Tinbergen, Jan (1903–1994)

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Abstract

Jan Tinbergen was the first Nobel Laureate in economics in 1969. This article presents a brief survey of his many contributions to economics, in particular to macroeconometric modelling, business cycle analysis, economic policymaking, development economics, income distribution, international economic integration and the optimal regime. It further emphasizes his desire to contribute to the solution of urgent socio-economic problems and his passion for a more humane world.
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Keywords

business cycles; capability tax; Club of Rome; cobweb model; computable general equilibrium models; development economics; econometrics; economic integration; educational attainment; foreign aid; Frisch, R.; gravitation model; Great Depression; Haavelmo, T.; Haberler, G.; Harvard Barometer; income distribution; inequality; inequality between nations; innovation; international division of labour; international external effects; Keynes, J. M.; lump sum taxes; Mitchell, W.; models; Netherlands Bureau for Economic Policy Analysis; optimal distribution of income; Persons, W.; planning in stages; positional-exchange criterion; rent seeking; Slutzky, E.; social welfare function; statistical mechanics; targets and instruments; tax shifting; taxation of income; Tinbergen rule; Tinbergen, J.; velocity of integration; Yule, G.
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Article

Jan Tinbergen was born in The Hague, The Netherlands, on 12 April 1903, the first of five children in an intellectually stimulating family with a love of foreign languages. Eventually two of the children would win a Nobel Prize: Jan in economics (in 1969) and Niko, an ethologist, in physiology or medicine (in 1973).

Jan Tinbergen enrolled as a student of mathematical physics at Leiden University in 1921, where he obtained his doctorate in 1929. By that time he had already decided to switch to economics. From 1926 to 1928 Tinbergen worked as a conscientious objector to national military service, first in a convict prison and later, and of greater import to his subsequent career, at the Central Bureau of Statistics. He continued to work there until 1945. In 1933 he became extraordinary professor of statistics, mathematical economics and econometrics at the Netherlands School of Economics in Rotterdam. As a result of his quantitative approach to the study of economic dynamics, he was invited to the League of Nations in Geneva during the period 1936–8 in order to carry out statistical tests of business cycles theories. In 1945, at the end of the Second World War, Tinbergen was appointed as the first director of the Central Planning Bureau at The Hague. He held this position until 1955, when he became full professor of mathematical economics and development planning at the Netherlands School of Economics, later Erasmus University, Rotterdam. Throughout the 1960s and a part of the 1970s he acted as adviser to various international organizations and

to governments of a considerable number of less-developed countries. He was elected chairman of the United Nations Committee on Development Planning in 1965 and held this position until 1972. In 1969 he was awarded, together with Ragnar Frisch, the first Nobel Prize in Economics. After his retirement as full professor in 1973 he held the Cleveringa Chair in Leiden for two years. He continued to be involved in various research projects at old age. Jan Tinbergen died on 9 June 1994.
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Personal motivation

Already at an early age Tinbergen was profoundly impressed by the horrors of the Great War – subsequently numbered as the First World War – partly because of the fate of the Austrian refugee children his parents had lodged. Later, in Leiden as a student, when he was invited by his postman to join him on his rounds, he was appalled by the conditions of poverty in which the local population lived. Wishing to contribute to the struggle against such social evils, he decided to become an economist. This decision was characteristic of Tinbergen and his attitude towards economic science in his later life: his scientific contributions would always be inspired by the desire to tackle the social problems he observed. Paul Ehrenfest, professor of theoretical physics and Tinbergen's mentor in Leiden, was not unsympathetic towards the switch from physics to economics. Having made important contributions to statistical mechanics together with his wife Tatyana Afanasyeva, he called Tinbergen's attention to the possibilities that a mathematical representation of economic problems would offer. The dissertation on minimum problems in physics and economics that Tinbergen defended in 1929 bridged the two disciplines.
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Econometric modelling and business cycle research

