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MARX, KANTOROVICH, AND NOVOZHILOV: *STOIMOST'* VERSUS REALITY

BY ROBERT W. CAMPBELL

Like other aspects of Soviet life, economics has been revivified by Stalin's death. The most visible part of its reawakening has been an extensive discussion of, and experimentation with, institutional arrangements, though even questions of strategy and basic policy have also been exposed to an unwonted amount of free discussion. The real measure of this freedom, however, is that the search for theoretical clarification, which inevitably accompanies discussion of practical issues, has been allowed to develop in a way not permitted since the late twenties. One aspect of this dramatic change is the controversy which has developed around the use of mathematics in economics. After long aversion to any introduction of mathematical reasoning into analysis of economic relationships, the Russians are now thinking about the possible usefulness of input-output techniques in balancing supply and demand and in price planning and about the application of linear programming to enterprise planning, and have begun to resort to mathematical models to explore the abstract essence of practical problems.

The expectation was that mathematical economics could be borrowed from the capitalist world just as implements and techniques are. One of the common themes in the post-Stalin discovery of what economists in the capitalist world have been up to is the need to sort out the usable from the nonusable, and to purge mathematical methods of their bourgeois interpretations before they are applied in the Soviet economy. As one might expect, hopes for such an antiseptic transfusion are likely to be disappointed, and even the beginning of Soviet work on mathematical techniques has led to a search for clarification of the theory of value. Mathematics and computers in themselves are ideologically neutral; but the mathematization of any science implies measurement, and in economics the unit of measurement is value. Hence, as one of the participants in the controversy has said, understanding how to measure value is basic to all practical problems of calculation. But progress toward an improved explanation of value

MR. CAMPBELL *is associate professor of economics, Indiana University.*

and an understanding of its connection with the problem of allocation will require Soviet economists to free themselves from the limitations of Marxist theory. In fact this emancipation has nearly been accomplished already in the writings of two of the participants in the discussion of the use of mathematical methods in economics, L. V. Kantorovich and V. V. Novozhilov. Thus apart from its manifest content, the term "mathematical methods in economics," which is bandied about so freely by Soviet economists, has also become a euphemism for a new theory of value. The present article describes this search for a new theory of value.

Deficiencies of the Labor Theory of Value

As an introduction we must review briefly the divergent histories of the mainstream of world economic theory and Marxism. The basic theory of economics has come of age only in about the last half century. In this period the bits and pieces, the partial insights of earlier years, have been integrated into a unified general theory. Marxist economics, on the other hand, has spent this period marking time in a blind alley, to use a favorite Soviet metaphor. Marxist value theory broke away from the tradition that prevailed in the time of Ricardo, and has missed out on the great scientific success of generalization and unification which has taken place in Western value theory since then.

The nature of this achievement can be explained as follows. One of the central preoccupations of economics has always been what determines price. Movements of foreign exchange rates, the distribution of income among social classes, changes in the general price level, and so on, all involve questions of relative prices, how much one thing is worth in terms of others. Hence the search for a general explanation (i.e., theory) of value has always occupied the center of the stage. The practical questions that economists have struggled to unravel have always led back to this as the basic theoretical problem to be solved. During most of the nineteenth century no consistent and satisfactory explanation was offered. There were cost theories and utility theories, to mention only one dichotomy, and any one theorist might well try to embrace several different theories and use them in different parts of his book for different problems. Ricardo, for instance, has two theories of value—one for the value of land, and another very different one for the value of everything else. The reconciliation of all these conflicting partial explanations into a unified general theory of value came only in the late nineteenth century with the concept of general equilibrium and the reduction of all explanations to the common denominator of utility by the writers of the utility school.

In the process, it also came to be understood that the explanation of value is only one aspect of the central problem of economics. The question of relative prices is inextricably intertwined with the explana-

tion of relative quantities. Indeed the reconciliation and integration of all the conflicting parts of value theory as it had previously existed was made possible only by widening the perspective to take in the question of what determines the proportions among different kinds of output along with the question of what determines value. One reflection of this new insight into the problem of value was the formulation of a new definition of economics, the one commonly used today, as the theory of allocation of scarce resources among competing ends. This definition slights the value aspect of the problem, but its rapid adoption was a response to the profound insight that economic theory must explain not only value but also quantities and the interdependence of both these sets of magnitudes.

