

TINBERGEN'S WORK: CHANGE AND CONTINUITY

BY

J. KOL AND P. DE WOLFF*

1 INTRODUCTION

Tinbergen's economic writings started being published in 1927 and have continued till the present day, thus spanning a period of more than 65 years. The number of scientific publications is now well over 900.

In order to present an overview of such a vast body of work, a selection is needed as well as a classification.

With respect to the classification this overview follows Tinbergen's own interest which is 'in economic substance rather than in methodological econometric issues' (Tinbergen 1979). Six broad areas of Tinbergen's economic work have thus been distinguished:

- I Economic Dynamics and Business Cycles
- II Economic Policy: Theory and Models
- III International Economics and Economic Integration
- IV Economic Development
- V Income Distribution
- VI The Economic Order

The six areas of work mentioned allow for the classification of much of Tinbergen's economic writings.¹ But obviously, some of Tinbergen's work falls out-

* J. Kol is Associate Professor of International Economics and Economic Integration at the Faculty of Economics of the Erasmus University in Rotterdam; P. de Wolff is Emeritus Professor at the University of Amsterdam and was Director of the Central Planning Bureau in The Hague as successor of J. Tinbergen. The authors are grateful to Mrs. I.M. Lageweg and Mr C.J. van Opijnen for their assistance with references.

1 This classification is more extensive and comprehensive than those in Klaassen, Koyck and Witteveen (1959), Bos (1984) and Chakravarty (1988), but is congenial to these in nature. The present deviates, however, from such as in Hansen (1969) with its stronger focus on methods.

side the areas indicated. Examples are professional recollections such as in Tinbergen (1970-3, 1979, 1984 and 1991-3). These publications have been used as a framework for this overview. They further served as a first indicator for the selection of publications to be dealt with under the various headings in this overview. A second criterion was whether a publication's content could be considered to be of major scientific importance for a specific area of work. A third criterion was whether a publication could be considered as typical for any of the headings in this overview.

Some commentators on Tinbergen's work, such as Hansen (1969), concluded that the areas of research could be regarded as stages in Tinbergen's development, marked more or less clearly by specific time periods. It is true that Tinbergen's work on Business Cycles was mainly done in the 1930s, that Economic Policy was the main subject of the late 1940s and early 1950s, followed by some 15 years when his work concentrated on Economic Development. A too strict periodization would, however, obscure the continuity in Tinbergen's work. For instance, Tinbergen (1928 and 1989-2) mark the period of his intermittent writing on Unemployment. The writings on Economic Integration cover a period of 46 years (Tinbergen 1945 and 1991-1), while Tinbergen (1934) marks the beginning of his writing on Economic Planning. Moreover, recently Tinbergen (1991-4, 1991-5, and 1992) addressed anew the measurement of welfare and the Optimum Economic Order.

There is a further, and more important element of continuity in Tinbergen's work, which relates to its nature. To underline this aspect of continuity four characteristics have been selected, which are constant marks of Tinbergen's work. These four main characteristics are adopted from Tinbergen's own guidelines for scientific work given in his professional recollections (Tinbergen 1979, 1991-3):

1. Policy Relevance
2. Measurement
3. Balance
4. Learning from Experience

The six areas mentioned above embody the change in Tinbergen's work, whereas the four characteristics mark its continuity. These are the subjects of sections 2 and 3 in this study, respectively. Section 4 concludes with some of Tinbergen's observations on the motivations and tasks of an economist's work and the achievements to be expected from scientific research.

Making an overview such as this poses various options. The procedure adopted here is that Tinbergen's work should speak for itself. Also regarding comments on Tinbergen's work, this overview derives most from Tinbergen's own recollections. And, as has been said above, even the classification and selection of the publications is in line with Tinbergen's own priorities.

2 AREAS OF TINBERGEN'S WORK: CHANGE

2.1 *Introduction*

In the years 1921–1925 Tinbergen studied physics at the University of Leiden. Professor Paul Ehrenfest was his most influential teacher, with his brilliant didactic capabilities (Tinbergen 1979). Later, working with Ehrenfest as a member of staff, Tinbergen prepared the thesis for his doctorate in physics; the title of his thesis was (translated from Dutch): 'Minimum Problems in Physics and Economics.' This thesis, published in 1929, marked the shift in discipline of Tinbergen's work from physics to economics. Naturally, this shift in interest had not come about suddenly but had been inspired in previous years by a growing awareness of unemployment and poverty. Already in 1928 Tinbergen had addressed the measurement of unemployment, in particular the distribution of the duration of unemployment, first at the moment of the unemployment count and, derived from that, at the start of re-employment (Tinbergen 1928). In his doctoral thesis, Tinbergen (1929-2) presents an overview of results in physics that can be explained by the assumption that certain central phenomena, such as energy and time, have a tendency towards an extreme, mostly minimum, value. In this respect, some striking analogies are demonstrated to exist with economic phenomena, such as production, stocks and business cycles.

In retrospect, Tinbergen (1970-3) explains his shift towards economics as follows: 'I felt the existing inequalities among people as an injustice but was told it to be something that could not be removed without a better knowledge of the structure of society ... The Great Depression, some years after, reinforced my conviction that economic research might be more useful than physical research.'

More generally, a sense of responsibility for society was one of the powerful motives for Tinbergen's transition from physics to economics and the same explanation can be applied to 'the changes in emphasis on the main subjects that I tackled' (Tinbergen 1970-3). These are the topics of the remainder of this section.

2.2 *Economic Dynamics and Business Cycles*

In 1929 Tinbergen joined the Central Bureau of Statistics in The Netherlands and concentrated his research on dynamic phenomena in economics.² Economic theory at the time ran almost exclusively in static terms (Hansen 1969). Tinbergen's work on economic dynamics arose from his interest in business cycles, an essentially dynamic phenomenon. Tinbergen started his work at a

2 In fact, Tinbergen rejoined the Central Bureau of Statistics, having worked there shortly – after finishing his study in physics in 1926 – in fulfillment of his duties as a conscientious objector. As a result, a study was published on the mathematical-statistical methods for business cycle research. (Tinbergen 1927).

time when little empirical information was available. Statistical data were collected and a series of studies was made by Tinbergen, later joined by various colleagues at the Central Bureau of Statistics, on the behaviour of demand as well as supply on markets mostly of individual products such as potato flour, ship building and the stock exchange (Tinbergen 1930, 1931, 1932).

Tinbergen (1979) recalls the example of the Dutch anchovy market, for which data were available over the period from 1855 to 1930, when the closing of the Zuiderzee disturbed the functioning of the mechanism. Annual catches had varied in the ratio 200 to 1, for which a biological explanation was known; the main factor involved was the temperature in March in the sea around Den Helder, the nursery of the anchovies. Another interesting feature of the market was that the fish, after being salted, had to be stocked for four years to reach top quality and be fit for canning. As a consequence prices clearly varied negatively with the total of the last four years' catches.³

A somewhat different example of a supply lag Tinbergen (1979) recalls, was implied by the analysis of the pork market in Hanau (1928). Farmers need time to react to price changes and raising pigs also requires time. The result is a roughly 3-year cycle in the pork market. Because of its graphical presentation this mechanism became known as the cobweb theorem, which constitutes the simplest example of a family of explanations of cycles in individual markets.

These studies on demand and supply were therefore of great importance for the empirical knowledge of the business cycle. Invariably, a large part of the fluctuations of the turnover in the different markets could be explained by the cyclical movements of either income or production (De Wolff 1970).

Tinbergen's pioneering work drew attention both in The Netherlands and abroad. In 1931 the University of Amsterdam appointed him part-time as a private university teacher. Later, the Netherlands School of Economics in Rotterdam offered him a part-time professorship. Tinbergen accepted; his inaugural lecture was on statistics and mathematics in the use of business cycle research (Tinbergen 1933). Tinbergen kept his chair in Rotterdam (full-time since 1955), till his retirement in 1973 from the – then – Erasmus University.

International recognition was apparent from the invitation by the League of Nations in 1936 to subject the various theories on business cycles to statistical analysis as far as possible. A survey of these theories had been made by G. von Haberler (1936), also on request of the League of Nations which was interested in the subject because of the Great Depression. The first results were published in 1939 in a volume containing an outline on the method of correlation analysis, and applications to fluctuations in investment, in general, and in residential building and in railway rolling-stock, in particular. Data of varying quality were used for the UK, the USA and other industrial countries (Tinbergen 1939-1). The main result was, that the method of correlation allowed to dis-

3 These findings were never published (Tinbergen 1979).

criminate on an empirical basis between the various factors theoretically conceived to influence fluctuations in investment.