In 1969 Tinbergen was awarded, together with R. Frisch, the first Nobel Prize in Economics ‘for having developed and applied dynamic models for the analysis of economic processes’, as the Nobel Prize committee described it.
The desire to combat the socio-economic consequences of the Great Depression of the 1930s was Tinbergen's most important motivation for studying business cycles. In his inaugural address as extraordinary professor in 1933 he summarized his project as ‘statistics and mathematics in the service of business cycle research’. His approach contrasted with previous approaches to business cycle research (for more details, see, for example, Morgan, 1990 and Jolink, 2003). After a 19th-century undertaking by Juglar (1862) ascribing the recurrent business crises in Europe and North America to credit crises, and Jevons's (1884) study pointing to agricultural production cycles connected with sunspot numbers, several research projects in the early 20th century were devoted to the construction of so-called business cycle barometers. The purpose was to measure economic fluctuations through a particular index (or set of indices) with the aim of giving warning signals for turning points that would lead to a depression. An example was the Harvard Index of Business Conditions, informally known as the Harvard Barometer, constructed by a team led by Persons (1919). Another well-known descriptive approach to the business cycle during this period had been initiated by Mitchell (1913). His work was followed by that of Yule (1927) and Slutzky (1927), who suggested that the cumulative effect of random shocks could be the cause of cyclical patterns in economic variables. Frisch (1933), co-recipient of the

1969 Nobel Prize, applied these ideas introducing econometric models in which impulse propagation mechanisms led to business cycles.
However useful it could be as a starting point, Tinbergen criticized descriptive analysis as being too vague for use in policy preparation, and started a quantitatively oriented research programme to explore the possible economic causes of the periodic upswings and downswings in economic activity. In an earlier theoretical study Aftalion (1927) had argued that lags in an economic model could generate cyclical variation in economic activity. Following up this argument, Tinbergen specified a first simple case using a system of difference equations to express lagged responses of supply to price changes in a market for a single good. He noted that the systematic fluctuations that could arise in such a system had been observed in an empirical study of the pork market by the German economist Hanau (1928), a phenomenon that became known as the 'cobweb model' (Tinbergen, 1979, presents additional relevant literature).
Tinbergen subsequently generalized the specification of dynamic equations with lagged adjustment processes to macroeconomic settings, arguing that fluctuations in components of national product, such as investment and consumption expenditures, would lead to business cycle fluctuations in general economic activity. In 1936 he published the first applied macroeconometric model (for the Netherlands). It was a dynamic model, consisting of 22 equations in 31 variables. Employing what we now see as basic statistical techniques like correlation and regression analysis, it was meant to be used for the analysis of the particularly pressing unemployment problem. The specification of consumption and employment in this model anticipated elements of Keynes's theory (1936). This modelling exercise resulted in a strong policy recommendation in favour of a devaluation of the Dutch guilder to tackle unemployment. But its importance for the economics profession was far more profound: for the first time the economic-policy debate had been based on empirically tested, quantitative economic analysis and not on rather informally stated economic theory, the so-called verbal approach. Thus, according to Solow (2004, p. 159), Tinbergen's work during this period 'was a major force in the transformation of economics from a discursive discipline into a model-building discipline'.
In 1936 Haberler had published a survey of theories on business cycles for the League of Nations. As a follow-up, and in reaction to the dynamic model for the Netherlands Tinbergen had published in that year, the same institution invited him to examine statistically which factors could be considered to contribute most to macroeconomic fluctuations. This project resulted in his two-volume book *Statistical Testing of Business Cycles Theories* (1939). The first volume contained a description of the methodology applied, while the second volume presented a dynamic macroeconometric model for the United States with the aim of studying business cycles in that country after the First World War. This model was not only considerably larger than the one for The Netherlands; as imports and exports were much less important for the United States, it also allowed a relatively undisturbed view of internal dynamic mechanisms. Subsequently, the US model was much refined and enlarged by Klein (1950) and Duesenberry et al. (1965). Tinbergen presented his views on the dynamics of business cycles and on objectives and instruments of business-cycle policy for a wider audience in Tinbergen (1943) and Tinbergen and Polak (1950).
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Discussion with Keynes