It was this achievement that the Marxists and their Soviet intellectual heirs missed out on. The Russians retain, through Marx, ideas about value extant at the time of Ricardo. Marx took the theory of value as it then existed, and compounded from some of its confusions a theory of the dynamics of the capitalist system. (It might be more accurate to describe the process the other way round: Marx had the conclusions and was trying to show how they flowed rigorously and inevitably from the theory of value then generally accepted. With the benefit of hindsight we may look back on his effort as a *reductio ad absurdum* technique for proving the deficiencies of Ricardian value theory.) Thus the bondage of a Marxist heritage in economic theory is not so much that the Marxist view is simply wrong in one particular (i.e., that it assumes that value is created only by labor) as that it does not comprehend the basic problem of economic theory; it has not achieved a full understanding of what a valid economic theory must illuminate. That achievement came in the mainstream of world economic theorizing only after Marxism has already taken the turning to enter the blind alley mentioned above.

This isolation of Marxist economic thinkers from the rest of the intellectual community has not been natural or easy to maintain. Marxist groups have had to wage a constant struggle to preserve the sanctified shortcomings of their economic doctrine against the encroachments of greater sophistication, but they have considered it important to do so because of the central place that the labor theory of value holds in the Marxist theory of the transition from capitalism to socialism. The stagnation of economic theorizing within the Marxist tradition of economic thought has resulted in an irony often commented on. The Soviet planned economy, in which the efficient allocation of resources to achieve competing goals is a constant preoccupation, has muddled through with no body of theory to explain the implications of actual and potential choices. It must seek its guidance in a theory which not only misunderstands value but which does not even envisage the question of value as having any connection with rational allocation.

This is a supremely unsatisfactory situation, full of tension. As explained above, in the market economy the notion of describing an optimal allocation of all society's resources was essentially an abstract construct, imagined in the process of integrating all the bits and pieces of economics into a theory of choice and value. The social necessity for such an allocation among the competing ends is not self-evident to the individuals in Western society, where the allocation results from the impersonal operation of the price system. In the Soviet economy, on the other hand, the allocation of all society's resources among alternative uses is a highly visible and operational process, which calls out for some sort of theoretical conceptions to clarify and inform the manipulation of it. At the same time a strong motive to find a unified theory of economics grows out of preoccupation with questions of measuring cost and value. Despite central planning there is still a tremendous need in the Soviet system for decentralized calculation of benefits and gains among alternatives, and these calculations must always be cast in terms of some common denominator of value. At the micro-economic level the Russians are engaged in a quest for what they call "effectiveness," but their efforts to calculate effectiveness always founder on the inadequacy of their understanding of value and how it is related to the problem of choice in its allocation aspects. This is clearly an unstable situation; the practice of planning calls for theoretical guidance which Marxist value theory is incapable of providing. Economic theory bears the same relation to planning that physics does to engineering. It provides a model of concepts and interrelations that makes it possible to comprehend the dependence of consequences on other variables as a prelude to manipulation. When Soviet planners seek such insight in Marx, they are not likely to find anything relevant, or if they find something on the subject, it is likely to be misleading. What is needed is some way of seeing the process whole—a vision that makes clear the interdependence of the problem of allocation and the problem of value.

Failing to find such a vision in Marx, practical planners in the Soviet Union are continually trying to make one up for themselves. There are innumerable instances in which planners in some corner of the economy are rediscovering some of the basic ways of economic reasoning, figuring out for themselves some of the basic ideas of value and allocation. It was surely inevitable, for instance, that electrical engineers and mining engineers would come to realize that the condition for efficient allocation of a program among production units working in parallel is equality of marginal cost.[1] Those who are called on every

[1] Such propositions are developed, for instance in В. М. Горнштейн, *Наивыгоднейшее распределение нагрузок между параллельно работающими электростанциями* (Moscow-Leningrad, 1949) and Н. В. Володомонов, *Горная рента и принципы оценки месторождений* (Moscow, 1959).

day to decide how far to carry the substitution of capital for labor in designing production facilities quickly come to realize that there must be a limit, and common-sense considerations soon suggest what the nature of that limit is. The difficulty is that these creative responses by individual thinkers have never coalesced into a general theory of allocation and value on the scale of the entire national economy, and that is what is needed. The failure to achieve such unification has been due partly to the fact that the theorists to whom this responsibility is allotted in a modern specialized society were hobbled by Marxism, and such generalization would inevitably contradict some of the Marxist simplicities. Moreover, the task of generalization and integration is probably more difficult than the development of partial theories and explanations.

The seminal works on the problem of value and allocation by V. V. Novozhilov and L. V. Kantorovich originated in precisely the way we have described, as efforts to deal with partial problems of calculation. Novozhilov is an economist who at one point tried his hand at the problem of rational criteria for investment choice, with which Soviet economists have long struggled. In trying to set out conditions for maximizing the effectiveness of investment expenditures, he found that no answer could be given except as part of the answer to a larger question of criteria for the effective allocation of *all* resources. Kantorovich, who is really a mathematician rather than an economist, was drawn to the problem when he was asked to solve a highly specific, parochial, and actually insignificant problem of allocation. But in bringing to bear the broad vision of a mathematician upon this problem of allocation within a limited framework, he discovered concepts and operations for clarifying the whole problem of value and resource allocation on a national economic scale. In making these advances, both men inevitably came into conflict with the labor theory of value as developed by Marx, and this is the revolutionary and controversial feature of their work.

