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Mathematical Economics in the Soviet Union: A Reflection on the 25th Anniversary of L. V. Kantorovich's Book, *The Best of Economic Resources**

Aron J. Katsenelinboigen

Twenty-five years ago in the USSR, "Nauka" ("Science") publishing house published a book by L. V. Kantorovich entitled *The Best Use of Economic Resources*. The English version of this book appeared in 1965, published by Harvard University Press. Although this book was written in 1942, for certain reasons, its publication was delayed for seventeen years. Kantorovich's book is a great achievement of economic science, a fact acknowledged by the Nobel Prize he received for it. It had an enormous influence on the development of economic science in the USSR, but the influence was many-sided and contradictory in nature.

I already have had an opportunity to publish my remarks concerning the significance of this book and the history of its appearance.[1] In the present article, I would like to express some thoughts on the subject of the book's influence on the development of Soviet economic science. These comments will supplement and develop my previous publications on this topic.[2] I have relied mostly on my personal experience in giving an account of this material, because for the first fifteen years, I myself played an active role in establishing and developing methods described. I received most of the information concerning the development of mathematical methods in economics in the Soviet Union in the last ten years' published sources, in particular, from *Economics and Mathematical Methods*, a journal which I follow systematically.

1. *Illusion and Reality concerning the Usefulness of Mathematical Methods in Soviet Economic Science*

The influence of Kantorovich's idea of optimal planning on the development of Soviet economic science can be best understood within the general context of the development of mathematical methods in the analysis of economic processes. These methods include also input-output tables and econometric models. Therefore, I will begin by touching upon the general attitude towards the application of mathematical methods to economics in the USSR during the past twenty-five years.

The difficulties in the Soviet economy accrued after Stalin's death have confronted the Soviet leaders. Subsequently the rate at which the Japanese and the West German

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* This article is based on my talk presented May 8, 1984 at the seminar on the Soviet Economy headed by Prof. H. Levine. I am greatful to the participants of this seminar for their comments. The translation of the article into English was prepared by my son Alexander; A. Varesano was the editor. My thanks to both of them.

economies were grown in the fifties and the sixties, and the success of the U. S. in creating new technology, especially ones with military significance, forced the Soviet leaders to seek new avenues of economic development.

Mathematical methods of analyzing economic processes, supported by computers, created an illusion that with their help, it would become possible to improve the efficiency of the Soviet economy considerably. If we suppose that economics can be reduced to the production of goods with a given technology, that its participants are interested in the growth of production, and that the main source of difficulty is the lack of *coordination* of effort directed at fulfilling the positive intentions of the country's leaders, in that case, up-to-date mathematical methods and computers can, in principle, help improve the situation. The fact of the matter is that the decisive reasons responsible for economic success are, on one hand, the opportunity of limiting leaders' intentions (which may not always be good), and on the other hand, the creation of new ideas (not only of goods and services directly) and personal interest on the part of the people for improving the efficiency of production (and not only plan fulfillment). These reasons belong to an area which, so far, defies automatization and formalization. Here, initiative on the part of a free individual is of foremost importance as functions within the framework of a democratic society. We can only guess if the Soviet political leaders do or do not understand the necessity of creating a democracy for the successful development of the country. It is quite possible that some of them are under the illusion that a wise authoritarian regime can develop successfully. In any case, what we can say with greater certainty is that Soviet political leaders not only do not want to part with their power, but do not even want to share it in order to improve the country's development. Nevertheless, at the same time, many understand that something must be done in order to improve the mechanism of economic performance.

As paradoxical as it sounds, the new mathematical methods of analysis turned out to be quite suitable for the majority of Soviet political leaders, who were far from understanding the essence of these methods, but who wanted some changes in the economic system. Their conservatism is, foremost, a concern with saving the existing political structure, characterized by a *commanding* style of leadership with a system of *appointments*. Mathematical methods of analysis, backed up by computers, create an illusion, that, when put into practice, they would radically improve the economic situation, and at the same time allow the present political system to exist. In contrast, all suggestions of improving the socio-economic mechanism through the introduction of the market and the accompanying institutions are typically characterized by verbal methods of analysis. Although these methods are more easily grasped by the common sense of the leaders, their implementation threatens to weaken the stability of the leaders and, most importantly, robs those in power of certain privileges. If, for example, a group of people are made responsible for the results of its work, then it must be granted the right to choose its own leaders. In this case, a way of acquiring illegal income such as an appointment system taken away from those in power.

