THE BEGINNINGS OF CREATING MATHEMATICAL METHODS IN ECONOMICS IN CZECHOSLOVAKIA

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Abstract

Count Georg Franz von Buquoy was the first mathematical economist in the territory of today's Czech Republic in the first half of the 19th century. This article deals in more detail about the creation of mathematical methods in the national economy during the interwar period of the 20th century. These were mainly the works of Jan Stocký (1897–1959), a lecturer in economic theory at Czech Technical University in Prague, and Stanislav Kohn (1888–1933), an associate professor at the Russian Faculty of Law in Prague.

After 1945, the development of econometrics in the developed countries of the world was also well received in Czechoslovakia, where econometrics was taught at the Faculty of Science of Charles University – Emil Schönbaum (1882–1967) and at the University of Special Sciences – Jan Stocký. After the onset of the communist regime in 1948, the teaching of econometrics ended, but under somewhat more liberal conditions it was resumed in the late 1950s at the University of Economics and the Faculty of Mathematics and Physics of Charles University.

Key words: econometrics, Jan Stocký, Emil Schönbaum, statistics

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Introduction

The history of statistics and mathematical methods in economics in our territory has not yet been comprehensively processed. The authors of this paper contribute to the improvement of this situation through a number of articles on the development of these disciplines in the 20th century – Kodera, Závodský and Šimpach (2015), Závodský and Šimpach (2016, 2017, 2018, 2019) etc. In this paper, we deal mainly with the beginnings of the application of mathematical methods in economics in our territory in the 1920s and 1940s. In the Stalinist period after February 1948, econometrics was rejected as a "bourgeois pseudo–science". This year we commemorate the 70th anniversary of the establishment of the Department of Statistics at the University of Economics in Prague (1952), where mathematical methods in economics were

re–cultivated after some liberalization in the late 1950s. A separate Department of Econometrics separated from the Department of Statistics in 1959.

1 The beginnings of mathematical economics in the Czech Lands

We could have met the first mathematical economist at our area already two centuries ago. Georg Franz von Buquoy (1781–1851) interpreted economic theory mathematically and used the apparatus of theoretical mechanics in his book *Die Theorie der Nationalwirthschaft* (Leipzig 1815, p. 506). He significantly preceded his time. Hence, he had no significant followers in our country, and today is known only to specialists in the history of economic theories In the 1920s, there were also attempts in our territory to systematically describe economic processes mathematically. These are mainly the works of Jan Stocký (1897–1959).

Jan Stocký was born Březnice (district Příbram). He studied civil engineering at Czech Technical University in Prague (today's Czech Technical University - CTU) in years 1914–1919. He received his doctorate in technical sciences (Dr. techn.) on the basis of a dissertation in the field of national economy in 1921. He also graduated from the Faculty of Law and the University of Business, and also studied sociology and national economics at the universities of Paris, Brussels and London in the 1920s. Already during his studies, Stocký became an assistant professor of Czech technology – from June 1, 1922 at the Institute of National Economy at the University of Special Sciences of the Czech Technical University. This institute was one of the largest at CTU, as it provided lectures and seminars for all fields of study in technology.[1] At the end of 1927, Stocký, already a honorary associate professor at that time, obtained a *venia docendi* in the field of national economy on the basis of his work on the applications of mathematics in the national economy. (Stocký, 1927).[2]

Jan Stocký focused mainly on the theory of overall equilibrium, that was almost unnoticed at the field of Czech economic thinking. Let us briefly list the personalities who inspired Jan Stocký the most. It is mainly Leon Wallras (1834–1910), founder of the theory of general equilibrium, who worked in the department of political economy at the university in Lausanne in 1870–1893. His the most famous book is *Eléments d´economie politique pure* (*Základy čisté politické ekonomie Fundamentals of pure political economy*). Another famous person was Vilfredo Pareto (1848–1923), that was oriented mainly on the utility theory. He

[1] In addition, it provided lectures on financial science and a national economic seminar for students of the field of insurance technology (later statistical-insurance engineering).
[2] CTU archive, cardboard 18.

replaced Walras at the head of the Department of Political Economy at Lausanne University in 1893. His the most famous work is *Manuel d´economie politique (The Handbook of Political Economy*). Jan Stocký also concerned the work of William Stanley Jevons (1835–1882). Jevons had worked at the University of London since 1876 and his the most famous work is *The Theory of Political Economy*. He significantly contributed to economic theory with his theory of exchange.