The Objectively Determined Valuations of Kantorovich

The development of Kantorovich's thought can be briefly summarized as follows. In the late thirties, the Plywood Trust in Leningrad asked the help of the Institute of Mathematics and Mechanics of Leningrad State University for help in solving a production-scheduling problem. The Trust had several different kinds of machines for stripping logs for plywood, and the machines had different productivities, in terms of volume of logs handled, depending on what kind of logs were to be handled. The proportions among the different kinds of logs to be worked on the machines were given, and the problem was to assign the different kinds of logs among different machines so as to make possible the maximum throughput per unit of time, or in other words to maxi-

mize the productivity of the machines. Kantorovich was asked to help find the solution to this problem.

It is logical enough to appeal to a mathematician for help in such a problem. There is a whole branch of mathematics concerned with just the problem of finding *maxima* and *minima* of interrelated variables under specified conditions. But when the problem of the logs and machines was formulated as the maximization of a function subject to certain conditions, it was not the kind of problem that could be solved by the traditional methods of analysis. This did not mean that it was insoluble but that some practically usable technique for finding the solution had to be worked out, and this is what Kantorovich did.[2] His method involved a modification of the use of Lagrange multipliers of traditional analysis to the needs of the problem as he had formulated it. The multipliers could be found by an iterative process, and once found they could be used to find the solution of the problem. That he happened to stumble on this technique for solving the problem was purely an accident. The whole class of linear programming problems, as this kind of problem later came to be called, were rediscovered in the United States, but were solved here at first by a different approach called the "simplex method."[3] That Kantorovich happened on this particular technique, however, was of great significance, since the multipliers he employed turned out to have the same significance as prices in Western value theory, and his trial-and-error search for them an analogue of the process of price determination in a market economy. At the time, Kantorovich thought of these multipliers as simply an intermediate step in the process of finding the set of variables he was interested in, that is, the allocation of log types among machines to maximize throughput. He did note that the multipliers had some significance in relation to the problem: they represented certain trade-off possibilities that one might wish to consider in making decisions about the allocation involved. However, it seems quite clear that he did not then realize the broad significance of these multipliers as indexes of value.

As is widely known, this discovery was almost completely neglected in the Soviet Union. Such a fate is somewhat difficult to understand. Besides solving the specific problem of the Plywood Trust, Kantorovich had remarked that a great variety of production planning problems could be cast in the same form and hence would be amenable to solution by the same means. Moreover, he made no little effort to pave the

[2] His explanation of his approach is in *Математические методы организации и планирования производства* (Leningrad, 1939). This has been translated and published as "Mathematical Methods of Organizing and Planning Production," in *Management Science,* July, 1960.

[3] For a history of linear programming and an explanation of its relationship to traditional value theory, see Robert Dorfman, Paul Samuelson, and Robert Solow, *Linear Programming and Economic Analysis* (New York: McGraw-Hill, 1958).

way for the widespread application of linear programming to practical problems. The original publication contains a classic defense of abstract theorizing in the form of a rebuttal to all the objections that he supposed "practical" people would make to the mystifications of a mere mathematician. He also took pains to describe a wide variety of situations faced every day by Soviet planners where his method could provide useful guidance; and the Institute sponsored several conferences to bring together mathematicians and planning personnel to explore the feasibility of such practical applications.

Nevertheless, Kantorovich never succeeded in arousing much interest, although he apparently continued to work on linear programming. There is a short list of articles on the subject,[4] which appeared during the forties, but it seems doubtful if more than a handful of Soviet economists had even heard of Kantorovich up to the early fifties.

In the meantime, linear programming was rediscovered independently in the United States a short while after Kantorovich's original paper. In sharp contrast to the Soviet history, it quickly found wide application in practical problems of production planning in the United States, and was also quickly reconciled with and assimilated by the body of traditional economic theory. Ironically, one can find in the extensive literature outside the Soviet Union practical applications illustrating all those potential uses which Kantorovich had pointed out in his pioneer article.

Despite the lack of interest in his discovery, Kantorovich apparently continued to think about its applications and about its general economic significance. When the Soviet infatuation with mathematical methods in economics after Stalin's death had finally made the climate right, Kantorovich was rediscovered as a Soviet pioneer, the original inventor of linear programming. The Academy of Sciences published a full length book by him entitled *Economic Calculation of the Optimum Utilization of Resources,*[5] in which the method and its implications for value theory and for allocation are explained.