Thus the political aspect of these new methods for the analysis of economic processes suited the conservatism of political leaders, who were ready to make certain changes as long as they did not undermine the stability of their power. Meanwhile, these methods

provoked negative reaction both from the reactionary political leaders who did not want any changes in the *managerial* system, or more precisely, who wanted to preserve the blessed regime of Stalin, and from the political circles, which were prepared to create a more flexible economic mechanism, somewhat resembling the mechanism during the time of the New Economic Policy.

Ideology was not, in my opinion, a serious obstacle for the development of new methods of economic analysis. Although these methods threatened to undermine Marxist economic dogmas, the exsiting political mechanism safely protected the accepted ideology. Marxist ideology is quite flexible and, if necessary, it is easy to call black, "white", and white, "black." Soviet leaders are quite cynical and are indifferent to changes in ideology when offered something which can broaden and strengthen their power and at the same time create an outward impression of adherence to the accepted ideology. These leaders did not permit an open criticism of Karl Marx or V. I. Lenin, because these figures had been elevated to the rank of the saints and every word in their writings regarded as holy. But, each of these venerated figures wrote diverse material at different times on different subjects, so that if one wished, he could find statements in their writings which would justify almost any point of view. Picking such a general statement, a scholar could develop his own point of view.

The experience of the development of mathematical methods in economics confirms to a large extent what has just been stated. During these years big investments were made in the development of mathematical methods in economics and in computers. Several research institutes were created responsible for the development of mathematical methods for economic analysis, and foremost among them TsEMI–the Central Mathematical Economics Institute of the Academy of Sciences in the USSR. In many research institutes, both dealing with the national economy as a whole as well as with certain of its branches departments were opened to explore mathematical methods in economics. During these years, a large network of design bureaus were organized in different ministries, specializing in the field of automatized control systems. Naturally, they required economic and mathematical foundations. A network of computer centers was formed specializing in processing economic data ; foremost among them was the computer center of the State Planning Committee.

In the last twenty-five years, a lot was done to train economists and mathematicians who specialized in the field of mathematical economics. A number of specialized departments were formed in certain universities (including Moscow, Leningrad, and Novosibirsk) and colleges. The teaching of up-to-date mathematical methods, especially linear programming, was strengthened for all students of economics.

One of the indications of the increasing role of mathematical economics is the growth in the number of "generals" and "officers" in it. In the USSR, the rank of the "general" is a title that connotes an academician or a corresponding member of the Academy of Sciences. These titles are, first of all, given for administrative activity, but they in turn help in the acquisition of administrative authority. Needless to say, the prestige incurred by such titles allows their holders to exert a lot of influence of the development of certain scientific trends. As a reminder, the first organization specializing in mathematical economics — the Laboratory of Mathematical Methods in Economics — was formed in the

late fifties by the academician V. C. Nemchinov. He did it using his priviledge as an academican, forming an *independent laboratory*.

Among the total number (around 30 people) of Soviet economists who have the title of academicians and corresponding members of the Academy of Sciences of USSR, a substantial majority is not familar, and because of its age is unable to be familiar, with the methods of mathematical economics. This does not mean that they all feel the same way about them; quite the contrary, the range is wide: from the openly hostile to the extremely positive. Among the Soviet economists, after Nemchinov's death in 1965, three academicians, A. G. Aganbegian, N. P. Fedorenko and A. I. Anchishkin came to represent this trend. In past years, certain shifts took place in the composition of corresponding members of the Academy of Sciences of the USSR and such known economists as V. L. Makarov and S. S. Shatalin, who are directly involved in mathematical economics, became corresponding members.

Unfortunately, I am not familiar with the proper statistics. But I can say with assurance that, in past years, there has been a sharp increase in the number of "upper and middle officers" in the field of mathematical economics. I estimate that about 100 doctors of economics (or mathematics) and 1,000 candidates of economics (or mathematics) who specialize in this field were trained. This constitutes about 5% of the total number of doctors and candidates in economics. There are about 10 specialized councils in the USSR in the field of mathematical-economics that are granted the right to award doctorates and candidates degrees.

The organizational undertaking, mentioned above attracted a noticeable number of capable individuals into mathematical economics. First of all, I want to mention a group of talented mathematicians who dealt with "pure" mathematics. It seems to me that the presence of such a group of scholars creates a potential for appearance of new great ideas because pure mathematics allows us to see the deepness and "rethinking" the economic problems. The most important concept in economics in the last four decades were elaborated by mathematicians who have an interest in combining pure mathematical ideas with its applications. I have in mind the *Theory of Games* and the *Theory of Optimal Planning* elaborated accordingly by two outstanding mathematicians J. Von Neumann and L. V. Kantorovich. Kantorovich told me in one of our conversations that the knowledge of functional analysis allowed him in the late thirties to understand the essence of non-classical optimal problems which are used for the representation of an economic system. Meanwhile, in the beginning of the thirties, functional analysis as a branch of pure mathematics was recognized by many mathematicians as a dead end. Kantorovich was among the few Soviet mathematicians who inspite of this opinion intensively studied functional analysis.