Tinbergen's methodology was exceptional at that time and was received sometimes with scepticism. In particular J.M. Keynes (1939), at the time editor of the *Economic Journal*, reviewed 'Professor Tinbergen's Method' quite critically, raising as one of the fundamental points that 'The method is neither of discovery nor of criticism. It is a means of giving quantitative precision to what, in qualitative terms, we know already as the result of a complete theoretical analysis.' Of course the latter criticism illustrates precisely Tinbergen's conviction that knowledge relevant for policy making should preferably be quantitative in nature. As to 'discovery,' Tinbergen (1940) in his 'Reply' indicated that 'it sometimes happens that the course of the curves itself suggests that some factor not mentioned in most economic textbooks must be of great importance,' and he mentioned some examples. 'As to the possibility of 'criticism,' it seems to me,' Tinbergen (1940) argued, 'that the value found for one or more of the regression coefficients may imply a criticism on one or more of the theories that have been used.'

In a 'Comment' to Tinbergen's 'Reply,' Keynes (1940) still held some doubts: 'that there is anyone I would trust with it at the present stage or that this brand of statistical alchemy is ripe to become a branch of science, I am not yet persuaded.' But Keynes concluded: 'No one could be more frank, more painstaking, more free from subjective bias or *parti pris* than professor Tinbergen... But Newton, Boyle and Locke all played with alchemy. So let him continue.' And so Tinbergen did.

2.3 *Economic Policy: Theory and Models*

The main problem of the business cycle, however, was not connected with a single market, but with the complete process of investment, production and consumption, and price and income formation. Keynes' model leading to the famous multiplier concept did not try to explain the period of the main cycle. Consequently, the two main features of testing business cycle theory were considered to be (Tinbergen 1979):

- (i) formulating and testing statistically a whole system of relations;
- (ii) finding out which of the elements in these relations could explain the relative constancy of the cycle's period.

Such a system of relations was developed in Tinbergen (1936), containing a model for the economy of The Netherlands as a whole. This first macro country model has 24 equations and can be regarded as an extension of the Keynesian equations of income formation and consumption expenditure. Additions were made by splitting up money flows into a price and a quantity component, and by the introduction of imports, exports, employment and wage rates (Tinbergen 1979). In a number of equations, lags were introduced. Consumption and investment were assumed to lag behind their explanatory

variables such as income and profits. The model was constructed partly to discover the dynamic properties of The Netherlands' economy.

The model, however, could not give a full explanation of the business cycle fluctuations in The Netherlands' economy, because some of the main influences in such an open economy, like world exports and foreign price levels, were exogenous to the model. The aim of the 1936 model, however, was first and foremost to evaluate the various policies considered to remedy the depressed economy: wage cuts, public works, increased trade protection and devaluation, the latter turning out to be the preferred policy. For the first time there was a possibility to make quantitative assessments about policy implications (De Wolff 1970).

Subsequently, a similar model was made for the USA which was published as part II of Tinbergen's study for the League of Nations on Statistical Testing of Business Cycle Theories (Tinbergen 1939-2). With its foreign trade being relatively unimportant in relation to its national product, the USA presented a better case for explaining business cycle fluctuations than the open economy of The Netherlands could provide. The USA model had 48 equations and was estimated for the period 1919-1932. Tinbergen (1979) highlights a main finding on fluctuations in investments. The principle of rigid acceleration with its assumed full capacity production was rejected on the basis of the empirical estimates, and the flexible accelerator was developed instead. The new principle implied investments to be equal to a fixed portion of the deviation between required and actual production capacity, with required capacity equal to the demand for the consumer good concerned. Regarding the short cyclical movements, the mechanism for the USA shows that an automatic revival is to be expected, but for the movements of longer duration a definite statement could not be made. The results further indicated several possible policies that would prevent a depression from developing (Tinbergen 1939-2).

During the early years of World War II, Tinbergen built a similar model for the economy of the UK covering the period 1870-1914. This study was published some years after the war (Tinbergen 1951). An unsatisfactory property of the models developed thusfar was the extreme sensitivity of the cycle period to changes in the lags and to the coefficients appearing in the equations (Tinbergen 1979).

In 1945, Tinbergen left the Central Bureau of Statistics of The Netherlands to become Director of the Central Planning Bureau. This Bureau was a new institution in The Netherlands, established in September 1945 on initiative of the Minister of Trade and Industry at the time, Mr H. Vos.⁴ The Planning Bureau was given the task to produce a Central Economic Plan containing a balanced set of estimates and directives for the economy of The Netherlands.

4 Ten years before, during the Great Depression, Tinbergen and Vos had cooperated in designing a Plan for Employment offering a socialist alternative to the government policy at the time.

The Central Economic Plans are produced annually (De Wolff and Van der Linden 1988).

During his directorship at the Central Planning Bureau (1945–1955) Tinbergen's insight and experience resulted in three monographs on economic policy (Tinbergen 1952-1, 1954-2, 1956-2).

On the Theory of Economic Policy (Tinbergen 1952-1) presents a brief description of the issues involved; qualitative and quantitative policies are distinguished, variables are divided into targets, instruments, data and irrelevant variables,⁵ static and dynamic processes are distinguished and the equality and implications of inequality between the number of targets and instruments are discussed. In addition, *Economic Policy: Principles and Design* (Tinbergen 1956-2) explains the use of models for economic analysis and for economic policy in which variables switch their position between being exogeneous and endogeneous. Moreover, 21 examples of models are presented varying in being closed or open, static or dynamic and macro or micro, each model designed to deal with a specific set of policy issues. This monograph also contains chapters on changes in the foundations of society, utopist ideas regarding complete freedom or complete state regulation, and on the organisation of economic policy, discussing national and international agencies and their tasks.

Within the framework of Tinbergen (1952-1 and 1956-2), Tinbergen (1954-2) discusses Centralization and Decentralization in Economic Policy, stating among others the need for centralization in the case of supporting and conflicting instruments, with decentralization possible or warranted in the case of neutral instruments. This discussion also appears in Tinbergen (1954-1) on International Economic Integration.

Mainly in view of this work on economic modelling and in particular for his pathbreaking work for the League of Nations, Tinbergen, together with Ragnar Frisch, was awarded in 1969 the First Nobel Prize in Economics. In his Lecture to the Memory of Alfred Nobel on 12 December 1969 Tinbergen summarized once again the advantages of models: on the one hand, 'they force us to present a "complete" theory by which I mean a theory taking into account all relevant phenomena and relations, and, on the other hand, the confrontation with observation, that is, reality.'

2.4 *International Economics and Economic Integration*

In Tinbergen (1979) it is recalled that Keynes (1919) tried to show that the war indemnity required from Germany by the Allied Nations after the First World War was unrealistic, given Germany's limited export possibilities. Keynes' argument would have been weakened considerably had the value of the price elasticity of demand for exports been taken equal to the theoretical value of minus infinity and not to -2 as Keynes had assumed. Econometric studies

5 According to Tinbergen (1973-3, 1979) the distinction of these four types of variables was due to Frisch (1949).

carried out by Tinbergen and his colleagues found, however, values around -2 indeed and Tinbergen told Keynes so. Keynes' reaction was surprising: 'how nice for you to have found the correct figure!' Tinbergen (1979) admits that sometimes intuition indeed constitutes a basis for new scientific results, but adds that it should be the intuition of a genius. Simpler souls have to rely on measurement.

Tinbergen (1949) presents a study on long-term price elasticities of foreign trade; the measurement of these elasticities was important because at that time Western European countries were considering devaluation as one of the means to balance their foreign accounts. Estimates of short-term elasticities had resulted in rather low values rendering the success of a devaluation policy doubtful. Tinbergen (1949) put forward some reasons why long-run elasticities would probably be significantly higher than short-run elasticities: the empirical estimates showed such a difference indeed.

In Appendix VI to Tinbergen (1962-2) the *gravitation model* was developed. This model assumes that bilateral trade flows depend positively on the GNP of the exporting country and on that of the importing country, and negatively on their physical distance.⁶ The model and its estimation were meant to establish a normal or standard pattern of bilateral trade; observed deviations from this pattern would be indicative of the existence of trade barriers or preferences. Although the gravitation model's simplicity renders it somewhat restrictive, its empirical applications turned out to be very successful.

Written during World War II and published shortly after, Tinbergen (1945) described the essence of international economic relations and outlined the desirable extent of their regulation. This study was inspired by the observation 'that lack of international cooperation ... has played an important part in causing many of the controversies of an intricate nature from which ... war arose.'⁷ Although Tinbergen (1984), in retrospect, considered this *International Economic Co-operation* as amateurish, it already contained proposals for international policy coordination regarding trade, investment, finance, the business cycle and competition, as well as a proposal for supranational institutions designing and executing such coordinated policies.

Nine years later the study *International Economic Integration* was published (Tinbergen 1954-1).⁷ In his preface Tinbergen said the study was, in a way, a second edition of *International Economic Co-operation*, completely rewritten, however, to take into account the rapid development in thinking as well as in international economic co-operation itself. The study defines the concepts of *negative and positive economic integration*; the former would be merely the reduction of barriers to trade,⁸ while the creation of new institutions for policy

6 The model and its mathematical formulation closely resemble Newton's Law put forward in 1687, describing the attraction between any two particles of matter. In his well-known study Linnemann (1966) elaborated the model.