This is a remarkable book. The title itself represents a significant advance, betraying as it does a focus on the problem of the allocation of resources. What distinguishes it from the earlier work is that in it Kantorovich has now fully recognized the significance of his multipliers as indexes of value, and that he has integrated the theory of value and the theory of allocation. This vision is boldly proclaimed by relabeling

[4] These include Л. В. Канторович, «О перемещении масс,» *Доклады Академии Наук,* No. 7-8, 1942, Л. В. Канторович, «Подбор поставов, обеспечивающих максимальный выход пилопродукции в заданном ассортименте,» *Лесная промышленность,* No. 7, 1949, and Л. В. Канторович and М. К. Гавурин, «Применение математических методов в вопросах анализа грузопотоков,» in the volume *Проблемы повышения эффективности работы транспорта* (Moscow, 1949).

[5] *Экономический расчет наилучшего использования ресурсов* (Moscow: Издательство Академии Наук СССР, 1959).

the multipliers of the earlier work as "objectively determined valuations" (*ob"ektivno obuslovlennye otsenki*). The term is an artful invention. It not only goes as far as one may with propriety in a Marxist society toward saying that these multipliers actually express value, but it also symbolizes the integration of the value problem and the allocation problem. He calls the values "objectively determined" because they are uniquely defined by the conditions of the problem. The allocation of resources which maximizes (or minimizes, depending on the nature of the problem) the variable of interest is consistent with only one set of values for the multipliers. Kantorovich does not use the word *stoimost'* to describe his indexes of value since that term has already been pre-empted by orthodox Marxist value theory. Nevertheless he is perfectly clear on the point that "value" in any meaningful sense is defined by his *otsenki* rather than by *stoimost'*.

The new book contains much else in addition to this basic discovery. Kantorovich has used his method to deal with problems of capital allocation, and he has long sections developing the proposition that the familiar deficiencies of *khozraschet* (which we can define for our purposes here as the technique of administrative decentralization in a centrally planned economy) can be overcome if the objectively determined valuations are substituted for the kind of prices, based on bookkeeping costs, that the Russians now have. His *otsenki* reflect not only the cost aspects of value but also the demand aspects, and their use will therefore discourage those characteristic irrationalities of the Soviet system in which a producer is tempted to do something that looks cheap but is actually a waste of scarce and valuable resources, or to do something that seems very productive but really produces something not vitally needed. In short, Kantorovich has reconstructed most of the significant propositions of the body of production theory previously developed in the West, though in the modern linear programming form rather than in the traditional form which assumed continuous differentiable production functions. And in contrast to the neglect of his earlier work, his ideas are now being widely disseminated not only by the book, but also through articles, papers at conferences, and educational programs for training young economists in the new mathematical methods.

Novozhilov's Theory of Value

The second contributor to the renaissance of economic science in the Soviet Union, Novozhilov, also arrived at general conceptions of value by way of a limited problem of resource allocation—the capital allocation problem. The history of that problem cannot be recapitulated in detail here, and the reader is referred to the paper by Grossman.[6] The

[6] Gregory Grossman, "Scarce Capital and Soviet Doctrine," *Quarterly Journal of Economics*, August, 1953.

basis of the controversy over capital allocation was that ideological difficulties were encountered in any attempt to formulate practical rules for deciding how far Soviet designers should go in substituting capital for labor in designing new products, new plants, and new processes. Any workable rules necessarily implied the productivity of capital, a proposition in conflict with the labor theory of value. Moreover, there was a danger of getting involved in the question of the proper division of investment between the consumer-goods and producer-goods industries. The subject was therefore politically as well as ideologically treacherous, and after a short flurry of discussion in the twenties, most economists carefully avoided it. Novozhilov published several papers in which he tried to find an approach that would avoid both these dangers.[7] Actually his basic proposition concerning the theory of value and allocation were developed in these early papers, and his more recent publications contain only restatement, extension to additional problems, and mathematical demonstrations. Nevertheless, we will take as the text for the following discussion one of these more recent papers, "The Measurement of Expenditure and Its Results in the Socialist Economy," published in 1959.[8]

This paper is a wonderful document. It has great appeal to a Western economist as a vicarious rebuttal of all the traditional nonsense of Soviet economists. Novozhilov goes unerringly to the point, with pithy comments on the sterility of the clichés with which Soviet economists treat problems of value and allocation. The following paraphrase of his introduction gives the tone of the whole paper:

One of the most important problems of our economic science today is the problem of measuring the expenditure and results of socialist production. In fact, that is the main problem. It is natural that much attention is devoted to the methods of economic calculation. There are many books and articles on the subject and not a few conferences have been concerned with the discussion of this question. However, all this huge effort has not yet led to a solution of the problem. The confusion stems from the absence of a correct methodology of measuring expenditure [i.e., the absence of a correct theory of value]. In practice our planners have found it indispensable to make adjustments in the value magnitudes they manipulate in order to avoid absurd conclusions. My objective in this paper is to reconcile theory and practice and to improve the latter through clarification of the theory.