The appearance in the seventies in the USSR of several books in mathematical economics written by the above mentioned group of pure mathematicians[3] confirm that these scholars can make an essential contribution into economics. Certainly, these books did not bring revolutionary ideas, but they are essential in the creation of a bridge between pure mathematics and economics.

The picture of the situation of appearance of pure mathematicians in the field of mathematical economics will not be complete if I do not mention the reasons which

stimulated some talented pure mathematicians to join this field. These reasons are mainly linked not to a normal way of development of science but with ugliness of the Soviet political system. One can see among this group of pure mathematicians a great percentage of Jews who as a result of anti-Semitism can not find a job in a specialized mathematical organization which they deserve in accordance with their qualification. A fast developing of a new field, such as mathematical economics in the sixities and early seventies, required capable people and absorbed many of these good mathematicians.

But in any case, their situation was bad because they have felt themselves to be as step-children who have been forced to start a job in mathematical economics while their Russian colleagues have an opportunity to develop their ideas in specialized mathematical institutions. That is why many of these mathematicians reacted positively to the opportunity to emigrate from the USSR which was open to them in the seventies. From TsEMI alone emigrated such brilliant pure mathematicians as A. S. Dynin, E. B. Dynkin, A. B. Katok, B. S. Mitiagin, and B. G. Moishenzon. All of them have been tenured by the best American universities where they have an opportunity to develop their mathematical ideas, and do not have to pay contribution in the form of doing research in economics for the right to continue their research in pure mathematics.

Still, in spite of all the effort exerted on developing mathematical economics, it has not had a significant effect upon the development of the Soviet economy. The implementation of this method was unable to prevent the growth rate of the Soviet economy from falling. I share the view of Professor V. E. Shlapentokh from Michigan State University on this subject that political leaders who supported the trend of mathematical-economic methods have become disillusioned.

The following indirect facts may serve to confirm this. It is known, for example, that the State Planning Committee was always quite hostile in its attitude towards mathematical economics. But still, under the pressure from "above," it was forced to "flirt" with and outwardly acknowledge the expediency of these methods. In the beginning of the sixties, a special department was founded in the State Planning Committee applying mathematical methods to economics. But in the beginning of the seventies it was liquidated, or more exactly, it was made into a subdepartment and merged with the Department of Integrated Planning. The fate of this subdepartment is not known to me ; but recently its chief V. Kosov transferred to another job, and I know nothing of the new chief of this subdepartment.

In the late sixties, a special rubrik devoted to the application of mathematical methods to economics was introduced in the journal, *Planovoe Khoziaistvo*. In 1972, ten articles were published under this heading ; eight were published in 1977. Year 1979 was the last for this topic since only two articles were published that year. In the eighties, although the journal mentions such tools of mathematical economics as production functions and input-output tables, articles with mathematical formalism have totally disappeared as has the general rubic related to the application of mathematical economics.

Even in the sixties, the progressive critics of mathematical economics warned that socio-political reforms are the decisive tools for solving economic problems. They rightly supposed that one cannot expect significant positive shifts in the economy unless the introduction of the market mechanism and the accompanying socio-political institu-

tions such as decentralized ownership, and the removal of the party from the economy takes place. Thus, they considered all hopes of mathematical methods and computers playing role to be technocratic utopia—an attempt to build a golden cage.

If we agree with this criticism of mathematical-economic methods and take it to the limit, then all that was done in the USSR in developing these methods must be considered useless. It seems to me that things are not so simple in this case. In principle, I agree with the statement that without the appropriate socio-political reforms (in particular, creation of a pluralistic mechanism) it is impossible to achieve an effective economic development. But at the same time, without the developed science of economics, which includes mathematical methods, it is also impossible to achieve steadily high results. A characteristic view of many Soviet liberal scholars is that the market does everything automatically. They often confuse *market* with an oriental *bazaar*. Nowadays, the market is a very sophisticated mechanism which may include certain very complex institutions, even indicative planning. It demands knowledgeable participants, especially managers of large enterprises, and workers at governmental agencies which regulate the economy. One can not seriously think of participating in the workings of a market mechanism in a developed industrial society without the knowledge of up–to–date mathematical methods in economics.