The formulation of some relations in Tinbergen's 1936 model showed some resemblance to Keynes's theory. Nevertheless, in an article in the *Economic Journal* of 1939, Keynes was remarkably sceptical of Tinbergen's work. Keynes labelled Tinbergen's method of estimating the parameters of an econometric model and computing quantitative policy scenarios as 'statistical alchemy', arguing that this approach '… is a means of giving quantitative precision to what, in qualitative terms, we know already as the result of a complete theoretical analysis' (Keynes, 1939, p. 560). Their widely diverging views on the relevance of quantitative economic analysis were also illustrated by Keynes's reaction to Tinbergen's estimate of the price elasticity of demand for exports. When, in 1919, Keynes had strongly criticized the excessive war indemnity payments enforced upon Germany after the First World War, his argument had depended critically on the value of this elasticity. Tinbergen empirically found this value to be minus 2, precisely the value that Keynes had assumed a priori in his study. When informed about this Keynes replied: 'How nice that you found the correct figure' (Kol and de Wolff, 1993, p. 8.)

Keynes's critical attitude towards macroeconometric modelling and analysis originated from his view that the underlying economic theory should be complete in the sense that it should include all relevant variables and set out in detail its causal and dynamic structure. Econometrics could be used only for measuring the relations ('curve fitting' was the term used); it could not refute economic hypotheses or evaluate economic models. Tinbergen, on the other hand, argued that economic theories cannot be complete. Econometric research could be useful for scrutinizing elements of economic theories and for examining whether one theory describes reality better than another. Further, it could provide the numerical values of the coefficients in dynamic models that determine the cyclical and stability properties of a model, and, by applying a testing procedure of trial and error, it could yield suggestions for an improved specification of dynamic lags.

In this controversy Tinbergen's approach soon gained the upper hand as increasing numbers of economists, especially in the United States, noted its practical results in terms of model construction and verification, including forecasting. However, Keynes's comments on the role of expectations and uncertainty in macroeconometrics and on specification and simultaneous equation biases remained relevant. Haavelmo (1943) advocated the use of probability theory in bridging the gap between theory and data in business cycle analysis. Later these issues would become the subject of intensive debate and research.

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Theory and practice of economic policy

In 1945 Tinbergen was appointed director of the newly established Central Planning Bureau (CPB), an institution occupied with forecasting the effects of economic policy and advising the government on related matters (tasks which are more adequately captured by its present-day English name: Netherlands Bureau for Economic Policy Analysis). In the aftermath of the Second World War work at the CPB concentrated on the nation's pressing macroeconomic problems: a depleted capital stock, severe inflationary pressure, low levels of employment and an extreme shortage of foreign exchange.

In the economics discipline macroeconometric modelling had rapidly become accepted as a useful tool with the publication of such studies as by Klein (1950), Leontief (1950) and Klein and Goldberger (1955). But Tinbergen, having gained

experience with the practice of policy preparation, felt the need for a systematic discussion of the logic of economic policy and of the use of models for policy purposes. It led to several monographs on the theory of economic policy (1952; 1956). He distinguished, among other things, between reforms (changes in the foundations of society), qualitative policy (changes in the structure of economic and social organization) and quantitative policy (changes in the instruments of economic policy). The latter could help to avoid the shortcomings of the traditional approach by offering a systematic policy where trial and error had been practised, by taking account of interdependence between instruments and by providing a quantitative indication of effects. Further, building on earlier work by Frisch distinguishing between various types of variables in relation to their role in policy models, Tinbergen demonstrated the connection between the analytical, or explanatory version and the policy, or normative version of economic models. In the analytical version, the policy targets were explained by other endogenous variables and by exogenous variables, which included the policy instruments. In the policy version the position of targets and instruments would be reversed (targets becoming exogenous and instruments endogenous variables) such that, in a well-behaved linear system, a solution requires only equality of the numbers of targets and instruments. This conclusion, which became known as the ‘Tinbergen rule’, brought an end to the popular misconception of a one-to-one correspondence between targets and instruments.
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Development economics