His answer to the problem of how to measure cost is a theory of

[7] В. В. Новожилов, «Методы соизмерения народнохозяйственной эффективности плановых и проектных вариантов,» *Труды Ленинградского Промышленного Института,* No. 4, 1939, and «Методы нахождения минимума затрат в социалистическом хозяйстве,» *Труды Ленинградского Политехнического Института,* No. 1, 1946. These two papers have been published in translation in *International Economic Papers,* No. 6, 1956.

[8] «Измерение затрат и их результатов в социалистическом хозяйстве,» in the volume *Применение математики в экономических исследованиях,* ed. В. С. Немчинов (Moscow, 1959).

value based on "opportunity cost." That is, it takes account not only of the labor used in the production of a commodity but also of other resources used, such as land and capital, on the grounds that these are limited in supply, and that their use in the production of one good means that they cannot be used to save on the labor required for the production of some other good.

He begins by formulating the general task of calculation in the socialist economy as one of maximizing the effectiveness of labor, by which he means producing the national output with as little labor expenditure as possible. However, this is not possible just by minimizing the labor cost of producing each component of the total output separately. The problem is that in addition to the direct, obvious labor input into each good there is a second kind of labor expenditure, which he describes as "inversely related expenditures of labor" (*zatraty obratnoi sviazi*). This concept is identical with the concept of opportunity costs. These originate in the circumstance that there are some kinds of input that are in short supply in any given planning period. If the labor input into a particular product is minimized by substituting these scarce inputs for direct labor, then the labor cost of outputs elsewhere in the economy will rise in consequence. To reconcile the local efforts to minimize the cost of each good separately with the objective of achieving the minimum labor input for all output taken together, these inversely related costs must be taken into account. To make this possible, it is necessary to have a measure indicating the effectiveness of each scarce input in saving labor. If these costs are known, then they should be taken as the appropriate price tags for such nonlabor inputs in economic calculation. Thus all partial decisions aimed at minimizing costs will take into account not only direct expenditures of labor but also the indirectly related expenditures of labor, and the totality of partial efforts at cost minimization will be consistent with the aim of minimizing the labor input for all output taken together. He later on develops a mathematical proof for these assertions, and before he is done he has shown how the allocation and value problems interact. Value is something that cannot be determined just by accounting; it emerges only from the problem of allocating resources optimally.

All this is perfectly familiar to economists outside the Soviet Union, except for the formulation of the problem as one of minimizing the labor input required to produce an assigned program of total output. The Western economist would formulate the problem as one of finding the values coincident with maximizing the output from given resources. The formal essence of the two problems is identical, but Novozhilov's approach permits him to avoid analyzing what determines the proper assortment of final output, and also expresses all his values (including the inversely related expenditures) in terms of labor inputs, thus preserving an appearance of Marxist orthodoxy.

Armed with a competent conception of value, Novozhilov vanquishes a good share of the problems that confuse the Soviet planner and economist. With a mere flick of this powerful weapon he parts those Gordian knots that Soviet economic theorists have worried fruitlessly for three decades. How can the comparative performance of enterprises in unlike circumstances be compared? Charge for the differential advantages that some enjoy! How stint the importunate demands of project designers for "deficit" good? Price goods not at *stoimost'*, but at their opportunity costs! How maximize the effectiveness of investment resources? Suffer them not to be used except where the returns justify their opportunity costs! How should a socialist society reckon with obsolescence? Novozhilov's answer is not the customary twenty pages of twaddle, but a few short paragraphs directed faultlessly at the essential issues.

Altogether it makes exhilarating reading for a non-Soviet economist, and one suspects that most Soviet students would have the same reaction. This is not to say that Novozhilov never stumbles. His theory of value has the fundamental deficiency of dealing with value only as it reflects production constraints, and when he approaches a problem such as the proper rate of accumulation or the proper choice of output mix, his concept of value is of little help. In these passages, in contrast with other sections of the paper, there are no mathematical formulas, and even his vocabulary—terms like welfare, wants, useful results—becomes fuzzy. It lacks analytical power since it is not infused with meaning drawn from his theory of value. It does not necessarily follow that he does not understand these issues. His vagueness may only reflect discretion.

With so much accomplished, what remains to be done? Have not the Russians overleaped a century of Western thought and made good at last their cultural lag in the science of economics? That would be too sweeping a judgment, as we shall see in a moment, but certainly these two works represent a great achievement. Kantorovich and Novozhilov have shown convincingly that other things besides labor are scarce, and that the problem of value and the problem of allocation are inseparable. They make it clear that value is not something metaphysical, as Marx made it, but that what something is worth is clearly defined as an index of its scarcity in relation to objectives. What are the prospects for the success of this revolution?