7 A second edition was published in 1964.

8 This therefore represents only the removal of distortions previously introduced.

co-ordination and centralization would represent positive integration. The *optimal level of decision making* was discussed. *Decentralization* is desirable in view of the maximum participation in the decision making and its low cost of implementation. *Centralization* or at least co-ordination is necessary in view of external effects. Such external effects can be positive when the policy instruments used by individual countries are supporting each other, negative when conflicting. In both cases co-ordination or centralization of the use of policy instruments would be welfare improving. Earlier, Tinbergen (1952-2) had already advocated that the choice between economic freedom and economic planning depends on the specific circumstances and should be made on rational grounds.

The equalization of factor prices between free-trade areas was studied in Tinbergen (1949). It was concluded that under a number of specific conditions, equalization of factor prices will occur, even if factors cannot move across countries. In the likely case however, that the number of factors is smaller than the number of products, the equality of factor prices is no longer warranted.⁹

With foresight, Tinbergen (1957-2) studied the effects on welfare of increased membership of a customs union. It is shown that with increased membership total production rises in an accelerated way, in proportion to the number of tariff walls eliminated. Upon entrance, a previously non-member country jumps to the position of shared welfare increases among member states.

Recently, Tinbergen (1991-1) presented a method to measure the velocity of integration. This velocity is measured for several processes of economic integration in history, such as in Switzerland in the period 1291–1978, in France from 1205 to 1919 and in Europe as a whole from 1500 onwards. The velocities of integration arrived at are then used to estimate the time needed for the completion of integration in Europe and the world as a whole.

2.5 *Economic Development*

In 1955 Tinbergen resigned his post as Director of the Central Planning Bureau of The Netherlands and accepted a full-time professorship at the Netherlands School of Economics.¹⁰ From then on most of his work would be connected with the unequal distribution of welfare among countries. In retrospect, Tinbergen (1984) explained that contributing to the economic development of the underdeveloped continents seemed to have the highest priority from a humanitarian standpoint.

9 In fact, Tinbergen (1949) investigated the viability of the conditions and the evidence provided by empirical facts regarding the theoretical formulation of the factor price equalization theorem by Samuelson, which formulation was later mentioned as an example of the irrelevance of some purely theoretical work in Tinbergen (1979).

10 Previous academic appointments had been part-time in combination with positions at the Central Bureau of Statistics and the Central Planning Bureau.

Tinbergen's interest in economic development, however, was already present in the 1930s. With the study of economic dynamics came the desire to break down time series into a number of components; namely, the trend and cyclical, seasonal and random components. The trend component reflected *long-term developments* and was given a mathematical form, which varied from a straight line and a parabola to exponential and logistic functions. The choice was determined by statistical fit rather than on theoretical grounds, a comprehensive theory of economic development not being available. Elements of such a theory were to be found in theories of population and its growth and theories on the growth of capital and savings. A first attempt to combine these elements can be found in Tinbergen (1942).¹¹ This was a theory of economic development 'in an embryonic state' (Tinbergen 1984). It distinguished between periods in which production is determined by the supply side and those in which it is determined by demand. For long-term movements the supply side was considered more relevant. The analysis was meant as a supplement to business cycle theory and was typically inspired by the situation in developed countries (Tinbergen 1984).

The focus on developing countries grew from a visit to India in 1951. Poverty prevailing as a normal situation in a country was such a contrast to the situation in the industrialized countries that Tinbergen's thinking and main activities were redirected (Tinbergen 1984).

Upon invitation from the World Bank Tinbergen wrote a general guide on development policy in 1955: *The Design of Development*. This study discussed some of the techniques available and in use for setting realistic targets and deriving appropriate policy instruments; it dealt with the evaluation of public investment projects and the choice of appropriate industries; it also discussed the means to stimulate private initiatives (Tinbergen 1958).¹²

Limited data availability and uncertainty about the efficiency of public and private economic agents called for a simple but nonetheless consistent framework for economic development. This led to the concept of *planning in stages* (Bos 1970). Three stages were distinguished (Tinbergen 1956-1, 1957-1, 1968-1).

- 1) *The macro-stage*, where for the economy as a whole the desired rate of growth and the required savings and investments are determined.
- 2) *The middle-stage*, where total investments are distributed over economic sectors, according to their contribution to the development aims while avoiding bottlenecks and overcapacities.

11 Tinbergen (1984) adds that as a check on the non-Nazi attitude of the editors of the *Weltwirtschaftliches Archiv* – in which the study was published in 1942 – a considerable number of Jewish authors were quoted. The editors accepted the text as it stood. A translation in English can be found in Tinbergen (1959-1).

12 The World Bank delayed publication for three years probably because of the author's view on the role of the public sector in development (Tinbergen 1984).

3) *The micro-stage*, where concrete projects are chosen on the basis of their contributions and costs in terms of the targets of development.¹³

To establish overall consistency, the models and methods used in the three phases may have to be employed iteratively. Apart from its practical structure, the method of planning in stages can also be justified theoretically (Tinbergen 1962-1).

Gradually it became clear, that apart from the scarcity of physical capital, the lack of human skills was also a bottleneck for economic development. Consequently, the planning of education became part of the planning procedure (Tinbergen *et al.* 1965-1).

Finally, the element of space was introduced in development planning. Commodities and industries were classified according to four degrees of transportability and shiftability: international, national, regional and local (Tinbergen 1965-2). Furthermore, differences in economies of scale between industries and hence in their optimum size gave rise to the so-called hierarchy model. This model enables the determination of the number of economic centres for a country and its regions and the spread in industries over these centres given demand (Tinbergen 1961-1).

In this work on economic development, Professor Tinbergen contributed also to the activities of international organizations such as the OECD and UNESCO, and he was chairman of the UN Committee for Development Planning (1965–1972). Furthermore his advice was sought by the governments of many developing countries, of which Egypt, Indonesia and Turkey are mentioned in particular by Tinbergen (1984).

2.6 *Income Distribution*

In 1973, after 40 years, Tinbergen retired from his chair at the Netherlands School of Economics, which in the same year ceased to be an independent institution and became the Faculty of Economics of the Erasmus University in Rotterdam. With Tinbergen's valedictory lecture on November 8th, 1973 both occasions were combined; H.M. the Queen of The Netherlands bestowed upon him the Order of the House of Orange, a distinction granted only very rarely.¹⁴

Tinbergen now returned to the university where his academic life had begun: Leiden, where he became a visiting professor for two years. During these years Tinbergen concentrated his research activities on income distribution issues.

Studies on income distribution deal with such distribution between produc-

13 Project evaluation was also applied by Tinbergen to the Delta Works in The Netherlands, a large public investment project in an industrialized country (Tinbergen 1961-4).

14 Queen Juliana declared (translated from Dutch): '... to Professor Tinbergen who represents this university in such a unique way, I wish to present the Medal for Drive and Ingenuity, a distinction from the Order of Orange, established by my mother (Queen Wilhelmina) for great Dutch citizens'; and, after handing over the order to Professor Tinbergen: 'With this I declare the Erasmus University open.'

tion factors, or, going a step further (Tinbergen 1979) between individuals. Regarding the factorial distribution, Tinbergen (1979) observed that nature had been often neglected as a production factor since the countries for which figures were available were industrialized countries, where the role of primary production had become small. In traditional analysis, capital and labour are being paid their marginal product; since the marginal product can be derived from the production function, the analysis of the distribution of factor income and the estimation of production functions are closely connected subjects.

With respect to the distribution of personal income Tinbergen (1979), in retrospect, observes that existing approaches in the 1950s lacked an economic interpretation for individuals or occupational groups of individuals and, as a consequence, lacked the possibility of giving rise to an economic policy directed at reducing income inequality – a generally accepted aim of economic policy.

This induced Tinbergen to design a theory in which the homogeneity of labour as a factor of production is replaced by the introduction of a considerable number of types of labour, characterized by a number of relevant qualities. Moreover, a distinction was made between the demand side and the supply side of each of the many compartments into which the labour market is then subdivided.

Until the time Tinbergen (1956-3) developed this line of thought income distribution studies had concentrated on the supply side. Inequality in incomes was then seen as a result of diversity in income earning capabilities. The neglect of the demand side of the labour market renders a policy on income distribution difficult to design (Hartog 1970). Tinbergen (1970-1) indeed distinguishes between a positive and a normative theory of income distribution.