Stocký published eight papers on mathematical methods in the national economy in the 1920s. From a methodological point of view, his most recently published work is the most elaborated *Role matematiky v bádání národohospodářském* (*Role of mathematics in economic sciences*) (Stocký, 1927). This book emphasizes at the beginning the motive of its publication, namely to acquaint the Czech scientific public with the use of mathematical procedures in a world where mathematical interpretation of economics is considered common. Stocký is aware of a certain lag of Czech economic science in the use of mathematical methods. He considered the first part of the book, in which he talks about the possibility and necessity of using mathematics in economics, to be crucial. The second part, where he talks about building a mathematical economic theory, is not a comprehensive presentation, which the author is aware of and explicitly states.

Czechoslovakia (and mainly Prague) became in 1920s a centre of educated Russian and Ukrainian exiles with the support of the government and President Masaryk. In 1921 the Ukrainian University was transferred to Prague from Vienna. There was a Law Faculty in 1922–1933. Important economists and statisticians worked in Prague in the 1920s, such as A. A. Čuprov (1874–1926), P. B. Struve (1870–1944), S. N. Prokopovič (1871–1955) and Stanislav Kohn (1888–1933), who is famous as an author of first Czech written textbook of modern statistical methods *Základy teorie statistické metody* (*Fundamentals of statistical method theory*) (Kohn, 1929).

Stanislav Kohn come from Warsaw and studied economics and statistics in St. Petersburg. He dealt mainly with theoretical and applied statistics. He later worked in Tiflis (Tbilisi), in Paris and since 1923 in Prague where he, among other things, lectured as a private associate professor of statistics at the Russian Faculty of Law. He also worked for the Institute of National Economy for prof. Prokopovič and for the Agricultural Institute for prof. Brdlík. Kohn gave a remarkable presentation *on probabilistic-statistical approach to problems of economic theory* at the 3rd Russian Academic Congress in Prague in 1924. He developed these ideas the following year in two papers in scientific proceedings.

Kohn's paper *About „Statistification" of Policitac Economy* (Kohn, 1925b) is a criticism of theoretical opinions of Russian economics and politics Petr Berngardovič Struve, who was leading ideologue of the Russian right, who in years 1922–1924 lectured at Russian Law Faculty in Prague. As an economist, he held the position of empiricism and idiography. He very often criticized the general claims of economic theory and considered them unjustified universalism.

Kohn's paper critically analyses some theoretical conceptions of Struve in the area of distribution and price creation. According to Kohn, Struve sees unjustified universalism even where it is fully justified and necessary for further economic research. According to Kohn, this is very evident in the issue of distribution. Struve argues that the distribution of the social product is an imaginary problem, because in reality there are only singular facts about the creation of individual incomes of economic individuals in the created price environment, which is, of course, diverse. There is no distribution outside of these singular facts of income generation, and so the notion of (society-wide) distribution is unjustified universalist fiction. Kohn disagrees with this methodological conclusion.

According to Kohn, it cannot be denied, of course, that the distribution of a social product takes place in the specific environment of a large number of farmers who create their incomes through sales of goods and services in an environment of individual prices, which not only differ according to goods.

However, Kohn argues, it does not follow that there can be no legitimate, real, meaningful and general concept of (social) division. It is also justified to define individual groups or classes of economic individuals. The consequence of these theoretical approaches is the notions of division between groups and classes. Struve has a milder view in price theory. There is no renunciation of the possibility of the mass action of singular price-creating factors, which act as a quantity in the environment of individual acts of sales and purchases. Struve allows the interpretation of price as a general category. The relationship of price to the factors that determine it is not deterministic, so price can be considered a random variable. Such a procedure is called by Kohn as statistical-nomographic. According to Kohn, the perception of the price and other economic variables as random variables, the most important characteristic of which is the mean value, is important for the behaviour of an economic operator in the market. Kohn's stance on Struvem is much more critical in terms of distribution than in terms of price theory.

In 1925, Kohn published another remarkable article in two parts – *Mathematical and Empirical Direction in Price Theory* (Kohn, 1925a). In the middle of the 19th century, the

theory of price was considered a completed knowledge that would not need to be further developed. Such an opinion was held, for example, by the prominent British economist J. S. Mill. This state of affairs was disrupted in the 1970s with the advent of the Austrian school of subjective value, which argued that price is determined by the psychology of the consumer.