The Response of Soviet Economists

It is too early to predict with assurance whether these innovations in the theory of value will be able to make their way into Soviet economic thought and teaching. There are, however, very strong factors favoring their survival. Much damage has been done just in the opportunity allowed for their expression; once Soviet economists have had a chance

to ponder them, they can scarcely be rejected except by arbitrary repression. If these innovations are as unorthodox as we have argued, then one might hold that such must be the outcome. But the counterargument is that heretical though sophisticated value theory may be, it is wonderfully useful, like traditional logic and quantum mechanics. Hence there must be strong pressure on Soviet economists to gain an understanding of it, even though the novices in those secular seminaries, the economics and philosophic faculties of universities, may still be required to learn by rote the old catechism.

In the meantime Soviet economists are not willing to be converted without at least a protest. Kantorovich's book contains a foreword by Academician Nemchinov, expressing strong reservations about some of the implications Kantorovich draws. Similarly the reviews of both men's works in the authoritative economic journals have been unfavorable. However, the most interesting thing about this criticism is that the critics seem to understand very well what Kantorovich and Novozhilov are doing. The new theory has been given competent, if reluctant, sponsors for its debut. They have done their homework well and have thoroughly grasped the logic of the new approach. Their reactions reflect the difficulties of dealing with this threat to orthodoxy. Nemchinov agrees that the objectively determined evaluations and the inversely related expenditures are useful concepts, acceptable when kept in their proper place, as techniques for solving particular production problems. The main theme of his protest is that the temptation to find a more general significance in them must be resisted. The novel concepts have nothing to do with value, but are just a special kind of indicator used in a technical problem. Nemchinov is embarrassed by Kantorovich's intransigence in openly labeling his numbers as objectively determined valuations, though he sees perfectly well that this is precisely what they are. In fact he is sufficiently convinced that he equivocates in his denial of their general significance, and in the end does not really deny the possibility of their extension to an economy-wide framework but only says that such applications have not yet been worked out. In evaluating Novozhilov's work he is much comforted that labor remains the *numéraire* for all elements of Novozhilov's measure of value, but is upset by the problem that in Marxist theory rent-like elements (which is one way to describe the opportunity costs) have nothing to do with value but are only a distributive category.

Boiarskii, too, in the review in *Planovoe khoziaistvo*[9] seems to see the truth of Kantorovich's arguments, but also sees that they lead to the wrong conclusions. His review has a schizophrenic air. The first part is devoted to explaining the ideas and praising the practical usefulness of linear programming. But in the second part he says that the book

[9] А. Я. Боярский, «О математических методах и требованиях экономической науки,» *Плановое хозяйство,* No. 1, 1960.

demonstrates the danger of turning a mathematician loose to deal with issues that Marxist economic science has already settled. The real conclusion of his review seems to be that there is nothing wrong with these theories about the proper allocation of resources except that they lead to un-Marxist conclusions about the measurement of value. Boiarskii is never able to explain, however, where Kantorovich got off the track toward something useful and arrived at something harmful.

The review by Kats in *Voprosy ekonomiki*[10] also exudes intellectual distress. He begins with praise, but is then at such a loss to explain what is wrong with the mathematical approach that he is obliged to resort to all sorts of irrelevant and ridiculous criticisms. For instance he complains that it is a weakness to take the composition of output and the amount of resources as given, but as will be explained below, that is one of the ground rules imposed by the Soviet setting. The reasons for the distress are obvious. The only refutation would be to say that the assumptions are wrong or that the mathematics is wrong. For instance, it might be denied that factors other than labor are in short supply or that they can be substituted for labor. (This is indeed the implicit difference between the Marxist conception of value and better ones.) But such a criticism would outrage common sense. It is hard to see how the reviews could be otherwise, of course. Reviewmanship is an exacting art in the Soviet Union, and one of its first rules is to evaluate the conclusions rather than the logic of an argument.

What is really subversive about Kantorovich and Novozhilov is that they are right, and to allow them to propagate their views is to give them the victory. They have formulated the problem, found the solution, derived the corollaries, and all one can do is challenge either their formulations or their mathematics. It is disquieting to good Marxists to see such concepts as rent, returns for capital, and opportunity costs emerge as implications of assumptions with which they cannot quarrel, but this unpleasantness is no refutation. The only protection is to bar mathematicians from the temple. Once they are allowed intercourse with the rest of the intellectual community, they have a tremendous advantage. The veneration of science in the Soviet Union confers great prestige on mathematics, which is after all, the "queen and servant of science." Kantorovich is by all accounts an unassuming, even diffident, man, but shielded by mathematics he has shown no hesitation in pressing his attacks on existing Soviet value theory. At the recent conference on the use of mathematics in economics he replied quite boldly to his critics. Nemchinov in his closing remarks at the conference made a point of rebuking Kantorovich for upsetting the "creative and comradely spirit" of the conference by

[10] А. Кац, «Экономическая теория и применение математики в экономике,» *Вопросы экономики*, No. 11, 1960.