If it is still possible, within the framework of the command-style Soviet planning mechanism, to manage the economy on the basis of experience and common sense, although at the cost of incredible losses, one can hardly hope to construct and to exploit successfully a developed economic mechanism without the knowledge of modern economic theory. This theory must combine sophisticated horizontal mechanisms (the market) with the vertical mechanisms (government interference). Therefore, methods of mathematical economics are a *necessary condition* for building a developed socio-economic system. The mistake in understanding the role of these methods was tried either to an *overestimation* of these methods, i. e., taking them to be a *sufficient condition* for improving the mechanism of planning, or to their underestimation, i. e., ignoring their significant role in the foundation and performance of a modern economic system.

Taking what has been said into account, it seems to me that the evaluation of the role of mathematical-economic methods in the development of Soviet economic science, and its practical realization, should be based on creating the *potential* for future socio-economic progress in the country. These methods will become especially important when socio-economic reforms, which allows for rapid growth of economic efficiency, take place. Under these conditions, the necessity of having people educated in economics will become particularly great because the complexity of the economic mechanism will increase considerably. I do not want to deny the practical usefulness of all measures which took place that were meant to improve the Soviet economy using mathematical methods. I only wish to note that their role within the framework of the existing system may not be as important as it would be in the formation and functioning of a more developed system.

2. *Application of Methods of Mathematical Economics during the Past 25 Years*

The following part shall analyze the successes and the difficulties in developing methods of mathematical economics during the last twenty-five years, and examine the

potential for the effective application of a more developed economic mechanism. In analyzing their successes, I want to discuss in great detail the development of economic theory as it was influenced by mathematical methods, together with the difficulties and the problems faced by a wide range of economists on understanding these methods.

The leading concept in the development of economic theory in USSR in the past twenty-five years has been the concept of optimal planning.[4] It included other methods of mathematical economics and most importantly, *input-output tables* which display cases where the number of technologies equals the number of goods and there are no nonreplaceable resources /natural resources. As far as *econometric* research was conceived, it seems at first that it could be used chiefly in a statistical analysis of economic data. At the same time, econometric methods brought forth some ticklish theoretical questions.

The methods of econometrics rely upon extrapolation from past trends or, more precisely, they accentuate the analysis of uncontrolled variables. Therefore, these methods can be used only for *forecasting*, and their applications requires a rejection of goals, i. e., the intentions of the present-day leaders. Harsh criticism of econometrics from this point of view was given early as the thirties, when it became obvious that a plan is not a forecast, not a wish, but a directive, a law compulsory for all branches of the economy, and that Soviet planning must rely not upon extrapolation of past trends of industrial development, but must express the interests of the current leaders (at that time, Stalin) aimed at creating a militarily powerful Russia. Therefore, when, at the end of the sixties, econometric methods of analysis emerged, thanks to B. N. Mikhalevskii and A. I. Anchishkin,[5] to forecast the Soviet economy, a number of conservative Soviet planners perceived in this a threat to directive, goal-oriented planning. In connection with this, I can mention one particular article published as early as the beginning of the seventies by an advisor to the Planning and Finance Organs department of CC CPSU, Iu. Belik, in which he announced his opposition to the mathematical methods in economic forecasting.[6] Nevertheless, these methods of forecasting were used for analysis of the Soviet economy and even played a practical role in long-range planning—an even more significant one than optimal planning.

It is to be supposed that the absence of long-range plans (15 to 20 years) in the Soviet Union in spite of their practical necessity is tied to the notion that an ideological component is very important in these plans. Even in five-year plans one could limit one-self to general statements about the growth of the standard of living and support them with non-obligating figures. In a long-range plan, qualitative development of Soviet economy on the road to communism must be shown. Of course, one could do this by using demagoguery as was done with the long-range plan for years 1961–1980, which was declared to be the program for building Communism in USSR. But in the seventies, more caution was exercised in making a long-range plan because the new leadership was more conservative and relatively less ambitious. Econometric research indicated that an *extensive* growth of Soviet economy, i. e., growth mainly from involving new labor force and capital, could not continue further. The depletion of natural resources at discovered sites, obsolete machinery, and demographic shifts leading to a decrease in the labor force, precluded it. The conclusion of the forecast stated that there is a need to switch to

intensive methods of economic development based on technological progress and workers' personal interest in growth. This in turn requires major reforms in the socio-political mechanism. But in any case, the forecast showed that the level of production in the Soviet Union by the nineties will not exceed that of the United States and other developed capitalistic countries on a per capita basis. These findings have a very negative ideological ring. It turns out that, as progressive a system as Soviet Union considers itself to be at this stage of developed, mature socialism, and already surrounded by socialistic countries, it cannot exceed the economic level of the leading capitalistic countries, which have been for almost 200 years in a state of degradation affected by antagonistic internal contradictions and torn by wars stemming from the egoistical interests of national bourgeoisie.

