TINBERGEN'S CONTRIBUTION TO BUSINESS-CYCLE THEORY AND POLICY

BY

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When Tinbergen together with his old friend and co-pioneer in econometrics, Frisch, received the first Nobel prize in economics a few months ago, he had been active in the theoretical and practical aspects of this field for about 40 years. His doctoral thesis, *Minimum Problems in Physics and Economics*, appeared in 1929 and this title is revealing. On the one hand it marks the transition of the author's interest from the realm of the natural sciences to the area to which he was going to dedicate his life and on the other hand, it is characteristic of his conviction that quantitative methods can fruitfully be applied to the solution of economic problems, a vision which has been fully reawarded by past years' experience. Obviously, such a shift in interest does not occur at once and if one looks through the extensive bibliography attached to the volume of „Selected Papers" [1] commemorating Tinbergen's 25-th anniversary as professor at the Rotterdam School of Economics one comes across a few articles already written before 1929. Some of them are still of interest to us to day as they show another and dominating aspect of their author's personality, his socialistic faith and his social motivation. They suggest that Tinbergen's change was not only caused by scientific curiosity but also and perhaps mainly by his sympathy for the poor and his desire to use his intellectual powers to improve their position.

There are few areas in economics which have not at times occupied Tinbergen's mind and to many he made lasting contributions. His scientific output is surprisingly extensive and I am greatly relieved that the editors of this periodical have invited a group of authors to share the task of reviewing this work among them.

In spite of his versatile spirit, Tinbergen has always concentrated

his efforts on the solution of the great economic problems of the day. Therefore, during the thirties when his reputation as an economist of international standing was gradually being built up, Tinbergen was mainly engaged in business-cycle research since at this time the persistently reoccuring slumps, with unemployment and misery in their wake, stood in the fore, the year 1929 being of significant importance in this respect. Apart from a long series of articles in international periodicals, the volumes of De Nederlandsche Conjunctuur, a publication of the Dutch Central Bureau of Statistics, during this period witness the activities of its department for business-cycle research of which Tinbergen was the leading spirit. Still it may be appropriate to pay tribute to the memory of Methorst, the director general of the bureau and of De Bosch Kemper, the head of the department, for their endeavour to support and even enlarge this small nucleus of research in a period of continual cutting down of public expenditure. Personally, I consider it a great privilege to have had the opportunity to work for some years in this highly stimulating environment and I am pleased that the editors have allocated the task of reviewing the part of Tinbergen's work which is so closely related to those years to me.

I have already mentioned that Tinbergen strongly believed in quantitative methods. This is true with respect to both the application of mathematical tools to economic theory and the empirical verification of theory with the help of statistical data. But his pioneering role is mainly connected with the second part. Even in the 19th century there was an impressive list of distinguished mathematical economists but when Tinbergen started his work, very little empirical evidence was available. In particular with respect to Dutch statistical data he trod on virgin soil and studies were made by him and his collaborators in almost even field where promising empirical material could be found. Many of these investigations can be classified as demand studies but they have also great importance for the empirical knowledge of the business cycle as invariable a large part of the fluctuations of the turnover in the different markets could be explained by the cyclical movements either of incomes or production. Typical studies of this kind are those referring to agricultural products like butter, meat and potato flour [2], public and private means of transport like railways [3], tramways [4], bicycles [5], motorcars [6], etc. They contributed considerabley to our knowledge of price- and income elasticities but

at the time they were mainly of academic interest. Although I can recall one amusing and rather negative example of their use in policy considerations. The publication of the demand for railway transport almost coincided with an effort of Goudriaan, then president of the Netherland's Railways, to improve the economic situation of his company by introducing a system of differentiated tariffs including reduced evening fares, etc. The famous economist, F. de Vries, at that time president of the board of directors, objected to this policy of partial price reductions on account of the low price elasticity of the demand for railway transport resulting from the study. It took Tinbergen some time to make clear to all parties concerned that its results could only be used to reject an overall cut in tariffs but that no evidence on the outcome of the proposed tariff differentiation could be derived from them.

These studies, however, did not detract Tinbergen from his main interest, viz. the explanation of the business cycle phenomenon itself and in particular by what might by called a „unified" theory. The mainly non-mathematical business-cycle theories existing at the time nearly all depended on different explanations for the various phases of the cycle. The mathematically inclined economists on the other hand were strongly in favour of models explaining the cycle as a whole from one and the same set of causal connections.