"underestimating and deprecating the work of Soviet economists."[11] Just what Kantorovich had said to merit this rebuke is not revealed, but it is well known that he considers Soviet economic theory mostly claptrap. At the 1959 annual meeting of the Division of Economics, Philosophy and Law of the Academy of Sciences he expressed the following unflattering opinion of the contribution made by economists to the economic achievements of the USSR:

> How great is the role of economists in these achievements? The accumulation of practical experience in economics and planning has played a definite role here, but this has not been at all generalized by economic science.... In the forty-second year of the existence of the socialist state our economic science does not know precisely what the law of value means in a socialist society or how it should be applied. It does not know what socialist rent is, or whether in general there ought to be some calculations of the effectiveness of capital investment, and if so, just how. We are offered as the latest discovery in the field of economics, for example, the proposition that "the law of value does not govern but only influences," or that "the means of production are not simply commodities but commodities of a particular kind," and so on.[12]

The probable outcome of this co-operation with mathematicians is foreshadowed in one of Nemchinov's remarks in summing up the results of the volume on *The Application of Mathematics in Economic Research*. He warns:

> ... the chief peril in applying mathematical methods to economics is that the qualitative nature of the economic phenomena being studied falls into oblivion. In the winged expression of V. I. Lenin, directed at idealistic theories in physics and mathematics, the perversion of the role of mathematics both in natural sciences and social sciences is that in these theories matter disappears and only equations remain.[13]

Invoking that lost cause to defend Marxist prejudices against equations conveys a presentiment of defeat.

If our prognosis is right and these innovations are accepted after proper exegesis in Marxist terminology, they will only lead to further trouble. As explained earlier, these theories of value and allocation are still seriously deficient. They take as given some very important variables in the economic system, such as the composition of the final bill of goods and, as one aspect of this, the division of the national output into investment goods and consumption goods. To employ a distinction that played an important role in the development of Western economic thought, Kantorovich's and Novozhilov's theories are *cost* theories of value. In terms of Alfred Marshall's famous metaphor, they

[11] Summaries of some of the presentations at this conference, held in April, 1960, in Moscow, are given in *Вопросы экономики*, No. 8, 1960. The rebuke to Kantorovich is on page 122.

[12] *Вестник Академии Наук СССР*, No. 4, 1959, p. 60.

[13] *Применение математики в экономических исследованиях*, p. 478.

still imply that since one blade of the scissors is stationary (that is, that demand is given) it is the action of the other blade (cost or supply) that cuts the paper. They represent an advance over the more primitive labor-cost theory of value that Marx employed, but still fall short of complete generality.

One criticism directed by Soviet writers against Kantorovich's objectively determined valuations is that they are not absolute. One of the factors that "objectively determines" them is the composition of output, which is taken as the starting point. One of the speakers at the conference on mathematical methods in economics pointed out that whether or not the objectively determined valuations mean anything depends on the "correctness" of the output mix postulated as a constraint.[14] He further suggests that maybe mathematical methods could fruitfully be used in illuminating what the correct output mix is. There is great mischief latent in that line of attack. This is indeed a valid criticism of both Kantorovich's and Novozhilov's theories, but their limitation of the problem of allocation to one of efficient production of a predetermined output program is founded on good reasons. To make determination of the correct bill of goods part of the problem involves asking what production is for, and leads directly to the introduction of the subjective category of utility into the analysis. Ideologically, that would be an unforgivable affront.

Novozhilov's approach contains in addition a special snare that will sooner or later cause trouble. His work has a disarming appeal since it seems to conform to the labor theory of value. He starts from the proposition that the problem is to maximize the effectiveness of labor, which sounds unexceptionable to a Marxist. Moreover, all the elements of value, including the inversely related costs, are expressed in terms of units of labor. It thus scrupulously preserves labor as the *numéraire* in which value is measured. But the consistency with the labor theory of value is completely illusory. It makes no sense to formulate the problem as one of minimizing the labor input into a given bill of goods (or to put the same idea another way, of maximizing leisure). The real problem is to maximize leisure and output together. In the Soviet setting, especially, minimizing labor input is a ridiculous goal. Nor can this absurdity be rationalized by claiming that minimizing the labor input is equivalent to maximizing output, since labor saved can be used to expand output. In Novozhilov's method labor is minimized under the condition of using up all the other inputs with which it can be combined. This flaw in the formulation of the nature of the problem is bound to be discovered sooner or later.