But let us return to the concept of optimal planning. The aforementioned book by L. V. Kantorovich and also the accompanying work by V. V. Novozhilov and A. L. Lurie[7] present the national economy as a model of optimal planning. Thanks to this model, economists for the first time were given a method of thinking which organically combined, on the one hand, target selection and examination of the structure and amount of the final products as unknown variables, and on the other, available technologies plus the initial endownment of different kinds of resources. Secondly, it was shown explicity that *prices* of good and resources, including labor, natural resources and capital goods, come up in the process of working out a plan and are tools in not only plan formulation but also plan realization. Even now, this type of thinking is unusual for an overwhelming number of Soviet economists.

Of course, these finding from the theory of optimal planning, especially in the works of L. V. Kantorovich and V. V. Novozhilov assumed a "Marxoidian" appearance, which muddied their purity and clarity. I cite as an example a model of optimal planning proposed by Novozhilov, in which the criterion of optimality is given by a function for minimizing total labor input and the quantities of the final goods, have been set as additional restrictions on available resources. These kinds of models create an impression of the Marxist character of prices in an optimal plan, since they are measured in abstract labor. But quite a high price must be paid for this sort of illusion. First of all, this poses an erroneous comeasuring of different kinds of labor, different in its complexity, and reducing them to simple labor. But if this is not done, it will be impossible to construct the criteria of optimality noted above.

The disregarding of the price of labor category in Marxism becomes entrenched in these types of models. An examination of this category allows one to understand the necessity of high wages for high-qualified workers : this is necessary for the correct computation of costs of production of various goods and optimal distribution of labor. It might be necessary, for the purpose of social justice, to redistribute income ; this might be done through a tax system. (Incidentally not only an overwhelming majority of Soviet intelligentsia, but also of Soviet economists do not understand the reason for income tax in a planned economy ; they perceive this as an unnecessary bureaucratic procedure).

In Novozhilov's model, the quantities of final goods are taken as given. Thus, one dispenses with the whole process of searching for the scale of production of the final goods in the process of an optimal plan and the intensity of use of a given technology for

production of a specific product. In Novozhilov's model, only the optimal intensity of a given technology is sought.

During the past twenty-five years, large numbers of Soviet economists who assimilated the ideas of optimal planning continued to develop Novozhilov's model and attempted to construct similar "Marxoidian" schemes.[8] Meanwhile, models of optimal planning and pricing based explicitly on the assumptions of comeasurability of the utility of final goods became wider spread. The appearance of a noticeable number of publications concerning the theoretical analyses of the category of social utility is a confirmation of the last statement.[9]

In the mid-sixties, in place of the *general* model which represented national economy as a problem of optimization, came a model of the Soviet economy as a problem of optimization of a *large* scale system requiring *decomposition* for its solution, and hierarchical representations of the management structure of the Soviet economy. The development of this trend is connected to names like V. A. Volkonskii, L. M. Dydkin, V. L. Makarov, Iu. V. Ovsienko V. F. Pugachev, E. Iu. Fearman, and the author of this article.[10]

The major theoretical contribution of this trend to economic science is a clear vision of how a local criterion of optimality for a given unit on a given level of the hierarchy is linked with the criterion of optimality for the unit of a higher level, and eventually with the global criterion of optimality for the whole system. In particular, it has been shown that such a linkage can be done by using prices. Prices, elaborated at a given level of hierarchy, are used in forming a local criterion of optimality for economic units subordinated to its level of hierarchy; this local criterion is termed *profit*. Meanwhile, the global criterion of optimality for the whole system can be expressed as maximization of the level of people's satisfaction.

These findings let one clearly understand the reasons for the emergence of a developed price mechanism in the Soviet economy. It is caused by the necessity of deconcentrated decisions-making, and of *granting* the choice of selecting the most expedient structure of input-output to the economic units who take into account their own options. This view completely erases the existing theories of the need of forming a price mechanism for the Soviet economy, based on the supposition of its provisional character because of factors such as the presence of two modes of ownership (government and cooperative), different qualities of labor, and so on.

The understanding of the price mechanism, which follows from the concept of optimal planning, prevents one from treating it simply as a synonym of the market. Even today, an overwhelming majority of the Soviet economists are convinced that the price mechanism is outcome of the market, and thus represents an atavism in Soviet planning system. So, categories such as prices and profit are treated as bourgeois categories within the framework of planned economies. I want to note on the side that some western scholars who deal with Soviet economy also make the mistake of attributing to Soviet supporters of optimal planning a closeness to the ideas of the market only because they are guided by the prices and profit in making local decisions. Prices and profit are economic invariants, inherent to any developed economic system. In this respect, planned systems differ from the market systems in the mechanisms of forming these parameters, i. e., whether

they are centralized or decentralized.

