in successive estimation of this variable it will show different values and the question raises, which value we should use in the forecast for Y.

11. The coefficient c. Usually this coefficient is estimated given a sequence of values for C and Y. The technique used is arbitrary. It ranges from least squares in a simple model, as the one mentioned here, to the k-class of simultaneous equation estimators for very intricate models. Several factors for uncertainty can be mentioned.

a. As before measurement errors for C and Y, when c is estimated, may exist.

b. The relation is estimated by a minimization process, which constitutes in its roots only an approximation.

c. The relation is estimated for past period. A change in the behaviour of the economic subjects will have an influence on the coefficient c. This makes the model useless for estimation with the present value for c.

A way has to be found to take these factors of uncertainty into account and to show their influence on the result. In principle this can be done along two lines.

A. A very great number of alternatives is computed. E.g., in the above-mentioned example a range of values for Y and c is excepted, say n for each. This results in n^2 solutions. It is obvious that the addition of many other variables to the system will complicate the computations very much. The use of a computer is inevitable in that case. In spite of the speed of the machine, this process is time-consuming, expensive and moreover it lacks efficiency. To put one question mark: which solution is most probable?

B. We try to develop a probability mechanism for each of the variables and, or coefficients. This means that we consider them subject to a stochastic process, which reveals a certain distribution for the variable. These distributions have their influence on the final result and will show an expected value, together with a probability distribution for this characteristic. We admit, that this result depends on the simplifying assumptions we accept. E.g., in the above-mentioned example the distributions for Y and c can be assumed either dependent or independent of eachother . This influences the result. One warning is justified. In the method for investment-appraisal applied by Tinbergen, which is outlined in the next section, we can distinguish technical relations and a criterion. Usually the-last function is due to personal decision. Variations in this function can not be explained by a stochastic process.

In the following section the Tinbergen approach is outlined and several problems in the field of certainty and uncertainty are touched. Those, who are interested in problems of a less academic nature, are advised to turn several pages and go directly to the last section. There they will find an enumeration of some practical problems, which still lack a solution.

2. The outline of the method.

The Tinbergen Approach distinguishes itself mainly from other planning methods, where it distributes the planning over three stages. It tries to solve the problems of planning in three sucsessive steps. This doesn't confront the government with a completed plan right away. As she is informed in the results of the paln in its different steps, the power of convincing the government will increase. Moreover, it will be possible to introduce new preferences in the model when we go through its successive

stages. This is contrary to other methods, e.g. the Frisch Approach. These planning methods introduce their preferences and assumptions in the beginning only. This makes its vertally impossible to detect their influence in the final result. The use of intricate untested models constitutes an additional risk. The purport of the three stages of the Tinbergen Approach will be memorated briefly.

I The macro economic plan: This estimates the most desirable time path of national income, total savings, total investment and some other variables. As the maximization of national income usually constitutes one of the main aims, the fixation of the development of the future consumption is an important decision. This choice should be left for the politicians. The pace of development of the macro economic variables can be laid down with the help of simple economic models, e.g. models of the Harrod-Domar type.

II The sector plan: Here the problems of the prospective development of demand in a number of sectors (10 to 20) have to be faced, taking into account the results of the first stage. This includes besides final demand and export demand, also the development of production of intermediate goods and raw materials, for each sector of the economy. From this we derive a program of production and an idea of the necessary investments in the different sectors. If a discrepancy between total investments in the first and, second stage exists, the planner will have to correct his outcomes. This can be carried and by an iterative procedure.

III The project Appraisal. We shall have to insert the seperate investment projects in the investment program for each sector. In principle this requires a comparison of the state of economy before the project is executed with the state of the economy thereafter. This

means an estimation of the returns of each project to the national economy. In Tinbergen's way of thinking this approach will have to be done for a project in the international sector and its complementary investments in the national sector. To compare different projects a criterion can be used which weights the contributions to the aims of development policy and the use made of the country's scarce factors. Accounting prices can play a role because they give a better insight in the scarcity of the factors. Ideally the accounting prices aim at using all the available scarce factors, while all the investment projects are executed . A more elaborate description of the appraisal of investments projects can be found in memo. 383 of the I.N.P.C.

In view of the repercussions of each project for the national economy, it is recommended that the decisions for the third stage also rest with the government. This enables here to prevail the general interest to the private interest. This contradicts the ever existing idea that the benefit of the individual shows the benefit of the economy as a whole. The necessity of the development of suitable a system will be clear now.