On the Theory of Income Distribution (Tinbergen 1956-3) already contains the main elements of Tinbergen's work on income distribution. The supply side of the labour market consists of individuals with productive capabilities, possessed by them in varying degrees. These productive capabilities relate to cognitive capabilities, such as intelligence, and other capabilities such as leadership, willingness to co-operate, and persistence. Likewise, the demand side of the labour market consists of available jobs, characterized by the same attributes as the productive capabilities mentioned above, but now labelled as productive requirements, again in varying degrees. Demand and supply on the labour market can therefore be represented by multidimensional frequency distributions, specifying for each relevant combination of degrees of attributes the number of jobs and individuals available. Normally, the two frequency distributions will not be equal; income differences emerge because of the differences between productive requirements demanded and productive capabilities supplied. Income differences thus play an allocative role, establishing equilibrium on the labour market.

This approach has important implications for income distribution policy (Hartog 1981). Only when from the outset the frequency distributions on both

sides of the markets are the same, will equality of income follow as a result. Otherwise, income differences have to play the allocative role mentioned above and are for that reason efficient. Moreover, the productive value of an individual does not depend exclusively on his productive capabilities but also on circumstances of demand. The non-homogeneity of labour as a factor of production was again underlined in Tinbergen (1973-1).

In his *Income Distribution: Analysis and Policies* Tinbergen (1975) brought the various elements of his previous publications on the subject together, presenting empirical estimates of important parameters for Canada, The Netherlands and the USA, and discussing proposals for income distribution policies. Part of the empirical verification made use of the assumption that utility can be measured, an assumption not very popular among economists as Tinbergen (1984) recalls. In this respect the material collected by Van Praag (1971) proved to be useful. The measurability of utility or welfare has subsequently been studied in Tinbergen (1985-2, 1987-1).

One of the chapters in Tinbergen (1975) deals with the race between technological development and education. Having dealt with the relationship between education and income distribution in a more general way in Tinbergen (1972-2), Tinbergen (1975) addresses more specifically the popular notion that the educational system in the industrialized countries has produced 'too many' university graduates whereas at the other end of the market unskilled labour is said to be in serious shortage and foreign workers have to be attracted. In the short run such statements can be more or less correct but for long-term developments these statements are irrelevant, because the price mechanism is neglected. Empirical evidence corroborates this assertion. Tinbergen (1975) concludes that there is no pre-ordained wage ratio between skilled and unskilled workers or any other type of labour, a point too often overlooked in public discussions on income and education policies.

Tinbergen (1975) also advocates a search for entirely different types of taxation, closer to lump-sum taxes and possibly based on human capabilities rather than on the results of their use. The feasibility of lump-sum taxes would require more refinement in psycho-technical testing, but the need for this type of tax derives from welfare economics and was already mentioned in Tinbergen (1959-2) within the framework of the optimal economic order.

Within the same framework, Tinbergen (1985-1) addresses income distribution issues again, partly in response to criticism on Tinbergen (1975). The 1985 publication consists of 19 chapters, based on earlier publications, and classified under four categories. The first three of these: Production, Income, and Welfare, are considered to be building blocks for the subject of the fourth category: The Optimal Social Order, to be dealt with in the next section.

2.7 *The Economic Order*

Tinbergen's work on income distribution – reviewed in the previous section – appeared to fit in with the search for the optimal economic order. In this

perspective, Tinbergen's work on business cycles, economic policy models, economic integration and economic development was also directed towards the improved functioning of the economic system.

This subject was dealt with specifically in *The Theory of the Optimum Regime* (Tinbergen 1959-2). The optimum regime was defined as the set of institutions which in their common operation would lead to maximum welfare. This is the efficiency condition for optimality. The distribution of income is another aspect of the optimum regime. Since efficiency and distribution are characteristics of the optimum regime, the terms optimal economic order and optimal social order have been used as alternatives (Tinbergen 1985-1). In his acceptance speech of the Nobel Prize, Tinbergen (1969-2) again underlined the role of institutions: 'The true unknowns of the problem are not so much the quantities of consumption and productive effort to be made ... but rather the set of institutions which, taken as a set, are able to approach the welfare economic optimum as well as possible.'

As a start to the problem of finding the characteristics of the social welfare optimum, Tinbergen (1972-4) distinguishes:

- 1) the choice of the social welfare function.
- 2) the choice of the restrictions under which the optimum can be attained.

Five approaches are considered regarding the choice of the welfare function, differing predominantly in the method of aggregating from individual to social welfare. The choice of restrictions involves four possible approaches, differing, among others, with respect to the presence of external effects of production.

The theory of the optimal economic and social order furthermore deals with the desirable degree of centralization in decision-making, the desirable degree of market regulation, and the desirable extent of the public sector. With respect to the need of a public sector, Tinbergen (1984) recalls that around 1900 the State Mines were created in The Netherlands because private initiative and capital were insufficient to exploit the national coal deposits. A few decades later state ownership was temporarily established for farms on recently reclaimed land in order to prevent the first generation of settlers from going bankrupt, as had happened on previous occasions. It turned out that state farms were slightly less efficient than comparable private farms, whereas for the mines the opposite was true.

A well-known derivative of the theory of the optimal economic order is the *convergence theory*. Tinbergen (1961-2) developed this theory mainly to lead the discussion on the optimal order in East and West away from hostile dogmatism towards scientific analysis (Tinbergen 1969-1). The convergence theory has an analytical and a normative component. Analytically, Tinbergen describes the main differences between the economic systems of East and West. These relate to the size of the public sector, and the degree of freedom regarding price movements and economic decision-making. Secondly, Tinbergen argued that the impression given in ideological statements that the economic systems in East and West are not subject to change is contradicted by the facts.

The changes in the West in the last century, for instance in the extent of planning and the size of the public sector, and more recently, changes towards more freedom and centralization in the Soviet economy, testify to that. These changes represent movements away from the extremes of unrestricted capitalism and complete central planning. Convergence, however, does not imply complete equality as the end result, as Tinbergen (1972-3) argued in answer to criticism.

The main component of the convergence theory is however normative in nature, in line with the theory of the optimal economic order (Tinbergen 1959-2). The main objective is the search for a synthesis of elements in the order of East and West that have proven their merit; no blue print is available however, the optimal economic order will differ according to time and other circumstances (Tinbergen 1970-2).

Tinbergen also considered the question of the optimum regime or the optimal economic order in an international context.

In a report to UNESCO Tinbergen (1961-3) discussed the economic criteria underlying the international division of labour. It formulated three main criteria: a) the international division of labour should be based on differences among countries in comparative costs, b) the international trade system should be open without discrimination and with protection as low as possible, and c) the balancing of a country's trade should not be aimed for in each bilateral trade relation but should be considered multilaterally. In this perspective, Tinbergen (1968-2) dealt with the optimal distribution of industries across countries, while Tinbergen (1968-3) addressed the problem of risk connected with a too narrow specialization. It was concluded that the need for diversification becomes less to the extent that undesirable fluctuations in prices and proceeds can be controlled.

In 1974 the Club of Rome suggested that professor Tinbergen should form and coordinate a group of specialists to report on the question what new international order should be recommended to meet – to the extent possible – the needs of present and future generations. The report *Reshaping the International Order* was published in 1976 and contains proposals regarding the international monetary order and development funds, the international division of labour and technological development.

Revitalizing the United Nations System is the subject studied in Tinbergen (1987-2). It is submitted that the essential task of the UN is managing our planet. A source of inspiration for reform is therefore good management, that is of large well-run enterprises or of a successful national government. Learning from well-organized large enterprises means that business-like approaches deserve attention, that staff forms a well-defined hierarchy and that for the resolution of each problem an optimal level of decision-making exists. Among the many concrete proposals, one relates to a new system of representation in the General Assembly; the present system of one nation one vote reduces credibility and impact to a very low level. Representation must reflect more

clearly the significance of member nations to world affairs, in terms of money contributions to the UN, or of real national income or of population size. For each of these variants a concrete proposal is made. A World Treasury is an example of the new institutions needed, representing at the world level a treasury so important in a well-run nation state.

In *Warfare and Welfare* Fischer and Tinbergen (1987-3) argued that security policy affects welfare, the conventional objective of socioeconomic policy, to such an extent that the two policies had better be integrated. This integration would imply that the aim of such a generalized economic policy becomes 'welfare in security' or 'generalized welfare.' The main conclusions and propositions of *Warfare and Welfare* are given in qualitative and verbal form, dealing mainly with the optimal world decision-making structure.

With *World Security and Equity* Tinbergen (1990) provided a quantitative foundation to the findings arrived at earlier with Fischer. A range of macro-models is designed, representing the world economy in two or three main regions – West, East and South – or more; in each model welfare in security is optimized under restrictions on expenditure, with transfers of assistance payments and development aid providing links between the regions.

The main conclusion of Tinbergen (1990) is that the aims of military policy (security) and development co-operation (equity) cannot be pursued independently. In order to maximize world welfare in security, reductions in military expenditure of the same order as the increase in development assistance are necessary. The UN norm of 0.7 percent of GNP for development assistance should be replaced by more sophisticated norms, the percentage rising with income per capita of the donor countries.