Furthermore it is not difficult to imagine institutional situations in the Soviet economy where anyone trying to apply Novozhilov's method

[14] See the remarks by A. G. Aganbegian in the report of the conference on mathematical methods in economics in *Вопросы экономики*, No. 8, 1960, pp. 110-12.

of reasoning will have to take as the point of departure a fixed labor supply and formulate his problem as one of minimizing some other input. For instance, we might realistically pose the problem of agricultural planning as one of finding the minimum capital investment consistent with the size of the agricultural population and the assigned output goal. Or planners in the railroad branch of the economy might be assigned the goal of choosing the patterns of resource use that would minimize fuel inputs, with everything else held constant. In these situations the conformity of Novozhilov's reasoning with the labor theory of value vanishes. In any of these problems the opportunity costs would emerge in terms of the input to be minimized as *numéraire,* and one would end up with a "capital" theory of value or a "fuel" theory of value. These anomalies will never be put right until the bill of goods is entered as part of the variables to be determined, which means resort to the idealistic magnitude utility as part of the explanation.

The reconciliation of two true but contradictory theories (that is, a "fuel" theory of value and the labor theory of value) is only possible when they are recognized as special cases of a general theory under different assumptions; and in the theory of value and allocation this general theory must involve some conception of utility. Utility is the more general, abstract, common denominator into which all other explanations can be translated. The discovery of this general theory and the final collapse of the labor theory of value is by no means only a hypothetical danger. As a matter of fact, the other half of the theory of value—the theory of consumption—has already been worked out and published in the Soviet Union. This is a paper by A. A. Konius in a prestigious volume of essays published by the Academy of Sciences of the USSR in honor of the eightieth birthday of S. G. Strumilin.[15] The theory of consumption is just hanging in the air, waiting to be joined to what Novozhilov and Kantorovich have already done for the theory of production. When someone brings the two together, the rediscovery of Western value theory will be complete.

Konius poses the problem of finding the proper relationship of prices to labor input of different consumer goods for the purpose of minimizing the total labor input for a given level of what he calls vaguely "consumption." Actually the content he gives this vague term makes it identical with the "welfare" or "utility" of Western value theory. Incidentally, Konius' question is not one made up in the quiet of the professor's study but one that has long agitated those who plan the prices of consumer goods in the Soviet Union. The answer given by Western economists to this question appears in every elementary

[15] *Вопросы экономики, планирования и статистики* (Moscow: Издательство Академии Наук СССР, 1957). The article by Konius is entitled «Теоретические вопросы цен и потребления в работах С. Г. Струмилина и пути их дальнейшего исследования.»

economics textbook as "prices should be proportional both to the marginal rates of substitution and the marginal rates of transformation of the goods in question." Not being accustomed to consulting this kind of source for answers to questions of socialist political economy, Konius enlisted the aid of a professor of mathematics (duly thanked in a footnote) and worked out the answer himself. Not surprisingly, he came to the same conclusion. Neither will it be a surprise to the economist that Konius could demonstrate his proposition only by specifying some assumptions about the nature of the "consumption" he was talking about. Specifically, his proof depends on the postulation of the familiar ordinal utility function or preference surface of Western economics. This assumption is there in the relatively inconspicuous form of some equations, it is true, but it is there.

Conclusion

Konius' case can serve as the thesis for our summary. The search for theoretical clarification of almost any important economic issue will ultimately require the elaboration of normative models regarding allocation of resources and conceptions of value, and these two problems ultimately merge. The rigor and power of mathematics is almost essential for describing and investigating such models, and there is thus great pressure in any science to employ mathematics. It will be difficult for economics to escape this pressure. As one indication, Nesmeyanov, the president of the Academy of Sciences, has admonished economists to make theirs a "real science" by using mathematics and modern computational technology.[16] But when one sits down with a mathematician, as Konius did, to demonstrate a general line of argument, the mathematician's role can only be to check whether the intuitively felt conclusion does or does not follow from the assumptions, or what assumptions might be required to prove it. As the mathematician A. N. Kolmogorov remarked in a speech at the conference on mathematical methods in economics, the advantage of having mathematicians and economists co-operate with each other is that the mathematicians force the economists to define more carefully some of their fuzzy conceptions.[17] If the conclusions are given and the task of economic science is to defend them, as Boiarskii claims in his review of Kantorovich, then it might be better to leave the conceptions fuzzy. But the really novel circumstance in the Soviet Union today is that this is no longer an adequate interpretation of the task of economic science. The planners feel so strongly the need for improvements in calculation and allocation that they must discover a more sophisticated theory of value than that willed them by Marx. It is to this end that they have delivered themselves into the hands of the mathematicians.

[16] In a speech at the 21st Congress of the Communist Party quoted in *Применение математики в экономических исследованиях*, p. 3.

[17] *Вопросы экономики*, No. 8, 1960, p. 114.