The concept of utility as a subjective category and the concept of marginal utility emerged. This direction is developed in detail by the mathematics school. Its exchange theory is based on the behaviour of a rational consumer who maximizes his utility represented by his utility function. When maximizing the benefit, the consumer is limited by his income from the sale of the goods at his disposal. The behaviour of a rational consumer is described by a mathematical problem to the bound extreme. Kohn describes a shift model for math school. The main points of his criticism are: (1) some functions used in the model are not specified, it is not possible due to the state of knowledge about the problem; (2) even if we know the forms of functional dependencies, the problem of numerical determination of parameters remains and we cannot even quantify prices, it is not possible to apply the model for price calculations; (3) model is static model, thus contradicts economic reality, where the actual economic quantities not only depend on each other at each point in time, but the value of a quantity at a given point in time is affected by the value of the same quantity at another point in time.

Kohn opposes the theoretical system of mathematics school with an initial thorough knowledge of the economic system, which can be obtained through a study of empirical material. He emphasizes the difference between his conception of empiricism and that of the historical school of economics, which consisted in a thorough description of empirical materials.

Kohn's international response is evidenced by his founding member of The Econometric Society, founded in December 1930 in the United States.[3] The following year, Kohn became seriously ill and died two years later.

At the State Statistical Office, some executives seriously considered the possibilities of enriching Czechoslovak economic statistics with economic-mathematical modelling, which they became acquainted with in foreign literature and at the congresses of the International Statistical Institute. It was mainly Robert Kollar (1884–1946) in his lecture *About Tasks of Economic Statistics* (Kollar, 1936). Besides, it was Josef Mráz (1882–1934), a member of the

[3] During 1931 were agreed 173 founding members of the Econometric Society from many countries of the world. (Bjerkholg, 2017).

Econometric Society in the USA, and Václav Myslivec (1903–1976), vice president of State Statistical Office and biometrist.

2 Development since 1945

After the resumption of the activities of Czech universities in the summer of 1945, the two-year study of insurance technology at the University of Special Sciences (USS) CTU and a similar study of actuarial mathematics and statistics at the Faculty of Science of Charles University continued. Stocký returned to USS and was appointed a professor. He tookover management of the Institute of National Economy, politics of economic and financial science. As before the war, this institute provided the teaching of these subjects for all universities in the union of CTU. Professor of Actuarial Mathematics Emil Schönbaum (1882–1967) returned to the Faculty of Science from exile.

At this time of post-war euphoria, it was possible to finally enforce the extension of the current two-year course in insurance technology at the USS CTU to a four-year university study of statistical insurance, starting with the academic year 1946/47.[4] For the first time, a full university study of statistics was established in our territory. In the second, professional, part of the study (ending with a professional state exam), the students were semi-officially divided into three directions: a) business statistics, b) insurance technology, c) public sector statistics.

The same law also extended a similar study at the Faculty of Science, Charles University (the so-called cycle of alternating lectures on actuarial mathematics and statistics) to a four-year study of mathematical statistics, actuarial mathematics and econometrics. A special feature was the joint lectures of some professional subjects for students of both universities. In the 3rd year, prof. Stocký lectured the subject of econometrics I for both semesters, in the 4th year prof. Schönbaum lectured on econometrics II. Econometrics was one of the subjects of the second (professional) state exam at the USS.[5] Students did not have any study materials on econometrics, they gained the necessary knowledge practically only in lectures. Records of them were reproduced as much as possible. We found manuscript records of econometrics lectures, so we know the approximate content of the course.

1) Lectures by prof. Schönbaum in both semesters of the study year 1945/46:

Econometrics is defined as the application of mathematics to economic phenomena. It deals mainly with national economic quantities and mathematically expresses the relations

[4] Law no. 122 Coll., from May, 16, 1946 about statistical-insurance studies.
[5] CTU Prague (1947).

between them. Econometric statics and dynamics are also defined. A substantial part of the interpretation is devoted to the defence of econometrics against the objections of some orthodox economists.

In the next part, the history of econometrics is discussed. Traditional names are mentioned in the history of econometrics: Jevons, Walras, Pareto, Gossen, Cournot, Fisher, Edgeworth ad. Significant works are also listed. The following is an explanation of the mathematical theory of national income, the methods of calculating national income are presented, the distribution of income and social consequences are discussed. Attention is paid to statistical data on national income, not only on structure but also on development. The author deals with related mathematical problems, i.e. Pareto distribution and its generalization.