The first models of this kind referred to special economic sectors possessing their own cycles. Tinbergen greatly appreciated Hanau's well known work on the pig cycle [7] and he did interesting work himself on the shipbuilding cycle as it developed before the first world war [8]. Hanau's theory presented an example of the cobwebb theorem as supply reacted to the price with a certain lag whereas demand was determined by the actual price and the market cleared through the equation of supply and demand. In the shipbuilding cycle the freight rate was mainly determined by the actual level of world tonnage, both measured as trend deviations whereas the rate of change of the tonnage level, i.e. the volume of launches, was dependent on the freight rate with a lag depending on the construction period for new ships. The mathematics of the mechanism generated this way is much more complicated than in the cobweb case but, with reasonable assumptions about the parameters of the model based on econometric research, it leads to a cyclical movement with a period of about eight years. In general this result is well in accordance with the actual developments during the years

1880–1910. A few marked exceptions occur, however, in years where the „internal" cycle deviates strongly from the general one. In such periods the demand for shipping, a trend factor in the model described, has a clear effect on the development.

Similar sector cycles have been studied for the international coffee market [9] and by Derksen, one of the members of the research group at the Bureau of statistics, for the building market in the U.S. [10].

In the mean time the macro-economic approach was strongly stimulated by Keynes' *General Theory*. Several attempts to construct unified business cycle theories along these lines were made. Some of these as e.g. Lundberg's sequential models [11] and Samuelson's multiplier-accelerator model [12] belong at present to the classics. However, during the same years Tinbergen was already engaged in a far more ambitious project, viz. the construction of a model which could be used for business cycle policy! Needless to say that such a model had to be much more refined than the purely theoretical ones already referred to and it also had to be based on empirical research to obtain realistic values for the parameters of such a model.

The first example of this kind was published by Tinbergen in a paper read to the Dutch Economic Association in 1936 as a reply to its question „Is a recovery in the domestic situation of this country possible, with or without action on the part of the Government, even without an improvement in our export position? What can be learned about this problem from the experience of other countries?" This paper can be considered as a bench mark in the history of economic theory and the editors of the „Selected Papers" in my opinion were fully justified to include an English translation of it in their sample of modest dimensions confined to the size of a single volume [13].

Compared to modern standards the model may look small, but it still contains 24 equations, 8 of which are identies or definitional ones. It also shows already a certain amount of disaggregation as two categories of commodities are distinguished, viz. consumption goods and means of production. Each of these is represented by a more or less complete set of variables referring to volume and price of their import, export, production and required volume of imported raw materials.

Its structure has no doubt been a good example for many successors, in particular among the Dutch ones, during the following three

decades. Many typical characteristics of such models can be found in it, particularly in the consequent description of each market occurring in the model by a demand- and a supply equation or more often still by a demand- and a price-formation equation, but also in the specification of the equations themselves. The volume of exports is, as in more recent models, made dependent on world exports and the ratio of the Dutch export price level to the world-price level in general. Price levels are mainly determined by prime costs but the price level of consumption goods is also sensitive to the degree of capacity utilisation, in this case simply represented by the level of production. Moreover, the simultaneous dependance of the export-price level itself on costs and on the competing world-price level was introduced. The recent lengthy and somewhat confused discussion on the Phillips curve has been foreshadowed in the relating of the rate of change of the wage level to the level of employment but also to the rate of change of the consumption-price level one year before! Finally, it is not surprising to see that investments are determined by non-labour income. Tinbergen's well known preference for this variable over those connected with the acceleration principle, firmly based on empirical evidence later on, was already expressed in this firstling.

As it should be for an open economy like the Netherlands, exogenous variables play an important role in the model. The size of world exports, the net income from investments abroad and not less than six foreign price levels belong to this group. Therefore, the model could not give a full explanation of the actual Dutch business-cycle fluctuations of the period. It could have been used to assess the importance of purely internal cycles but it is almost self-evident that the result would have been that a large part of the actual fluctuations were to be ascribed to the external forces which were data to the model. However, it lent itself very well to the solution of the problem for which it was designed. Given a pattern of development for the exogenous variables it was possible to forecast each endogenous variable 5 to 7 years ahead and to do so under different policy alternatives. As such were considered the most important variants under discussion at the time, viz. wage cuts, public works, increased trade protection, devaluation and rationalisation. As the model was linear (-ized) the difference between the outcomes for a given policy variant and unchanged policy was independent of the exogenous movements assumed and could thus be considered to be typical for the policy concerned.