3. The introduction of uncertainty in the appraisal of investments.

Up till now the problem of appraisal of projects has been considered as a static one. This meant, that the production side of the problem, i.e. the semi input-output table related to one period. This introduces the familiar assumption of input-output analysis, namely, constant input-output coefficient. In practice one will try to realize an increase in the productivity after the construction phase is over[*]. In the early stages of the development of economic forecast this was solved by assuming a fixed trend in the increase of productivity, demonstrating itself in a predetermined change in the coefficient. E.g.in the wellknown Cobb-Douglas production

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[*] This rise in productivity is clearly different from the aim to increase either production or productivity through the construction of the plant itself.

function a time factor was introduced. This showed the increase in production which could not be explained by both labour and capital. Except for the statistical methodological problems arising here, this is also contestable from the economic point of view. It introduces a rigid mechanism to explain increase in productivity. From reality we all know that the increase in productivity for sectors of the economy shows large fluctuations. This does not help us to be confident about the constancy of this variable on a less aggregated level. Several other solutions for the problem under hand exist. Two of them will be mentioned here:

1. Introducing the increase in productivity as a fixed percentage increase of the final result. This only shifts the problem to the final stage and neglects the influence of changes in productivity on the input-output mechanism. In fact, we deny the existence of increase in productivity, when suddenly we remember the lectures on economic theory we attended and feel obliged to shove it in the final result. This may seem rather strange now, but one should not fail to realize that this procedure was common during a great many of years which have past.

2. Introducting the change in productivity in the coefficients of the system. As the consideration of a fixed trend does not satisfy us, we can use a stochastic process to solve the problem. This is justified for reason that growth of productivity consists of a process in which a great number of factors play a role. This is one of the assumptions governing a stochastic process. The form of the probability distribution to be used, is uncertain and will be due to statistical testing. There are some reasons to believe that a rectangular

distribution gives the best fit. One of the sensible reasons is, that the chance for a certain percentage increase will be equal over a large range. The introduction of this idea in the input-output table itself can further be treated by the welknown process of random walks.[x] Those policy makers, who prefer to have certainty rather than uncertainty in the answers they receive will feel rather uneasy. They should realize, that the economic process in its foundation is a process of stochastic nature. By taking a fixed figure for truth, they close their eyes to reality.

The result obtained from the last method will not always be different from the classical result. If we combine the constraints with a fixed static criterion an interesting conclusion is reached: The mathematical expectation of the appraisal of an investment project with constraints under uncertainty and a fixed static criterion is equal to the appraisal of the same project under certainty. In order to obtain this conclusion some limiting assumption had to be made.

a. The probability distributions of the change in the technical coefficients are independent of each other.

b. The mathematical expectation of the percentage change in the technical coefficients is equal to the fixed figure used in the case under certainty.

The picture is changed greatly if we introduce dynamic factors in the criterion. This will be reviewed in a next section.

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x See W. Feller: An Introduction to Probability Theory and its Application.

4. Dynamization of the Criterion.

The criterion used by Tinbergen to compare the relative advantages of a number of investment projects in a sector, took the shape of a yield, defined as the ratio between the net benefits of the project to the national aims and the sacrifices made for its execution. Usually it is shown as a proportion of the two factors mentioned above. Alternatively it can be shown as a product of addition and deduction. This is useful when we try to estimate the optimal size of the plant. Several techniques are available, e.g. linear programming. As Tinbergen considers this a predetermined decision, we will not review it in this section. Therefore one will give preference to the first alternative definition of the criterion. Moreover it does not touch the problem we want to study here.

The easiest representation shows the criterion as a completely static relation. Market prices are used to show the importance of each scarce factor and to emphasize the contributions made to the aims of national economic policy*. This does not exclude completely the influence of future periods. Prices may refer to the benefits and costs in each of a successive series of years. A simple time discount is applied on the actual prices to represent our limited horizon. Further, and this is generally true, a truncation can be applied to keep the problem within manageable limits. In essence this approach is static and it will be considered as such. A first touch of dynamics is introduced from the moment we start fluctuating our discount factor. First of all it is not necessary for them to be equal for all factors. It may well be, that factor A has a future preferance over factor B. This can be demonstrated in a larger discount factor for B than for A.

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* The author is aware, he cannot escape the fashion of using accounting prices. Some remarks will be given in the next section.

A more general dynamization is attained when we consider all projects each year, not only the new ones, but also the projects under construction at that moment. For both groups we then appraise the whole project. If in a certain year a project under construction is rejected, we shall have to find ways to improve its profitability. This can be done by changing the plans for the part still to be constructed. E.g. if the plant is too capital-intensive, we should find ways to substitute labour for capital. This idea is specially useful for projects for which the construction period lasts many years, e.g. the High Dam projects. It means, that we do not take a once and for all decision, but we are able to adjust our plans to the changing circumstances.