This understanding of prices and profit helps one see the danger of strengthening the role of prices and profit without restructuring the price mechanism within the framework of an acting planning system. The use of Marxists schemes to set prices by the government on the basis of the labor theory of value, and using them in turn for making profit the leading criterion for evaluating the work of economic units, can lead to an economic disorder. Unfortunately, the economists supported the 1965 reform and especially E. G. Liberman, while being theoretically Marxist scholars, did not at all understand the danger inherent in their proposals. Economic reform in the Soviet Union was entailed for reasons other than the flaws in the theory upon which it was based. Meanwhile, the ideas of reform are alive, and mainly in the same framework of Marxist principles for forming a price mechanism.

In the seventies, new ways continued to be sought within the framework of the theory of optimal planning. Theoretical work in non-equilibrium economic situations comes closest to the previous work in this direction. It is presented in the remarkable works by E. M. Braverman and V. M. Polterovich.[11] Their work is an attempt to understand how, in a state of disequilibrium, absence of optimal (equilibrium) prices can lead an economy to the optimal (equilibrium) state. Considering the reality of the situation in USSR and the difficulties in applying optimal planning together with its corresponding prices, this kind of research can help in achieving a compromise decision for moving the economy in the direction of an optimal path.

The seventies brought new ideas in the development of the concepts of optimal planning. People realized the limitations of the concept as a result of underestimation of the role of an individual with his own desires and interests in the process of the performance the economic system.[12] For example, the supporters of the concept of optimal planning implicitly assumed that a given economic unit is interested in providing higher units with complete and accurate information about its productive capacities and will try to overfulfill the plan given to it from above. But such statement can not be an assumption: it has to be an inference, if one takes into account the real interests of workers. A group of researchers from the Institute of Problems of Control led by A. Ia. Lerner, made an attempt to construct a non-contradictory system to stimulate workers to disclose maximally true information regarding their internal capabilities to the planning organs above.[13] After Lerner expressed his desire to emigrate to Israel, he was dismissed from his job and this trend did not receive any significant further development. In the work on the optimal planning for the Soviet economy carried out in the late sixties early seventies by E. F. Baranov, V. I. Danilov-Danilian, M. G. Zavelskii, a group working in TsEMI, a major attempt was to strengthen the role of one factor in the model: specifically, to explicitly introduce the interests of people living in a certain region, the migrational flow of labor force, and so on.[14] Unfortunately, the group fell apart by the mid-seventies evidently, due to difficulties in allocating prestige among themselves. I do not know of any serious further work in this field.

Interesting research began to develop to link sociology and optimal planning.[15] Finally, in the seventies, there was a deeper realization of the limitations of the optimal planning approach as a whole. Due to a practical demand for developing specific

programs (such as programs for developing the chemical industry) a question arose as to sufficiency of an optimal plan for solving economic problems. It seemed that having an optimal plan would solve all problems of economic development both in time and in space. Why, then, is there a need for separate programs ? A group of mathematically oriented economists, headed by E. Z. Maiminas tried to answer this question.[16] Although the methodology of this research leaves something to be desired, its value lies in an attempt to find more general means of *efficient* planning, rather than simply optimal planning. It seems to me that sort of attempt is a step forward in the direction of more realistic planning patterns, which take into account the indeterministic character of economic processes. Optimal planning, even if it took the stochastics of economic processes into account, remains within the bounds of a deterministic system. Unfortunately, not enough attention is being paid in Western Sovietological literature to the Soviet research on the field of "effective" planning and this seemed to me to be a disappointing gap.

The eighties, judging from the literature, did not bring any new developments to Soviet economic theory which make use mathematical methods. At the same time, the Soviet invasion of Afghanistan put an end to detente. There is an ideological recruitment taking place in the Soviet Union with a rebirth of emphasis on the U. S., with its ambitions of world domination, as the main enemy of the Soviet Union. This is compounded by a reluctance and inability to carry out any reforms demanded by the stagnating economy. Under these circumstances, an ideological shot fired at the Central of Mathematical Economics Institute by K. U. Chernenko in mid-1983 in his speech at the plenium on ideology constitute an ill-omen of future restriction of the creative development of economic science in the USSR.