This approach was a big step forward because, for the first time, the possibility of making quantitative assessments about policy implications existed.

The immediate practical importance of the paper remained small. Among the policy alternatives considered attention was given to the Labour Plan, set up by the Labour Party some time before and proposing a programme of public expenditure on additional investments combined with certain incomes-policy measures to cope with the unprecedented unemployment. The plan to which Tinbergen had strongly contributed himself turned out to be a rather favourable policy line but it had already been rejected before the study appeared. To the inter-war governments responsibility for a favourable economic development was still a rather unfamiliar notion.

Moreover, the most appropriate measure according to the study, viz. the devaluation of the guilder had just been taken a few months before. But the decision was based not so much on economic reasoning, as on the fact that the remnants of the former gold block fell to pieces as a consequence of the devaluation of the French franc.

The impact of the study on economic thought, on the other hand, was considerable, although it is not possible to separate it from the total effect of, a large number of contributions by Tinbergen as well as others which followed this pioneer article. Together they had an influence not only on economists but also on politicians. They supplied the tools for a radically changed policy, particularly in the Netherlands, although a devastating war was needed to create a favourable climate for their implementation.

Before turning to succeding work it is perhaps interesting to recall the remarkable fact that the whole study, including the preparation of the statistical data, the econometrics, the building of the model and its use, is practically the work of one man, assisted by a slide rule and some sheets of squared paper.

The next important phase to be reviewed is Tinbergen's work at the Economic Intelligence Service of the League of Nations during the three years preceding the second world war. As far back as 1930 the Assembly adopted a resolution deciding to make an attempt to co-ordinate the analytical work being done on the problem of the recurrence of periods of economic depression. The first part of this work, consisting of a critical examination of existing theories, was entrusted to Haberler and led to his well known book *Prosperity and*

Depression which appeared in the course of 1937 [14]. The second, which started immediately after the first one and in which „an endeavour will be made to confront these various theories with the historical facts – to subject them in so far as these facts can be quantitatively expressed to statistical analysis, in so far as they are not quantitatively expressed to the recounted records of the past", was entrusted to Tinbergen, later on assisted by Polak. Two publications resulted from this period, both dated 1939 and both under the general title *Statistical Testing of Business Cycle Theories.* The first one, *A Method and its Application to Investment Activity* [15], more directly dealt with the problem assigned to Tinbergen. It studied investments in fixed assets, a prime mover in many business-cycle theories and tried to find out which of the numerous explanations offered in the course of time merited greatest confidence. Its results, based on statistical evidence from various countries in different periods, are well known. It was found, as has already been mentioned, that lagged profits (or non-labour income) was by far the most important explanatory factor of investment. The effect of other variables, like interest rates, rate of change of investment prices or the acceleration principle was either much smaller or could not even be ascertained at all. Only in special sectors of the economy the situation turned out be somewhat different. Residential building proved to be more sensitive to interest rates than other investments whereas the acceleration principle in addition to profits seemed to play a role in net investments in railway rolling stock.

The first publication was not received with great enthusiasm everywhere. It suffices to point to the review by the late Lord Keynes in the September, 1939 issue of the Economic Journal. He rejected the results entirely on methodological grounds. Too many important factors could not be quantified and, therefore, multiple regression analysis was inapplicable to the problem of the business cycle [16]. However, in spite of this authoritative statement and of other criticisms as well, the results have stood the test of time and even today have not lost much of their importance.

Still more interesting then the first study is the second one, *Business Cycles in the United States of America, 1919–1932,* [17]. In this publication as the title indicates the author deviated more from his assignment to follow his own ideas. He did not see great advantages in meticulously putting theory after theory to the test of statistical evidence as he was convinced that no single theory

would emerge as the true one. To him the cycle was a complex phenomenon in which various mechanisms could be active at the same time. Therefore, he was much more in favour of models like the one set up for the Netherlands. In these models each important relationship could be studied separately and the final effect of all these influences on the system as a whole could then be derived from the solution of the complete system of equations representing the various relations.