The second part of the materials is devoted to the overall balance. At the beginning of the explanation, the subject of the overall balance is defined, the role of the consumer is formulated and individual points of the lecture program are briefly proposed: the role of the consumer, consumer reaction to changes in income and prices, decomposition of price effect into income and substitution effect, extension to producers, introduction of time and risk. This is followed by an economic introduction, an analysis of the problem of data acquisition, and then we move on to a model which, mathematically, is the search for the maximum of a function bound to a linear constraint. In addition to the conditions of the first order, the author also deals with the conditions of the second order, ie the second total differential. Finally, the consumer's reaction to prices and income is mathematically studied. Some items in the lecture program (manufacturing sector, dynamics, stochastics) have been omitted.

2) Lectures in econometrics in both semesters of the academic year 1947/48:[6]

The first part of the record deals with the definition of econometrics as a national economic discipline that interprets economic laws mathematically. The necessity and naturalness of the mathematical interpretation of economic laws are illustrated in the development of astronomy, when centuries of observation of the motion of planets (and the starry sky) led to the creation of mathematical models of the motion of celestial bodies. Similarly, in national economic research, the starting point should be the statistical experience gained by studying the data. The developed theory should be constantly tested on new data. If it conflicts with the data, it should be repaired or abandoned. The parameters of theoretical models must be quantities that can be quantified. A short passage, devoted to the objections of some economists against the use of mathematics, follows a section on the history of

[6] The lecturer is not mentioned, perhaps it was prof. Stocký.

econometrics. It is necessary to emphasize that, in contrast to the modern and relatively narrow definition, the author understands econometrics relatively broadly as a discipline that interprets national economic laws mathematically. he also considers econometrics to be very abstract models, which we now classify as mathematical economics. So in econometrics he includes the Anglo-Saxon school (Jevons), the Lausanne school (Walras), the theory of W. Paret, the Austrian school (only Schumpeter).

The next part of the recording of lectures in econometrics deals with the distribution of pensions and the application of the Pareto distribution, including its generalization. The record for the summer semester begins with a historical introduction to the theory of general (general) equilibrium. The creation and development of the theory is associated with the names Walras, Jevons, Pareto, Wicksell, Marshall. Böhm-Bawerk deals with the same economic environment, but does not interpret it mathematically. The following is a description of the shift model, then the sensitivity of demand to prices (derived from the necessary conditions for maximum utility), a scientific article by Slucký, a new formulation of the problem by Hicks.

The establishment of the pre-war university study of modern statistics with applications in insurance, economics and other social and natural sciences aroused a great response among statisticians. A large part of the graduates of the current two-year course quickly continued their studies. Already on March 22, 1947, the first 134 candidates received a diploma in statistical and insurance engineering from the USS. Mathematical methods were gaining in popularity. Preparations were made for the establishment of the Czechoslovak Econometric Society.

However, this development of econometrics was short-lived. Soon after the communist coup in February 1948, the study of statistical and insurance engineering underwent radical changes. Actuarial mathematics and mathematical statistics were gradually reduced as "mathematical formalisms". Econometrics was excluded from the study program and loudly condemned as "bourgeois pseudo-science."[7] Prof. Stocký already in the first wave of purges in March 1948, at the initiative of the USS action committee, was withdrawn from school with immediate effect, and a year later he was (at the age of 52) definitively retired by Minister Nejedlý. He never returned to university and died in Prague in 1959.

At the Faculty of Science, suspicious "mathematical formalisms" were more tolerated. When prof. Schönbaum went to exile after February 1948 (to Mexico, because he worked as an expert in the field of insurance in Latin America already during Nazi occupation of

[7] This included biometrics and psychometrics, which have also been taught at both universities.

Czechoslovakia) his lectures from econometrics were substituted until their cancellation by RNDr. Josef Bílý (1905–1970). Prof. Schönbaum died in 1967 in Mexico.

Conclusion

After the end of the Stalinist period in the late 1950s, the –R, Poland, Hungary and also in Czechoslovakia gradually renewed the study of the possibilities of applying mathematics in economics. At mathematical-physical faculty[8] this problematic concerned mainly prof. Josef Bílý and prof. František Nožička (1918–2004). Mathematical methods were also elaborated by some employees of the Institute of Economics of the Czechoslovak Academy of Sciences.

In 1964, the Economic and Mathematical Laboratory was established here under the leadership of Ing. Jiří Bouška. Those methods were also elaborated at Department of Statistics of Pregue University of Economics and Business. A separate department was divided from it at September 1, 1959 under the leadership of doc. Benedikt Korda (1914–2010)[9]. It was named Department of Scientific Programming up to 1966 and then Department of Econometrics.

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[8] It was founded on September 1, 1952 by the division of the Faculty of Science.
[9] Šimpach, Kodera & Závodský (2021).

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