In reaction to his experiences during a trip to India in 1951, Tinbergen left the Central Planning Bureau in 1955 and moved to the field of development economics, more specifically the planning of the socio-economic development of low-income countries. Much earlier he had published a mathematical-statistical study of the theory of long-term economic growth (1942), but this had related only to industrialized countries. In the model technological progress had explicitly been included and the statistical tests (with data for Great Britain, France, Germany and the United States from the decades before the First World War) already suggested that capital and labour growth could explain only a relatively small portion of the growth of production.
Characteristically, Tinbergen applied a quantitative, systematic policy approach to the development problem. This approach, which became known as ‘planning-in-stages’, distinguished macro, middle and micro stages, dealing with policy problems of private and public decision makers at the national, sectoral and project level, respectively (1967). In view of the difficult transportation conditions and the scarcity of skilled labour in developing countries, he subsequently added spatial and educational dimensions to the backbone of the planning-in-stages approach. He greatly simplified the calculation procedure for project evaluation by devising the semi-input-output method. This method was based on the notion that only the indirect effects emanating from sectors producing non-tradable (national) goods needed to be incorporated. At a time when computer capacity was still very limited, such a simplification was most useful. However, consistency between the micro stage and the other two levels was achieved only with the advent of computable general equilibrium models.
Tinbergen acted as adviser on matters related to economic development to the governments of Egypt, Turkey, Venezuela, Surinam, Indonesia and Pakistan, and he wrote studies for international organizations such as UNESCO and the OECD. As

Chairman of the UN Committee on Development Planning from 1965 to 1972, he was involved with, among other things, the preparation of the UN Second Development Decade (1971–80).
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Income distribution

Tinbergen revisited the field of income distribution after his retirement as full professor (1972a; 1975). His approach, then as much as before, was inspired to a considerable extent by the positional-exchange criterion that had emerged from discussions in his student days with Paul Ehrenfest. According to this criterion a distribution of welfare could be considered fair when no one would wish to take another person's position. It was, for example, expressed in the individual welfare function Tinbergen proposed, which depended negatively on the difference (positive or negative) between the level of schooling required for a job and the actual schooling obtained by the person on this job. The notion that an income distribution is the outcome of a confrontation of demand and supply factors was another characteristic element of his approach. Thus, the development of a country's income distribution would be governed to a large extent by the process of technological innovation (a demand factor) and the rise of educational attainment levels (a supply factor). On the basis of material from the United States and The Netherlands from 1900 onwards, he found that this ‘race’ was mostly won by the rise in education, which resulted in more equitable distributions.
In his contributions to the field of income distribution – which concentrated on the remuneration of labour categories – he aimed to examine the effect of some unorthodox propositions. One such proposition was to consider the applicability of a capability tax which, as a lump sum tax, would be preferable to the familiar income tax. (Remarkably, this proposal ran counter to his finding that tax changes have a very slight impact on primary incomes, such that tax shifting would hardly be a problem.) Further, and true to his conviction that scientific progress and practical applications depend on quantitative tests of hypotheses, he treated welfare as measurable on the assumption that further progress in this area would be feasible. Assuming that workers move freely from one job to another so utility would be equalized, he derived an empirical relation expressing the connection between wage income on the one hand and attained schooling and the difference between attained and required schooling on the other. He then used this relation to compute an optimal or just distribution of income, tentatively relating to the situation in The Netherlands in the early 1960s. It would require very considerable shifts in income as compared with the actual situation.
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International economic integration

Tinbergen's earliest work on international economic relations was still connected with national policymaking. Thus, his estimates of price elasticities of trade packages were meant to examine the effectiveness of a devaluation policy, where he emphasized the need to use long-term rather than short-term elasticities. His gravitation model (1962, Appendix VI) was a Newtonian approach to the explanation of bilateral trade flows which appeared to depend positively on the GNPs of the trade partners and negatively on the shipping distance separating them. It could be used to identify, among other

things, the magnitude of potential trade lost to higher-than-average trade barriers, which impeded the efficient international division of labour he advocated in a number of studies written in the 1960s. Tinbergen (1954) applauded the international economic integration movement as it could remove trade barriers (which he dubbed negative economic integration) and could even result in new institutions for coordinated and centralized policymaking (positive economic integration). But he attached particular importance to the fact that economic integration would effectively reduce the probability of armed conflicts. From historical processes in Europe he derived a 'velocity of integration' which he hoped would remain positive until full integration at the regional and indeed the world level were achieved (1991a).
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The optimal regime