The United States offered itself quite naturally as a good test case. It was the only country virtually economically independent of others; its foreign trade, important though it might be for the rest of the world, was very modest in comparison to its national product. It was the country where the big depression of the thirties started and it offered an abundance of statistical data. And so he decided to build a model to explain the cyclical movements in the United States during the period after the first world war. The fact that some essential data become available only with considerable delay necessitated him to restrict his sample periode to 1919–1932.

Needless to say, such a bold undertaking caused some worries at the Economic Intelligence Service, particularly after the unkind reception of the first publication. In the words of its director written as a preface to the publication these feelings clearly resound in the many qualifications and reservations.

I have been told by an insider that Mr. Loveday still in his old days was not quite convinced that it had been a wise decision to publish such a provocative document under the auspices of the League of Nations! Anyhow, it is comforting that the decision was taken. However, it was a pity that the second world war broke out only shortly afterwards and so international discussion of the paper was seriously impaired. It is my feeling that, as a consequence, it never got the full attention it merited.

Obviously, it will not be possible to review the paper in detail but a few salient features may be recalled. It describes a model intended to explain the complete business-cycle phenomenon and this imposes severe conditions to this model. E.g. it was generally believed at the time that financial phenomena would play an important if not the decisive role in causing cyclical fluctuations and, hence, in contradistinction to the approach followed in its Dutch predecessor, much attention had to be given to the financial variables. As a matter of fact the model contains a „block" of financial equations

in which four different types of assets have been distinguished, viz., bonds, shares, short claims and money. The demand- and price-formation equations for these assets are fully worked out in their mutual relations and this part of the model by itself is an important achievement and it still stands out very well in comparison with attemps to do this for post-war periods.

As one of the chief aims of the investigation was to try to prove the possibility of cycles of internal origin, it was this time not sufficient to use the model to predict the future course of the economy a few years ahead but it was necessary to derive and solve the final equation of the system. With some simplifications and assuming moderately rapidly changing share prices this led to a fourth-order difference equation from which a main cycle with a period of 4, 8 years resulted. This figure does not differ very much from the average length of the actual cycles of the period of about 3,3 years. However, the cycle turned out to be heavily damped and, therefore, could only lead to sustained fluctuations when it was regularly resuscitated by external shocks.

Another important result related to the share price formation. It was demonstrated that in order to explain the fluctuations of the share price index one had, in addition.to the obvious influences of dividend level and long-term interest rates, to take recourse to an inherent dynamic mechanism by introducing the rate of change of the index itself as an additional explanatory variable. This relation which, as has been explained in a separate article [18], could also be traced in several other countries, proved to be markedly non-linear in the case of the U.S. When the rate of change stays below a critical level the dynamic effect does not occur. This was the case referred to before. But when this level was surpassed a cumulative process was initiated which along the causal chain from share prices over profits to expenditure could have a strong influence on the total development. In Tinbergen's findings this peculiar behaviour of the U.S. share market has been an important factor in the explanation of the heavy fluctuations around 1929.

During the early years of the second world war Tinbergen once more built a model comparable to the two already reviewed. In this period he constructed a model for the U.K. during the period 1870–1914 along the same lines as the U.S. model. In spite of the scarce statistical data from this early period he has been able to get sufficient material for his investigation. In this case he had the

advantage that the period of research contained not less than 5 complete cycles but on the other hand, the problem was complicated through the fact that he had to deal with all the complexities of the U.S. model and the fact that the U.K. has an open economy. The study was published with great delay, viz. in 1951 as a contribution to the Proceedings of the Royal Dutch Academy of Sciences [19]. According to the author the chapters I-VI ,,are dull literature" and ,,the best remedy is not to read them." This may be so, as these chapters mainly contain methodological considerations. Nevertheless they are very important and this is certainly true for what was called ,,the happy ending". The publication is particularly interesting as it roughly marks the end of the period of Tinbergen's business-cycle research. It is, therefore, interesting to quote a passage from the introduction which briefly but also very clearly describes his attitude with respect to the subject and, more generally, with respect to economic research on the whole.

,,The explanation of the business cycle phenomenon and the determination of the probable effects of various types of business cycle policy are complicated problems. Their subject matter consists of a great number of phenomena, showing innumerable relationships of very different and changing strength. It is no easy task to keep all these relations in mind and to find their combined effects by pure reasoning. The necessity for a mental administration of all these phenomena and relations is strongly felt by all who try to tackle these problems in a rigorous way. One form of such an administration is the mathematical treatment of these problems.