3 CHARACTERISTICS OF TINBERGEN'S WORK: CONTINUITY

3.1 *Introduction*

In 1923 Tinbergen, while studying at Leiden University, joined the Labour Party and its Youth Organization. Tinbergen (1991-3) recalls: 'I came in contact with the poorer part of Leiden, not usually known by students. Even before the Great Depression, conditions among the working classes in Leiden were about the most abominable in Holland. Unemployment was high, public assistance minimal. Many people were living in slums in utmost poverty. A postman I met and frequently talked with offered to show me the inside of this town with its famous history. I was horrified, and this certainly influenced my ultimate choice to focus on economics rather than continue in physics.'

A sense of responsibility for society has already been indicated in section 2.1 as one of the powerful motives for Tinbergen's transition from physics to economics. Specifically Tinbergen (1979) mentions strengthening solidarity with those living in poverty, organizing a peaceful world, and providing for the interests of future generations, as the three areas of research that have highest priority.

For scientific work, Tinbergen (1979) gives four guidelines: to minimize dogmatism and subjectivity, to remain as close to empirical data as possible, to work in interdisciplinary teams and to address the most pressing problems, as mentioned above.

Tinbergen's work itself has not predominantly been carried out in interdisciplinary teams. For that reason, another aspect is added, namely that of 'learning from experience,' so characteristic of Tinbergen's approach to scientific work (Tinbergen 1991-3).

The four characteristics thus arrived at testify to the continuity in Tinbergen's work, and are taken up in the subsequent sections.

3.2 *Policy Relevance*

In principle, research has to go through the basic, fundamental stage in order to reach that of application, a process Tinbergen (1972-1) compares to the production of commodities, starting with raw materials and continuing, through processed primary materials and semi-finished products to finished goods. Tinbergen (1972-1) adds however that concerning final products a choice has to be made and that this determines to a certain extent the corresponding fundamental research required.

The distinction between two phases in research, namely a fundamental one on the basis of which a stage of application can be reached, corresponds to the objectives of scientific work formulated by Tinbergen (1979) in his *Recollection of Professional Experiences*. The first is to analyze the operation of an economic system in an impartial, unbiased way. The second is the construction of an ideal economy. These two objectives are formulated in the following way by Tinbergen (1991-2) when discussing the Functioning of Economic Research:

- a) to attempt to explain an economic phenomenon;
- b) to recommend an economic policy or structure.

There is no doubt that Tinbergen considers the first and analytical objective as a first though indispensable step in pursuit of the second and normative objective of economic research, which in Tinbergen (1979) is described as its final goal.

With respect to the first element, Tinbergen (1950-1) underlines objectivity in the analysis as a task for all sciences, so that existing differences of opinion can be dealt with in an unbiased way. Similarly, Tinbergen (1979) recalls his physics teacher, P. Ehrenfest, saying that the objective of scientific work should generally be to formulate differences of opinion in a more noble way than merely as conflicts. This way, scientific research also leads to a better understanding of other views, in general, and to a greater tolerance, also in general, towards differences in economic attitudes and institutions; this in turn counteracts the powerful but dangerous and irrational forces of nationalism (Tinbergen 1968-4). Scientific research may contribute therefore to the solution of conflicts through reasoning rather than through violence, although science may meet its limits here.

In relation to policy recommendations, the second and ultimate goal of scientific research, Tinbergen (1950-2) expands on the role of planning in economic activities. In principle, planning in economics is superior to the blind working of free market forces. The reason is that planning involves more choice. Free competition precludes the setting of prices differently among countries, which may be desirable in specific circumstances. Complete free trade does not allow the introduction of selective import restrictions. When market forces bring about a change in the structure of the economy, the resulting unemployment may turn out to be a crude and wasteful way. Well-designed re-schooling and unemployment benefits are to be preferred.

Of course – Tinbergen (1950-2) adds – practice has shown that planning may lead to inefficiencies. With planning, incentives may be reduced to engage in adaptations, innovation, schooling and economic efforts in general.

A final point is the relation between preparing economic policy recommendations and economic forecasting. Forecasting is not a strong side of economics (Tinbergen 1988). Yet, in general, economic forecasts are very useful, especially when phenomena are involved with a long time horizon (Tinbergen 1962-3). The question has been posed whether the relative lack of success of economic forecasts may be due to the fact that – otherwise than in physics – economic behaviour is not independent of forecasts published. On this point Tinbergen (1962-3) observes that the form in which the forecasts are presented can make a difference.

As the future is a *terra incognita*, forecasts inevitably are based on assumptions. Basically, these assumptions come down to the supposed constancy of certain phenomena, be it their level, their growth rate or other characteristics. With increased knowledge of economic mechanisms, which represents the first goal of economic research, the quality of forecasts will improve. This is important especially with respect to economic activities, which have a long-lasting effect. Examples are the design, construction and implementation of infra-structural facilities, large capital intensive production sites, the use of exhaustible natural resources, and the educational system. It is there that economic forecasting and economic policy preparation are intertwined. (Tinbergen 1962-3).

3.3 *Measurement*

It is generally realized, Tinbergen (1979) in his *Recollections*, that the amazing progress made in the natural sciences is due in no small degree to the continual confrontation of thinking and measuring.

Economic theory, however, in order to be suitable for statistical testing must be expressed in quantitative – *i.e.* mathematical – form, explains Tinbergen (1939-1) in his introduction to his *Statistical Testing of Business-Cycle Theories*; it is added however, that many of the theories on cyclical fluctuation in business activity do not exist in a form immediately appropriate for statistical testing. That is not to say that non-measurable phenomena may, of course, at

times, exercise an important influence on the course of events, and the results of quantitative analysis must therefore be supplemented by such information about the extent of the influence of non-measurable phenomena as can be obtained (Tinbergen 1939-1). On the other hand, qualitatively interesting phenomena lose their importance as soon as it can be established that they are not of quantitative importance, and the phenomena that are of quantitative importance will usually also be of qualitative interest (Tinbergen 1950-1).¹⁵

In this sense, 'econometrics – a combination of economics, mathematics and statistics – lifted economics to the level of a fullfledged science' (Tinbergen 1989-1). Before the time econometrics was established as a discipline, in 1930 in the United States and in 1931 in Europe, economics was formulated mostly in verbal terms with a small part formulated with the aid of mathematical symbols. Empirical measurement was largely absent. As regards economic science however Tinbergen (1979) underlines that his interest is in economic substance rather than in methodological econometric issues.¹⁶

As a general argument in favour of the numerical measurement of economic concepts, Tinbergen (1989-1) puts forward that the qualitative solution of a number of economic problems can be different for different numerical values of the mathematical shape and the coefficients of the functions used. Firstly, the number of solutions depends on the shape of the functions used. Secondly, a market equilibrium may be stable or unstable, depending on the slopes of the demand and supply curves near the point of intersection. Thirdly, movements over time may be cyclical or unilateral, and both may be unlimited or approach some limit.

Addressing specifically the question of measurement in human sciences Tinbergen (1971) acknowledges that a description of economic phenomena should start with a qualitative description of these phenomena. After that, measurement of the phenomena can take place. Tinbergen (1971) explains the importance of measurement. First of all, measurement opens the possibility of testing theories. If the measurement result does not correspond to the theory, then the theory is rejected on that basis. In the case of correspondence, the theory may be accepted, but since more than one theory may fit the empirical facts, a choice can be made with simplicity as criterion. The testing of theories and through that their improvement is however not the only purpose of measurement. Secondly, and more importantly, it enhances the possibility of influencing society in pursuit of human welfare. In this perspective Tinbergen (1971)

15 Tinbergen (1950-1) recognizes of course that qualitative phenomena and quantitative problems cannot always be separated completely.

16 Hansen (1969) on this point observes that Tinbergen's preoccupation has always been with quantification and empirical application, and as soon as a method proves useful empirically 'he does not waste time on further theoretical refinements, obviously believing that marginal returns are rapidly falling.'

formulates as one of the ultimate aims of measurement in human sciences the design of an optimal social order.

Measurement is defined by Tinbergen (1971) as representation by numbers. Numbers can be cardinal or ordinal. The measurement of temperature in physics shows the development of an ordinal classification in cold, cool, lukewarm, warm and hot, based on subjective sense perceptions towards the use of thermodynamical changes in substances embodied in a thermometer leading to a cardinal classification. This historical development around the measurement of temperature illustrates the vocation of science: the retreat of subjectivity and the simultaneous advance of objectivity.¹⁷

In *The Necessity of Quantitative Social Research* Tinbergen (1973-2) expresses his plea for measurement in this intriguing way: 'For some queer and deplorable reason most human beings are more impressed by words than by figures, to the great disadvantage of mankind.'

3.4 *Balance*

Polarization in ideas is useful sometimes in order to demonstrate the existence of a problem, Tinbergen (1984) observed, when reviewing the changes over time in development economics. On the other hand, it is argued, polarization implies reinforcement of extremist political forces both within and between nations. This testifies to the fact that polarization is an incomplete process which must be supplemented by a synthesis. This is the well-known method of dialectic philosophy dealing with the consecutive phases of thesis – antithesis – synthesis.