3. *The Concept of Optimal Planning as Applied in the USSR*

It is usual to oppose theoretical construction of optimal economic performance with practical results in those cases where these constructions are not built in to some model which can be fed statistical data, and numbers derived from it, to direct economic activities. It seems to me this kind of dichotomy is not justified, as there is a whole spectrum of relations between the two extreme states mentioned above. An important area within this spectrum is the one in which theoretical constructions enrich the intuition of a planner, allowing him to make rough decisions in a reasonable direction rather than exact decisions in a false direction.

Mathematical methods play an important role in this phase. The role of mathematical methods in the development of economic theory is widely known. I just want to briefly mention certain aspects of their application which, in my opinion, are particularly important in determining the views of Soviet planners. First of all, mathematical models permit the *modeling* of the process, i. e., translating some problem within a given system into another *language* without saturating these models with concrete numerical data. Considering the compactness of mathematical language, this linguistic translation lets one see the problem in its *entirety*, to see the relationships of all its parameters. It is difficult to grasp the problem in its entirety given a verbal account, because of its cumbersomeness and impossibility of encompassing the total vision. Moreover, mathematical models guarantee the opportunity of analyzing the *total* picture, i. e., all the dependent and

independent variables in their relationships in the model. It is quite easy to lose sight of this totality given a verbal account.

The presence of these models disciplines the mind since they allow a clear vision of the assumptions which underlie the conclusions. It is typical for Soviet economists to make inferences without clearly stating the assumptions under which they are correct. Of course, Soviet economists are not the only ones to have the "privilege" of thinking this way : it is a trait common to all mankind. But it is a question of degree : compared to physicists or even biologists, economists are less accustomed to the correct relationship between assumptions and conclusions.

What I have said about modeling processes on mathematical language can be further realized in elegant deductive constructions which, having a small number of assumptions can lead to a variety of different conclusions. Together with S. M. Movshovich and Iu. V. Ovsienko, I have tried to construct a dynamic optimization model of the economy based on a relatively small number of assumptions, and to extract from it as inferences a variety of different economic categories (rent, depreciation, prices of durable and non-durable goods, price of labor and so forth).[17] At the same time, this model allows us to show how all these categories are interrelated in financial currents which accompany the transformations of resources and products in physical term.

Finally, I would like to turn my attention to an important aspect of the use of mathematics in economics : the possibility of constructing mechanisms of economic performance based on translating various algorithms for solving economic problems from the mathematical to an economic language. The success reached in writing algorithms for solving large-scale problems, based on the principle of decomposition, permits to a large extent imitation of a hierarchical management system so characteristic of the Soviet planning system. Availability of a variety of algorithms allows us to assume a corresponding variety of patterns of planning and plan implementation.

Because of what I have said about the role of mathematical methods in enriching the intuition of the planner, I do not want to downplay the role of these models in practical application (in the sense of feeding them with data and preparing for computer analysis). Various parts of the spectrum of theoretical constructions can be combined in the management system. A certain part of a spectrum can be used within a corresponding part of the management system, and then they can be combined together. This is how a designer of large system operates. His genius, enriched by theoretical knowledge, allows him to develop a concept of the given construction of, for example, a bridge. Its separate parts, if they are developed enough, can be described by a model and calculated. The synthesis of the whole system belongs to the designer.

Thus, the practical applications of the theory of optimal planning could, first of all, affect the leading planners as far as enriching their intitution is concerned. In particular, the work[18] mentioned above, serves this purpose, since it gives a general picture of financial and in physical terms goods flow in an optimizing economy, and allows these planners to see how their intuitive decisions can be coordinated among themselves. For example, if we introduce rent on natural resources at this point, intuitively setting its value, then we can see how this would affect the prices of goods and how the revenue portion of the budget would change. Thus role of taxation might have to be reduced in

order to maintain simultaneously the guiding role of price and guarantee coodination between the financial flows and the "motion" of resources and products.

Meanwhile, the practical application of the theory of optimal planning was understood primarily as a formalization of economic processes, plugging numbers into the models, and running them on computers. Considering that the existing economic mechanism resist the implementation of these models, then, even in those cases people succeeded in building such practical models; the system rejected them as if they were a foreign body. Much has been written about this in the literature, and I am not going to bother with any examples.

Unfortunately, very little was also done as far as enriching the intuition of the heads of ministries and State Planning Committee with constructions stemming from the theory of optimal planning. This was so even in the Academy of National Economy—the institute for teaching Soviet top-level managers, in which vice-ministers, leading CC CPSU workers, etc. study full time for several months. Even here, the ideas of optimal planning were reduced mainly to explaining the methods of formulating and solving specific optimization problems.

Speaking about the application of mathematical methods to Soviet economic research, one could say that, in general, in spite of great effort to implement them, an overwhelming majority of Soviet economists suffer from "math phobia." Up until now, Soviet economists are divided depending on whether they do or do not use *formulas* in their work.