Even with the help of such an administration there is a need for simplification: non-essential details must be eliminated as soon as possible. Only a sort of skeleton of reality is workable. In this model the relative size of various phenomena and the relative strength of their relationships must be chosen as close to reality as possible. This is best attained with the help of statistical information. Hence a combination of mathematical treatment and statistical measurement, i.e. an econometric treatment, presents itself as natural."

As to the contents of the publication the very last chapter on business cycle policy is indeed the most important. Tinbergen's main preoccupation with the cyclical phenomena has always been to derive useful policies to prevent or at least dampen as much as possible the disturbing cycles. At several occasions he has treated the problem from this angle (cf. e.g. [20]). In the U.K. publication

he summarizes once more his findings: The cyclical movements are due to shocks and to the reactions of the system to these shocks. The best thing business cycle policy can do, therefore, is to change the reactions to the shocks in such a way that only heavily damped reactions are possible. In addition to this result a shortening of the period is also favourable. As to the means to attain these goals he points to the reduction of the marginal propensities to consume and to invest through compensatory public expenditure programmes. An other important instrument would be the introduction of cost accounting on the basis of replacement instead of historical costs. Price stabilisation might be helpfeel but monetary policy in the sense of bank rate policy has hardly any effect at all.

Although in the preceding pages a number of Tinbergen's most important contributions to business cycle theory and policy have been described it certainly does not give a complete picture of his activities in these fields. A great number of publications has not been mentioned at all. Obviously, not all of them present fresh ideas. Often two or more articles treat the same subject in various phases of development or in varying degree of detail. E.g. the study on share-price formation [18] gave additional information on a special aspect of the U.S.-model [17]. The well known „Statistical Evidence on the Acceleration Principle" [21] was a forerunner of his first Geneva-study [14] and so on. Other publications had a purely educational purpose, like e.g. his *Economische bewegingsleer* [22] which has been translated into English and Spanish and which still is an excellent elementary introduction into economic dynamics or his *Lessons from the Past Thirty Years* [23] in which he gave his vision on the post-war economic policy based on the experience from the period 1914–1944. But even if we take these circumstances into account much interesting material remains uncovered.

I should still like to draw attention to one particular example, viz. a study on economic equilibria originally published in Danish [24] and later on translated and reprinted in „Selected Papers" [1]. This paper originated from a series of discussions with Goudriaan which started in 1934. Goudriaan did not believe in cyclical fluctuations around a certains equilibrium level. According to him an economic system would either be in a situation of practically full capacity utilisation or in a state of rather low activity. The transition between the two, in particular in the downward direction, could be

compared to „the collapsing of a bridge". This idea of a system moving between a ceiling and a bottom has also been put forward by others, e.g. by Hicks in his *Trade Cycle* [25]. Goudriaan was not very much interested in the mechanics of collapsing bridges, but Tinbergen although convinced that an economic system might be confined between certain limits due to boundary conditions had the opinion that such systems even in the transitory phase had to be subject to a well defined dynamic mechanism. Therefore, in the article mentioned already he studied the behaviour of a system described by a first- and a second-order difference equation respectively and kept between an upper and a lower bound. In particular he tried to find under which conditions the bounds, baptised 'Goudriaan-points', could be stable equilibria. That is to say: when would a system hitting the ceiling (or the bottom) stay there undefinitely and when would it be rejected and continue its way in the opposite direction. The results showed amongst others that a system without a stable equilibrium if not checked by bounds (without a stable „Keynes'-point) in general would lead to stable Goudriaan-points and vice versa and have considerably contributed to our knowledge of the factors determining the stability of economic equilibria.

It has already been said that Tinbergen's interest has always been drawn to the great economic issues of the time. Therefore, after the war he gave his attention chiefly to the reconstruction problems and the development of the Central Planning Bureau into a high-quality advisory institute for economic policy. Roughly ten years later he shifted his attention again to what then appeared to have first priority, viz. the problems of the developing countries. In each of these cases his restless mind helped to design the adequate tools of analysis but it is certainly true that in either case he could draw heavily on his earlier experience. This is in particular true for his work at the Central Planning Bureau. That the first directorate of this brand new post-war institute was entrusted to him was obviously due to his great prestige as an economist. But many ideas about the shaping of economic policy, the construction and the use of economic models, developed in earlier years, could immediately be applied in this new situation and this has certainly contributed to the speed with which the bureau found its place as an indispensable tool in the administration.

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