Tinbergen (1984) adds the following example. Some politicians hold that markets are self-regulatory and can solve many problems without intervention by the public authorities. Others are in favour of market regulation with the aid of buffer stocks, minimum and maximum prices, and quotas. So far this is a polarized situation. The synthesis can be created from the moment we understand that there are essentially two types of markets, stable and unstable. Stable markets can indeed be left to themselves, but unstable markets need regulation.

The same search for synthesis is applied regarding other aspects of the optimal economic order (Tinbergen 1959-2) and the convergence theory (Tinbergen 1961-2), namely, the size and tasks of the public sector in relation to the private sector, the degree of free competition, and more generally than in the example above, the relative position of market forces and planning, also with respect to the future course of the economy. Planning the main elements of the economy does not necessarily imply the need for detailed planning (Tinbergen 1961-2).

In answering criticism on the convergence theory Tinbergen (1972-3) makes it very clear that the search for a synthesis is something very different from

17 In one of his early publications Tinbergen (1929-1) had expressed the same thought.

seeking a compromise. Compromising is horse-trading or even jobbery, whereas the search for a synthesis involves the weighing of various points of view and diverse proposals until they integrate (Tinbergen 1950-2).

With respect to the optimal economic order Tinbergen's balance in analysis is also clear from the observation that no blue print is available and that 'the optimum organization of the economy will differ from country to country and from period to period' (Tinbergen 1961-2).

In the introduction to *Statistical Testing of Business-Cycle Theories*, Tinbergen (1939-1) mentions that many of these theories do not exist in a form immediately appropriate for statistical testing, while, on the other hand, most of the theories take account of the same body of economic phenomena -viz. the behaviour of investment, consumption, income, prices *etc.* Accordingly, the procedure adopted by Tinbergen (1939-1) is not to test the various theories one by one, which would involve much repetition, but to examine in succession, in the light of the various explanations which have been offered, the relation between certain groups of economic phenomena.

This modesty in wording of a researcher in his mid-30s has vanished 43 years later when Tinbergen (1982) more explicitly calls for a synthesis among modern economic views and their advocates, so that economics does not lose its credibility. Tinbergen (1982) wrote his plea for synthesis in view of the economic stagnation persisting in the industrialized economies. Monetarism and supply-side economics were sometimes advocated by economists believing that they represent the whole truth. It would be more mature, Tinbergen (1982) argued, to acknowledge that the various approaches offered contain part of the truth. The essence of scientific work is to forge a thesis (for example the work of Keynes) with one or more antitheses (for instance the work of Friedman) into a synthesis. The criterion for such a synthesis is that a better explanation for economic developments of the time emerges.

It is added, that politicians and citizens have the right to ask for such a synthesis; Tinbergen (1982) warned that if 'we as economists continue to oppose each other, we forsake our duty as scientists.'

3.5 *Learning from Experience*

'Trial and error' might characterize my way of working Tinbergen (1991-3) concludes and adds that this might be considered one of his shortcomings. However, this engineering approach to economic research has been advocated by Tinbergen in many instances.

Tinbergen (1940) in his 'Reply to Keynes' suggests that dealing with the 'supposed omissions' in estimating the influence of the rate of interest on railway investments in rolling-stock would be 'an invitation to try it out.'

Tinbergen (1950-2) discusses markets for agricultural products and investment goods in connection to market regulation. It is concluded that the markets for these products and goods differ in important aspects requiring, as a consequence, different types of regulation. It is advocated that such different

regulation regimes are installed and that experience is obtained regarding their effectiveness.

Regarding the measurement of welfare, Tinbergen (1989-1) concludes that it remains an open question among economists whether such measurement is possible. On this point Tinbergen also advocates a process of measurement in various steps. One could start with a questionnaire allowing for ten qualifications ranging from excellent, very good down to bad and very bad as in school reports, to express the respondent's degree of satisfaction with his real income. Next, each qualification is given a numerical score, for instance from 10 down to 2 and 1. By experience, the techniques of interviewing and the procedure for quantification of the material could be gradually improved. Such a procedure is advocated because 'In the practice of socio-economic policy, decisions are taken that are implicitly based on a scale; this scale is applied by politicians and, in serious cases, may be checked by ethical experts. As an economist I claim that such a check had better be made by economists, because the measurement of welfare affects economic policy and this connection is part of the economists' expertise' (Tinbergen 1989-1).

Tinbergen (1984) concludes that 'during its short history the development strategy for underdeveloped countries has been subject to an intensive learning process.' It was attempted to avoid repeating previous mistakes by shifts from less to more satisfactory approaches: for instance from capital to more appropriate labour-intensive technologies, from employment creation in cities to that in villages, from external, intergovernmental to internal policies. Such experience-induced shifts in priorities were also meant to combat negative forces blocking the road to further development: shortsightedness (*e.g.* too narrow nationalism), polarization (with its waste of energy) and cynicism (which discourages action).

Learning from experience is also advocated by Tinbergen (1961-2) in connection to the construction of an optimal economic order; it is thought 'hardly conceivable that we will soon be able to indicate precisely where the optimum lies.' It is added that conditions in developing countries seem favourable to try to combine the best elements from communism and free enterprise. 'These countries therefore may become the experimental ground for economic regimes' (Tinbergen 1961-2).

A second way of learning from experience is through finding parallels and exploiting similarities between various areas within one discipline or between various disciplines.

In his doctoral thesis Tinbergen (1929-2) indicated parallels regarding the formulation of the central problems in both physics and economics as minimum problems. And Tinbergen (1970-3) recalls that in his work on business cycle models several mathematical methods were used that were inspired by models used in physics.

In this perspective Tinbergen (1968-4) analyzed the similarities and differences between the social problem and the development problem, that is the

problems of income distribution within and among nations. A series of parallels is found regarding institutions and policies relevant to the development problem and the social problem: privileges of rich classes, taxes and social security, and education on the side of the social problem have their parallel for the development problem in protection by rich nations, financial transfers, and technical assistance. Such parallels are searched for and analyzed as a matter of efficiency: the possible transfer of experience from one field to another.

In this perspective Tinbergen (1987-2) advocates that in restructuring the United Nations likely benefits are to be derived from studying the experience of the management of well-run large companies and well-governed countries.

Tinbergen (1970-3, 1979) warns however against pushing the desire to see parallels too far; this may distort the nature of the problem.

A third way of learning from experience is followed in Tinbergen (1944, 1965-3). Thirty years after the beginning of the First World War Tinbergen published *The Lesson of Thirty Years*. It has three parts: a chronicle of the bitter experience of those thirty years, an analysis of the economic events and policies of that time, and a design for the future including improved policies to deal with business cycles, structural problems and international relations. Twenty years later Tinbergen (1965-3) wrote *The Lesson of Fifty Years*, focussing on developments in and prospects for East, West and South. The lesson of these fifty years is that in these three main areas of the world more or less serious forms of stagnation can be found; breakthroughs are formulated in terms of aims and policies.

Reported lessons from experience should however be taken with caution. Tinbergen (1950-1) mentions the example of the interest rate for decades reported in the literature as the main factor in explaining demand for investment goods. This however was true only for specific capital goods with a declining share in total investment, with, as a consequence, a declining relevance of the interest rate as explanatory variable in general. Tinbergen (1950-1) warns that the literature has a tendency to build on previous experience without checking its present day relevance.

And Tinbergen (1983) added – one day after his 80th birthday – that one is never too old to learn.

4 CONCLUDING REMARKS

In his inaugural lecture at the Netherlands School of Economics in 1933 Tinbergen expressed the wish: 'I hope to be able to contribute in due course to the solution of some of the main economic problems of this time' (Tinbergen 1933). No doubt, he had in mind the pressing problems of unemployment and economic stagnation of the 1930s. From the survey in this article the reader can judge whether Tinbergen has succeeded in that task and has continued to do so.

In general, Tinbergen (1963) argued, an economist has two main responsibilities: a scientific responsibility and a social responsibility. Economics being a

science, the economist as a rule will act as an adviser. Tinbergen mentions the example that he had to explain to the government of The Netherlands that a considerable increase in labour productivity overall – while maintaining the balance of payments – would lead to unemployment; and that it would be more desirable to promote productivity in a selective way, for instance in industries with a labour shortage. In order to be an objective adviser to governments, firms and institutions, the economist first of all should be a competent professional. He should also have the ability to communicate with politicians and others (Nobel Memorial Lecture, Tinbergen 1969-2).

Secondly, the social responsibility would imply that the economist has to consider the wider implications of actions undertaken by the firm or other institutions on his advice. Such implications may relate to negative effects on other firms and institutions or on the environment but, above all, to the distribution of income, which presently has assumed an international dimension.

Finally, the economist should be economical with his time and energy and also with those of others (Tinbergen 1963).