5. Accounting Prices.

The principal reason for the application of accounting prices is the existence of a structural dis-equilibrium in the economy. It is said that the relation between the market-prices of the factors of production does not give a proper indication of their relative scarcity. In order to obtain an optimal utilization of all factors of production, we have to adopt prices distinct from the market-prices. E.g. in most underdeveloped countries the factor labour is abundant. It was suggested by. Tinbergen to put its accounting price equal to zero. This seems an extreme position, however. With the use of a simple Cobb-Douglas function Qayum* showed that the maximal production was reached with an accounting price for labour which accounted for 90% of the marketprice, when 30% of the labourforce was unemployed. To the author's opinion the simplicity of the model will have had a favourable influence on the height of the accounting price.

Although the theoretical impact of accounting prices is clear, the application of their definitions gives additional problems.

I. Prof. Tinbergen proposes a solution by trial and error. He

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* A. Qayum: The Theory of Accounting Prices, ch. 7.

supposes full information on the quantities of all factors and project bunches available. Assuming a set of accounting prices he tries to find a solution, where, with a certain bunch of projects determined, all factors are exhausted at the same time. If all factors are not exhausted at the same time, the price relations have to be changed and the prodedure will have to be repeated, as long as the above mentioned position is reached.

II. The method proposed by Qayum differs from the former method in several respects. Besides the full employment of factors, he aims at a maximum value added. He formulates the problem as a Linear Programming problem and his accounting prices are derived from the dual solution. After the estimation of these accounting prices two ways can be chosen.

a. The state fixes all prices at their accounting level. This, however, cannot be done within a free economy.

b. A system of subsidies and taxes is adopted in order to induce the producers to use the techniques which ensure a maximum level of value-added and give full utilization of all factors.

Some disadvantages and incorrectnesses of both methods can now be mentioned. Tinbergen's method is less elegant, because it does not procure us a straight forward solution. Moreover it is not clear that he even shows us a way to the solution of the problem. For each change in the accounting prices will also affect the packet of project bunches in the result. In fact a next step (i.e. a change in the accounting price of one of the factors) may alienate us from the final solution. This reproach can be made to the whole Tinbergen approach , however, This is offset by the great advantage of easy manipulation.

Dr. A. Qayum: The Theory of Accounting Prices, ch. 7.

Further contrary to Qayum he does not obtain a maximum. This last method has a difficulty of its own. Koopmans* already suggested to use the dual problem of linear programming to set up a system of accounting prices. Given these prices the producers would then be allowed to take their own decisions with regard to investment and production. Unfortunately there is noting in the system of accounting price which holds the investor's decision down to the required optimum over-all program. So, either a dicision has to be taken from above or the investors must agree together. Additionally the investors will have to be instructed to work to the same optimum. These reasons make it impossible to substitute price planning for physical planning. So the only opportunity for the Qayum method lies there, where a central decision-making body for the investment decision exists.

It is sometimes argued that accounting prices will continue the existing market relations. In fact, hand-industries are subsidized. This prevents the introduction of better techniques of production. This on its turn has an unfavourable effect on the quality of the product and makes it more difficult to find an expert market for the product. A similar picture was shown in the Nether lands during the fifties. A policy of wage restrictions promoted labour intensive investments. This led to an unfavourable position in the export market compared with other countries, e.g. Western Germany, where capital deepening has been one of the main aims of post war economic policy. Summarizing it seems appropriate, to fix the accounting price for labour on a higher level than that

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* T.C. Koopmans, ed., Activity Analysis of Production and Allocation, Cowles Commission, 1951.

required by the linear programming solution. An elegant and mathematically sound solution may be found through the introduction of a quality factor in the L.P. model. This needs further study.

Some authors prefer to use many accounting prices for all available factors. It was rightly stated by Qayum, that only accounting prices for capital and unskilled labour are needed, because all other factors can be reduced to these two. For skilled labour, this means that training is considered as part of the capital costs of the project. Education is a very time consuming process and it is difficult to see how to procure trained labour at the end of the construction stage of the project. This calls for an educational program anticipating the economic development of a land. Short term adaptation courses can be useful. They should not become a rule, because they most certainly limit the general background of the people.

6. National projects versus international projects.

It is possible to make a distinction between two sorts of sectors; the national sector and the international sector. The first one has no international links while for the second one it shows its main feature. The Tinbergen approach combines an investment in the international sector with its complementary investments in the national sectors. This excludes the existence of projects solely in the national sector which are estimated on their own merit. Several examples can be mentioned where either the link with an international sector is very weak or non-existent at all. E.g. an irrigation or drainage project aims at improving the productivity of the soil. As a consequence either the quality or the quantity of the crop will increase. Assume the crop will be exported. Then