In the beginning of 1984, the Soviet journal, *Economics and Mathematical Methods*, published an article by the administrative head of the field of mathematical economics, N. P. Fedorenko.[19] This article summarizes certain results of the development in this field. The necessity of him having to justify the expediency of these methods and elucidating their basics shows how little these methods have disseminated.

The new economic ideas accompanying mathematical methods of economic analysis have had little effect on the range of economists or even the leading economists in their most active middle years. The evidence for this, in particular, is the round-table discussion on ways of perfecting the Soviet economic mechanism organized by the journal, *Economy and Industrial Organization*, in 1983.[20] Leading Soviet economists, alongside with practitioners took part in this discussion. Reading reports of this discussion, one feels once again that the categories used in conceptualizing the problems remain old-fashioned both in form and in content. All this is in spite of the fact that the organizer and the leader of this discussion was head academician A. G. Aganbegian, who is familar with mathematical methods of economic analysis.

What were the reasons for such a poor absorption of the theoretical constructions of optimal planning by the institution of Soviet economists ? One could name as one of the reasons the practicality of both scholars and workers and a limited vision in the field of optimal planning, a vision which narrowed the borders of practicality to numerical models. Also important is the opposition to new ideas put up by the great majority of traditional economists who are unable to master them. This opposition is quite strong, as the teaching of economic theory is done everywhere through textbooks on economics which are completely based on the obsolete Marxist dogmas. Up until now, there is no new

textbook in economics written on the basis of the concept of optimal planning.

All reasons are well known. But I would like to discuss in greater detail inherent difficulties in the cognitive process when dealing with new economic ideas. It seems to me that the difficulty is in the complexity of assimilating these methods by common sense. First of all, it is a typical form of common sense to analyze a problem at a high level of excessive information, *redundancy* given by its verbal description in economic language. Meanwhile, mathematical language is very concise and requires great concentration of effort for precise formulation. Formalism provides a language for such a precise expression of thoughts. Taking into account the fact that, for a long time, the study of economic disciplines in the Soviet Union was to a large extent cut off form the formal descriptions of economic processes, it becomes obvious how difficult it must be for the Soviet economists to deal with sufficiently developed mathematical models. This condition is greatly aggravated by the fact that it is easier for common sense to perceive *disjointed* sets of assumptions and conclusions corresponding to each one, rather than the total vision of the aggregate of assumptions, and appropriate the resulting conclusion based on their conceptualization. This last circumstance is especially important for understanding the concept of optimal planning. In this concept, the distribution of resources and price setting interweave organically, i. e., the price is a tool for the composition of a plan and its implementation. But, for common sense, it is easier to treat a *plan* as a process of resource allocation and separately prices as an expression the cost of production.

So, 25 years passed since the publishing of L. V. Kantorovich's book, *The Best Use of Economic Resources*, a book which signaled a revolution in the development of economic science in the Soviet Union. With all its limitations, the concept of optimal planning was a major step forward on the development of Soviet economic theory. Although, as I have already mentioned, this theory can not claim to have greatly affected changes in Soviet economy, it can further the development of economic theory and might play a significant role in future improved socio-economic mechanism. Meanwhile, by the mere fact of its existence, it could have greatly stimulated the development of economically educated specialists. But this did not happen.

Not so long before the publishing of Kantorovich's book, I had a conversation with the author. We discussed questions of possible reforms to Soviet economic science and management practices. Kantorovich thought that the existence of ideas of optimal planning, and "citizenship" rights which they would receive, will be enough to greatly change the state of Soviet economic science within five to seven years, to capture the hearts of most economists and planners, and to convert them to the new faith. The basis for such a statement is a notion that the ideas of optimal planning are obvious and logical, and that it does not require any special mathematical knowledge in order to understand the procedure of composition of an optimal plan and its implementation by means of prices. And even Kantorovich's book itself (except for the mathematical appendix) is written in such a way as to allow any unprejudiced reader, who knew the four arithmetic operations and was inclined to logical thinking, to be persuaded that Kantorovich's construction was correct and the most adequate ones for the nature of planned socialist economies.

I expressed my skeptisism concerning the time needed for economists to accept

Kantorovich's ideas, and mentioned a period of two generations. Slightly more that one generation has passed, and it seems that I was an optimist. There is a joke going around in the Soviet Union that "a pessimist is a well-informed optimist." It looks like I was not sufficiently informed to predict a more realistic period for radical changes in Soviet economic science under the influence of the ideas of optimality, not mention the broader and deeper concept of an indeterministic approach.

Notes

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