In Tinbergen (1972-1) the question is asked ‘Does science, on balance, advance overall human happiness?’ Reviewing examples of medical, chemical and nuclear research with their positive, negative and mixed effects on society, it is concluded that ‘important misallocations still exist because of traditional thinking and the large amounts spent on gainful but not-essential activities.’ Only when some co-ordination and organization of research can be obtained by a conscious policy of subvention on the basis of an agenda or priorities for research the answer could be more positive. As coordination and setting of priorities should include the international level, a world government is needed with authority in areas where national governments are bound to take the wrong decisions. Tinbergen (1972-1) concludes: ‘As long as we have not achieved this decision structure, I fear that I must remain uncertain about the real contribution of science to human happiness.’

REFERENCES

- Tinbergen, J. (1927), ‘Over de mathematies-statistische methoden voor konjunktuuronderzoek’ (On the Mathematical-statistical Methods for Business-cycle Research), *De Economist*, 76, pp. 711–723 (in Dutch).
- Tinbergen, J. (1928), ‘De roulering in het werklozenleger’ (The Circulation Among the Unemployed), *De Economist*, 77, pp. 772–782 (in Dutch).
- Tinbergen, J. (1929-1), ‘Het economiese getij’ (The Economic Tide), *De Socialistische Gids*, XIV, pp. 849–858 (in Dutch).
- Tinbergen, J. (1929-2), *Minimumproblemen in de natuurkunde en de ekonomie* (Minimum Problems in Physics and Economics), Amsterdam (in Dutch).
- Tinbergen, J. (1930), ‘Het verband tusschen den aardappelooget en den prijs en den uitvoer van aardappelmeel’ (The Relation between Potato Crop and the Price and Export of Potato Flour), *De Nederlandsche Conjunctuur*, 1, pp. 18–26 (in Dutch).

- Tinbergen, J. (1931), 'Ein Schiffbauzyklus?' (A Cycle in Shipbuilding?), *Weltwirtschaftliches Archiv*, 34, pp. 152–164 (in German).
- Tinbergen, J. (1932), 'Prijsvorming op de aandelenmarkt' (Price Formation on the Stock Exchange), *De Nederlandsche Conjunctuur*, 4, pp. 12–23 (in Dutch).
- Tinbergen, J. (1933), *Statistiek en wiskunde in dienst van het conjunctuuronderzoek* (The Use of Statistics and Mathematics in Business Cycle Research), Inaugural Lecture, Netherlands School of Economics, Rotterdam, October 4, 1933 (in Dutch).
- Tinbergen, J. (1934), 'De economische zijde van het ordeningsvraagstuk' (The Economic Side of the Planning Problem), *Ordening*, pp. 17–28 (in Dutch).
- Tinbergen, J. (1936), *An Economic Policy for 1936*, ook opgenomen in: L.H. Klaassen, L.M. Koyck and H.J. Witteveen (eds.), *Jan Tinbergen, Selected Papers*, Amsterdam, 1959 pp. 37–84 (original in Dutch).
- Tinbergen, J. (1939-1), *Statistical Testing of Business Cycle Theories, I, A Method and Its Application to Investment Activity*, League of Nations, Geneva.
- Tinbergen, J. (1939-2), *Statistical Testing of Business Cycle Theories, II, Business Cycles in the United States of America, 1919–1932*, League of Nations, Geneva.
- Tinbergen, J. (1940), 'On a Method of Statistical Business Cycle Research. A Reply,' *Economic Journal*, L, pp. 141–154.
- Tinbergen, J. (1942), 'Zur Theorie der langfristigen Wirtschaftsentwicklung' (On the Theory of Long-term Development), *Weltwirtschaftliches Archiv*, 55, pp. 511–549 (in German).
- Tinbergen, J. (1944), *De les van dertig jaar* (The Lesson of Thirty Years), Amsterdam, (in Dutch).
- Tinbergen, J. (1945), *International Economic Co-operation*, Amsterdam.
- Tinbergen, J. (1949), 'The Equalisation of Factor Prices between Free-Trade Areas,' *Metroeconomica*, 1, pp. 39–47.
- Tinbergen, J. (1950-1), 'Wesen und Bedeutung der Oekonometrie' (Nature and Importance of Econometrics), *Zeitschrift für Oekonometrie*, 1, pp. 5–13 (in German).
- Tinbergen, J. (1950-2), 'De Grenzen der Ordening' (The Limits of Planning), in the series: *Vraagstukken van heden en morgen* (16), (Problems of Today and Tomorrow), Comité ter Bestudering van Ordeningsvraagstukken, Voorburg, The Netherlands, (in Dutch).
- Tinbergen, J. (1951), *Business Cycles in the United Kingdom, 1870–1914*, Amsterdam.
- Tinbergen, J. (1952-1), *On the Theory of Economic Policy*, Amsterdam.
- Tinbergen, J. (1952-2), 'Dirigisme et liberté dans le cadre de l'intégration économique de l'Europe' (Planning and Freedom and Economic Integration in Europe), *Anais do Instituto Superior de Ciências Económicas e Financeiras*, Lisbon, 1952 (in French).
- Tinbergen, J. (1954-1) (2nd ed. 1964), *International Economic Integration*, Amsterdam.
- Tinbergen, J. (1954-2), *Centralization and Decentralization in Economic Policy*, Amsterdam.
- Tinbergen, J. (1956-1), 'The Optimum Rate of Savings,' *Economic Journal*, LXVI, pp. 603–609.
- Tinbergen, J. (1956-2), *Economic Policy: Principles and Design*, Amsterdam.
- Tinbergen, J. (1956-3), 'On the Theory of Income Distribution,' *Weltwirtschaftliches Archiv*, 77, pp. 155–175.
- Tinbergen, J. (1957-1), 'The Appraisal of Road Construction: Two Calculation Schemes,' *Review of Economics and Statistics*, 39, pp. 241–249.
- Tinbergen, J. (1957-2), 'Customs Unions: Influence of their Size on their Effect,' *Zeitschrift für die Gesamte Staatswissenschaft*, 113, pp. 404–414.
- Tinbergen, J. (1958) *The Design of Development*, World Bank, Baltimore, USA, 1958.
- Tinbergen, J. (1959-1), 'On the Theory of Trend Movements,' in: L.H. Klaassen, L.M. Koyck and H.J. Witteveen (eds.), *Jan Tinbergen: Selected Papers*, Amsterdam, 1959, pp. 182–221.
- Tinbergen, J. (1959-2), 'The Theory of the Optimum Regime,' in: L.H. Klaassen, L.M. Koyck and H.J. Witteveen (eds.), *Jan Tinbergen: Selected Papers*, Amsterdam, pp. 264–304.
- Tinbergen, J. (1961-1), 'The Spatial Dispersion of Production: A Hypothesis,' *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 97, pp. 1–8.