His lifelong concern for (inter)national policymaking and, in that context, his special concern for the underdog resulted in a number of publications on the optimal economic order. In a deviation from his usual approach, Tinbergen emphasized in his Nobel Prize acceptance speech (1969) that the problem here consisted not of establishing the right mix of values of economic variables but of finding the proper set of institutions regarding the size and content of the public sector, the extent and content of (de)centralization of socio-economic decision making and therefore also of market regulation. He developed his ideas on the optimal order within a welfare-economic framework concerned with identifying the conditions that must be fulfilled to achieve maximum social welfare subject to the restrictions, such as production technologies, that apply in human society (1972b). In such a setting it would be useful to select the social welfare function at the beginning so as to limit the ethical possibilities in the subsequent analysis. The activities of the institutions would be described by a number of behaviour equations, the total of which should coincide with the conditions for optimal welfare. Tinbergen argued against rigidities, privileges, monopolies and insider-determined remunerations that bore no relation to marginal productivities, but he also rejected excessively generous social security systems that invited rent seeking.
In Tinbergen's view the interests of developing countries deserved separate attention in discussions on the optimal economic order. No country would accept within its borders an income inequality between groups of rich and poor citizens as could be found between rich and poor countries in the world. Not only must obstacles to exports from developing countries be removed; it would also be necessary to support these countries' development efforts by providing technical and financial aid. Tinbergen urged replacing the arbitrary UN target for international aid of 0.7 per cent of GNP of rich countries by the volume of aid that would be required for a harmonization of incomes within a predetermined number of years. He coordinated a study (1977) for the Club of Rome offering views on the international order, development aid, food production, the international division of labour, energy sources and raw materials, technological development, the environment and the arms race, among other things.
With the help of the theory of the optimal regime Tinbergen further sought to rid the confrontation between the Communist East and the Capitalist West of the dogmatic character that dominated world politics before the fall of Communism in 1989. Horrified by the prospect of nuclear warfare, he devoted a large part of his later years to a plea for a rational debate on the pros and cons of both systems and for a stronger

role of a reformed United Nations taking decisions that would incorporate international external effects (1990).
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In conclusion

Tinbergen's contribution to the economics discipline lies in his pioneering work in a number of different economic fields. He would not consider himself an expert even in these areas, would gladly admit that others who had come in after him had meanwhile gained a better understanding, and would move on to another area where another pressing social problem needed to be addressed. In his own words (1991b), ‘solving the most urgent problems first’ is what moved him most in his intellectual agenda. He had little patience with studies lacking applicability to practical problems, and was not much impressed by scientific elegance for its own sake. His work discipline, punctuality and efficiency were exemplary. For an appointment, students and assistants he supervised would get seven minutes on the watch he would keep nearby. Still, Tinbergen also gave innumerable lectures for organizations and social action groups even of humble status.
His intense desire for a more humane world led him to put great trust in the benevolence and effectiveness of governments and international organizations, realizing that policies to overcome social problems would nearly always require the participation of public institutions. The latter's serious shortcomings in terms of management and governance were just another problem to be solved. He nursed a strong hope that people would behave more sensibly over time and learn to avoid the terrible conflicts that had caused so much suffering and devastation in the 20th century. It was for all these characteristics that Samuelson (2004, p. 153) described Tinbergen as ‘a humanist saint’. Naturally, during his long life Tinbergen was often deeply disappointed. Still, his optimism never left him, if only because, as he said at an advanced age: ‘I cannot afford to be pessimistic’.
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See Also

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- econometrics
- foreign aid
- Frisch, Ragnar Anton Kittel
- gravity models
- Keynes, John Maynard
- redistribution of income and wealth

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