- Tinbergen, J. (1961-2), 'Do Communist and Free Economies Show a Converging Pattern?,' *Soviet Studies*, XII, pp. 333-341.
- Tinbergen, J. (1961-3) 'Structures générales du problème de l'optimum du bien-être d'un groupe de nations' (General Structures of the Problem of the Optimum Welfare in a Group of Countries), in: *Les critères économiques de la division internationale du travail*, (Economic Criteria for the International Division of Labour), Report to UNESCO, Université Libre de Bruxelles, Brussels, (in French).
- Tinbergen, J. (1961-4), 'De economische balans van het Deltaplan' (The Economic Balance of the Delta Plan), in: *Rapport Deltacommissie*, Den Haag, 1961.
- Tinbergen, J. (1962-1), 'Planning in Stages,' *Statskønomisk Tidsskrift*, 1, pp. 1-20.
- Tinbergen, J. *et al.* (1962-2), *Shaping the World Economy: Suggestions for an International Economic Policy*, New York, 1962.
- Tinbergen, J. (1962-3), 'Voorspellingen in politiek, economie en sociologie' (Forecasts in Politics, Economics and Sociology), *Nederlands Tijdschrift voor de Psychologie en haar Grensgebieden*, XVII, pp. 193-197 (in Dutch).
- Tinbergen, J. (1963), 'De sociale verantwoordelijkheid van de economist' (The Social Responsibility of the Economist), *Universiteit en Hogeschool*, 10, pp. 21-28 (in Dutch).
- Tinbergen, J. and H.C. Bos (1965-1), 'A Planning Model for the Educational Requirements of Economic Development', in: *Economic Models of Education* OECD, Paris, pp. 9-31.
- Tinbergen, J. (1965-2), 'International, National, Regional and Local Industries,' in: R.E. Caves, H.G. Johnson and P.B. Kenen (eds.) *Trade, Growth, and the Balance of Payments*, Essays in Honour of Gottfried Haberler, Amsterdam.
- Tinbergen, J. (1965-3) *De les van vijftig jaar*, (The Lesson of Fifty Years), Amsterdam, (in Dutch).
- Tinbergen, J. (1968-1), *Development Planning*, London.
- Tinbergen, J. (1968-2), 'The Optimal International Division of Labour,' *Acta Oeconomica Academiae Scientiarum Hungaricae*, 3, pp. 257-282.
- Tinbergen, J. (1968-3), *Over de optimale internationale arbeidsverdeling* (On the Optimal International Division of Labour), Speech for the Royal Academy of Sciences in The Netherlands, Amsterdam (in Dutch).
- Tinbergen, J. (1968-4), 'Similarities and Differences between the Social Problem and the Development Problem,' *Mens en Maatschappij*, pp. 120-127.
- Tinbergen, J. (1969-1), 'Ideology and Coexistence,' *Review of International Affairs*, XX, pp. 1-2.
- Tinbergen, J. (1969-2), 'The Use of Models: Experience and Prospects', Lecture in Memory of Alfred Nobel, December 12th, 1969, in: *Les Prix Nobel en 1969*, Stockholm, 1970, pp. 244-252.
- Tinbergen, J. (1970-1), 'A Positive and a Normative Theory of Income Distribution,' *Review of Income and Wealth*, 16.
- Tinbergen, J. (1970-2), 'Was spricht für die Konvergenztheorie?' (What Speaks for the Convergence Theory?), *Wirtschaftswoche der Volkswirtschaft*, 23 December 1970 (in German).
- Tinbergen, J. (1970-3), 'Some Work Experiences,' in: T. Dalenius, G. Karlsson and S. Malmquist (eds.), *Scientists at Work*, Festschrift in honour of Herman Wold, Uppsala.
- Tinbergen, J. (1971), 'Over meten in de menswetenschappen' (On Measuring in the Human Sciences), *Jaarboek Maatschappij der Nederlandse Letterkunde, 1970-1971*, Leiden, pp. 11-26 (in Dutch).
- Tinbergen, J. (1972-1), 'Society Needs to Organize the Structures and Uses of Science,' *Impact of Science on Society*, XXII, pp. 289-297.
- Tinbergen, J. (1972-2), 'The Impact of Education on Income Distribution,' *Review of Income and Wealth*, 18, 3.
- Tinbergen, J. (1972-3), 'De convergentietheorie: antikritiek' (The Convergence Theory: Anti-Criticism), in: *Mens en Keuze* (Man and Choice), Amsterdam pp. 1-11 (in Dutch).
- Tinbergen, J. (1972-4), 'Some Features of the Optimum Regime,' in: *Optimum Social Welfare and Productivity*, The Charles C. Moskowitz Lectures, New York University, New York.

- Tinbergen, J. (1973-1), 'Labour with Different Types of Skills and Jobs as Production Factors,' *De Economist*, 121 pp. 213–224.
- Tinbergen, J. (1973-2), 'The Necessity of Quantitative Social Research,' *Indian Journal of Statistics*, Series B, 35.
- Tinbergen, J. (1973-3), 'Ragnar Frisch's Role In Econometrics: A Sketch,' *mimeo*.
- Tinbergen, J. (1975), *Income Distribution; Analysis and Policies*, Amsterdam.
- Tinbergen, J. (1979), 'Recollections of Professional Experiences,' *Banca Nazionale del Lavoro Quarterly Review*, 131, pp. 331–360.
- Tinbergen, J. (1982), 'De noodzaak van een synthese' (The Need for Synthesis), *Economisch-Statistische Berichten*, 67, pp. 1284–1285 (in Dutch).
- Tinbergen, J. (1983), 'Enkele ervaringen' (Some Experiences), *Economisch-Statistische Berichten* 68, p. 307.
- Tinbergen, J. (1984), 'Development Cooperation as a Learning Process,' in: Gerald M. Meier and Dudley Seers (eds.), *Pioneers in Development*, New York pp. 315–331.
- Tinbergen, J. (1985-1), *Production, Income and Welfare. The Search for an Optimal Social Order*, Brighton, UK.
- Tinbergen, J. (1985-2), 'Measurability of Utility (or Welfare),' *De Economist*, 133, pp. 411–414.
- Tinbergen, J. (1987-1), 'Measuring Welfare of Productive Consumers,' *De Economist*, 135, pp. 231–236.
- Tinbergen, J. (1987-2), *Revitalizing the United Nations System*, Nuclear Age Peace Foundation, Santa Barbara, Ca.
- Tinbergen, J. (1987-3) (with D. Fischer), *Warfare and Welfare*, Brighton.
- Tinbergen, J. (1988), 'The Role of Errors in Scientific Development,' *Review of Social Economy*, XLVI, pp. 225–230.
- Tinbergen, J. (1989-1), 'The Birth of New Disciplines and its Role in Teaching Science,' *Universiteit en Hogeschool*, 36, pp. 44–53.
- Tinbergen, J. (1989-2), 'How to Reduce Unemployment,' *Review of Political Economy*, 1, pp. 1–6.
- Tinbergen, J. (1990), *World Security and Equity*, Aldershot, UK.
- Tinbergen, J. (1991-1), 'The Velocity of Integration,' *De Economist*, 139, pp. 1–11.
- Tinbergen, J. (1991-2), 'The Functioning of Economic Research,' *Journal of Economic Issues*, XXV, pp. 33–38.
- Tinbergen, J. (1991-3), 'Solving the Most Urgent Problems First,' in: Michael Szenberg (ed.), *Eminent Economists: Their Life Philosophies*, Cambridge, pp. 275–281.
- Tinbergen, J. (1991-4), 'On the Measurement of Welfare,' *Journal of Econometrics*, 50, pp. 7–13.
- Tinbergen, J. (1991-5), 'The Optimum Economic and Security Order,' in: T.K. Kaul and J.K. Sengupta (eds.), *Essays in Honor of Karl A. Fox*, Amsterdam.
- Tinbergen, J. (1992), 'The Optimal Economic Order: The Simplest Model,' *De Economist*, 140, pp. 253–257.

BACKGROUND PUBLICATIONS

- Bos, H.C. (1970), 'Tinbergen's Scientific Contribution to Development Planning,' *De Economist*, 118, pp. 141–154.
- Bos, H.C. (1984), 'Jan Tinbergen: A Profile,' *Journal of Policy Modelling*, 6, pp. 151–158.
- Chakravarty, S. (1988), 'Jan Tinbergen,' in: *The New Palgrave, A Dictionary of Economics*, Macmillan, London.
- Frisch, R. (1949), *A Memorandum on Price-Wage-Tax-Subsidy Policies as Instruments in Maintaining Optimal Employment*, UN Document, E/CN 1/Sub 2/13.
- Haberler, G. von, (1936), *Prosperity and Depression, A Theoretical Analysis of Cyclical Fluctuations*, League of Nations, Geneva.

- Hanau, A. (1928), 'Die Prognose der Schweinepreise' (Forecasting the Price of Pork), *Vierteljahreshefte zur Konjunkturforschung*, Sonderheft 18, Institut für Konjunkturforschung, Berlin, 1930.
- Hansen, Bent (1969), 'An Appraisal of His Contributions to Economics,' *Swedish Journal of Economics*, LXXI, pp. 325–336.
- Hartog, F. (1970), 'Tinbergen on Prices, Incomes and Welfare,' *De Economist*, 118, pp. 126–140.
- Hartog, J. (1981), *Personal Income Distribution, A Multicapability Theory*, Boston.
- Keynes, J.M. (1919), *The Economic Consequences of the Peace*, London.
- Keynes, J.M. (1939), 'Professor Tinbergen's Method,' *Economic Journal*, XLIX, pp. 558–568.
- Keynes, J.M. (1940), 'Comment,' *Economic Journal*, L, pp. 154–156.
- Klaassen, L.H., L.M. Koyck and H.J. Witteveen (eds.) (1959), *Jan Tinbergen: Selected Papers*, Amsterdam.
- Linnemann, H. (1966), *An Econometric Analysis of International Trade Flows*, Amsterdam.
- Praag, B.M.S. van (1971), 'The Welfare Function of Income in Belgium: An Empirical Investigation,' *European Economic Review*, 2.
- Wolff, P. de (1970), 'Tinbergen's Contribution to Business-cycle Theory and Policy,' *De Economist*, 118, pp. 113–125.
- Wolff, P. de and J.T.J.M. van der Linden (1988), 'Jan Tinbergen: A Quantitative Economist,' *Review of Social Economy*, XLVI, pp. 312–325.

Summary

TINBERGEN'S WORK: CHANGE AND CONTINUITY

This article provides an overview of Tinbergen's economic writings, comprising well over 900 publications. Six broad areas have been distinguished to allow for the classification and discussion of Tinbergen's economic work. These six areas embody the change in Tinbergen's areas of interest apart from the shift from physics to economics early in his career. Tinbergen's work, however, is not only characterised by change of areas but also by continuity in approach. To mark this continuity four main characteristics of Tinbergen's work have been elaborated. The article concludes with Tinbergen's observations on the achievements to be expected from scientific research.